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Management of Degenerative Knee Disease With Bone Marrow Aspirate Concentrate and Intermittent Platelet-Based Therapy: Nearly Nine Years of Follow-Up

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Abstract

Meniscal injury and degenerative knee disease are common causes of chronic pain and functional limitation. Although bone marrow aspirate concentrate (BMAC) and platelet-based therapies have been investigated as nonsurgical treatment options, long-term clinical outcomes remain insufficiently characterized.

We report the nearly nine-year clinical course of a 45-year-old male with longstanding bilateral knee pain, a left medial meniscal tear with an associated parameniscal cyst, and bilateral patellofemoral degenerative changes documented on serial pre-treatment magnetic resonance imaging. Before treatment in December 2017, the patient reported severe activity-related pain (approximately 9/10) and walking tolerance of approximately 0.2 miles. He underwent an initial bone marrow-based orthobiologic intervention involving BMAC, followed by super-concentrated platelet (SCP) and platelet lysate (PLM) treatment and subsequent periodic SCP/PLM maintenance injections.

The patient retrospectively reported progressive symptomatic improvement during the first nine months. At nearly nine years, immediately before his September 2026 maintenance injection, he verbally reported a pain intensity of 0/10 during routine daily activities. He reported walking approximately 2.4 miles daily, the ability to walk up to five miles, and an estimated 95% overall improvement.

Interpretation is limited by retrospective outcome assessment, the absence of post-treatment imaging, repeated maintenance injections, and substantial weight reduction of approximately 25%. This case illustrates sustained patient-reported functional improvement during a longitudinal orthobiologic treatment regimen but cannot establish treatment-specific efficacy or structural regeneration. Prospective studies incorporating standardized functional assessments, serial imaging, and documentation of concurrent interventions are needed.

Categories: Sports Medicine, Physical Medicine & Rehabilitation, Orthopedics
Keywords: bone marrow aspirate concentrate, chondromalacia, degenerative knee disease, knee pain, long-term follow-up, meniscal injury, orthobiologics, platelet lysate

Introduction

Meniscal injury and knee osteoarthritis can result in chronic pain, progressive functional limitation, and impaired quality of life [1,2]. According to the American Academy of Orthopaedic Surgeons (AAOS) clinical practice guidelines, exercise therapy, including supervised, unsupervised, or aquatic exercise, is strongly recommended to improve pain and function in patients with knee osteoarthritis. Sustained weight loss is also recommended for patients with overweight or obesity to improve clinical outcomes [1]. Similarly, the 2019 Osteoarthritis Research Society International (OARSI) guidelines identify patient education, structured land-based exercise, and dietary weight management combined with exercise as core treatments for knee osteoarthritis [3].

Orthobiologic approaches, including platelet-rich plasma (PRP) and preparations derived from bone marrow aspirate, have increasingly been investigated as nonsurgical treatment strategies for musculoskeletal pathology. Bone marrow aspirate may be processed to produce bone marrow aspirate concentrate (BMAC), containing heterogeneous nucleated cell populations and other biologically active components, while platelet products provide concentrated platelets and associated growth factors. Clinical studies of BMAC for knee osteoarthritis have evaluated pain and functional outcomes using standardized assessment instruments [4]. The AAOS clinical practice guidelines state that PRP may reduce pain and improve function in patients with symptomatic knee osteoarthritis, although this recommendation is supported by limited-strength evidence. In contrast, the guidelines do not provide a specific recommendation for BMAC, reflecting uncertainty surrounding its role in routine clinical management [1].

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We present the nearly nine-year clinical course of a patient who was 45 years old at the time of treatment, with longstanding bilateral knee symptoms, imaging-confirmed medial meniscal injury, and progressive degenerative changes. The patient underwent bilateral bone marrow-based orthobiologic treatment, followed by intermittent treatment with super-concentrated platelets and platelet lysate.

This case highlights the importance of documenting repeated treatments, concurrent interventions, weight changes, and functional outcomes when interpreting long-term clinical improvement. Given the multiple interventions and lifestyle changes during follow-up, the observed improvement cannot be attributed to the initial BMAC intervention alone.

Case Presentation

Clinical history

A 45-year-old male with a longstanding history of bilateral knee pain reported the onset of shooting knee pain around 2003. An intra-articular corticosteroid injection provided symptomatic relief. Bilateral knee pain subsequently recurred, and podiatric evaluation identified bilateral pes planus. Removable shoe insoles reportedly reduced his symptoms.

Clinical examination in January 2012 documented bilateral medial joint line tenderness and crepitus, without joint effusion. Both knees demonstrated a range of motion of 0-120°, preserved flexion and extension strength (5/5), and stability to varus, valgus, anterior, and posterior stress testing. Lachman testing was negative bilaterally. Gait and lower-extremity muscle bulk were normal.

During the subsequent years, the patient experienced progressive knee pain. He recalled a marked exacerbation after jumping from a small height and landing on both feet. Although he associated this event with worsening symptoms, a causal relationship between this event and the subsequently identified meniscal pathology cannot be established.

Conservative management before orthobiologic treatment included shoe insoles, topical analgesic preparations, lifestyle modification, and one prior intra-articular corticosteroid injection. The patient reported that structured physiotherapy was not recommended by his treating physicians because of his bilateral pes planus and existing degenerative knee changes. He continued using removable shoe insoles throughout follow-up because his pes planus persisted. Regarding oral supplements, the patient reported taking vitamin D supplementation beginning around 2008-2009 and continuing throughout follow-up. He did not recall being advised to take other supplements, including glucosamine or chondroitin.

Alternative sources of knee pain should also be considered, including referred pain from hip and spinal pathology. Femoral head avascular necrosis may present with nonspecific musculoskeletal symptoms, while cervical spondylotic myelopathy has been reported as an underlying cause of persistent knee pain [5,6]. Although pre-treatment MRI demonstrated meniscal and patellofemoral abnormalities in the present patient, comprehensive hip and spine examination findings were not available for review. Therefore, alternative sources of knee pain could not be definitively excluded.

Imaging

2012 MRI

MRI of the left knee performed in February 2012 for left-greater-than-right knee pain demonstrated horizontal abnormal signal involving the posterior horn and body of the medial meniscus extending toward the inferior articular surface and root attachment fibers. Associated parameniscal cyst formation was present.

Patellar-apex cartilage demonstrated chondral irregularity without significant thinning or full-thickness defect. Subcortical marrow edema at the patellar apex and a small joint effusion were also present.

2015 MRI

Repeat left-knee MRI in April 2015 was directly compared with the 2012 imaging. The horizontal posterior-horn medial meniscal tear persisted, with a small parameniscal cyst adjacent to the root.

The patellar articular cartilage demonstrated persistent and slightly worsening thinning and irregularity, with mild subarticular degenerative change. The radiologist concluded that there were slightly worsening degenerative changes of the patellofemoral compartment.

Thus, serial pre-treatment imaging demonstrated persistence of the medial meniscal pathology together with interval progression of patellofemoral degenerative and cartilage abnormalities between 2012 and 2015.

2017 Bilateral MRI

Bilateral knee MRI performed in November 2017, approximately three weeks before the index intervention, provided the immediate pre-treatment imaging assessment.

Left knee MRI demonstrated a persistent oblique horizontal tear extending to the inferior surface of the posterior horn of the medial meniscus, with an associated multiloculated parameniscal cyst dissecting medially and laterally along the medial collateral ligament. Grade III chondromalacia patella and chronic patellar tendinosis were also present. The radiologist described the focal patellar degenerative change as without significant progression compared with the 2015 examination.

The medial meniscal abnormality, patellofemoral cartilage changes, and parameniscal cyst are illustrated in Figure *1*.

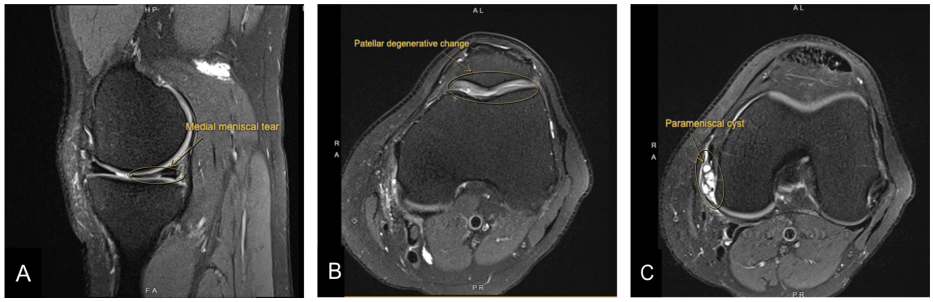


FIGURE 1: Representative pre-treatment MRI findings of the left knee.

Representative pre-treatment magnetic resonance imaging findings of the left knee obtained in November 2017. (A) Coronal image demonstrating the medial meniscal abnormality corresponding to the previously documented tear. (B) Axial image showing patellofemoral degenerative changes. (C) Axial image demonstrating a parameniscal cyst. Annotated regions indicate the relevant findings.

Right knee MRI demonstrated no apparent meniscal tear. Grade IV chondromalacia patella at the apex was present, together with chronic distal quadriceps and proximal patellar tendinopathy with ossicle formation. The radiologist reported no significant change compared with the April 2015 examination.

Although the parameniscal cyst may have contributed to the patient's medial knee symptoms, the available procedural documentation does not specify whether the cyst was subsequently aspirated or directly injected.

The patellofemoral cartilage abnormality and patellar tendinopathy with associated ossicle formation are illustrated in Figure *2*.

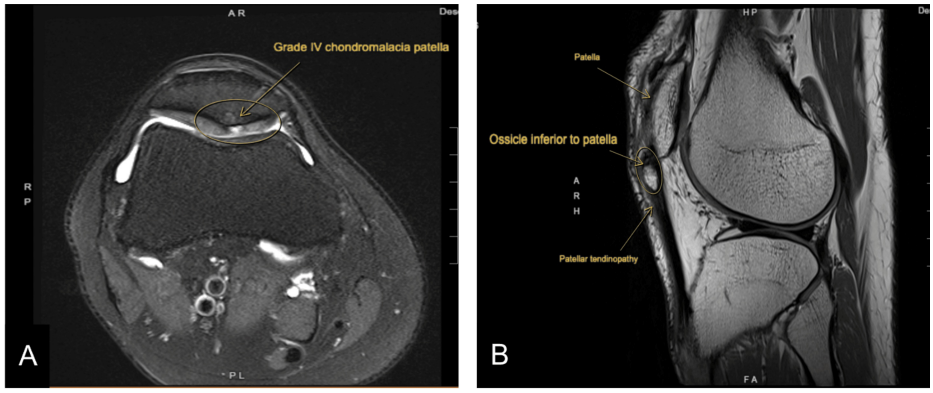


FIGURE 2: Representative pre-treatment MRI findings of the right knee.

Representative pre-treatment magnetic resonance imaging findings of the right knee obtained in November 2017. (A) Axial image demonstrating patellofemoral cartilage abnormality corresponding to the reported grade IV chondromalacia at the patellar apex. (B) Sagittal image demonstrating proximal patellar tendinopathy with associated ossicle formation as described in the radiology report.

The chronology of the initial orthobiologic intervention, subsequent maintenance treatments with super-

concentrated platelets and platelet lysate, and patient-reported clinical outcomes is summarized in Table 1.

Date	Imaging or intervention	Clinical outcome
2003	—	Onset of recurrent knee pain
February 2012	Left-knee MRI	Medial meniscal tear with parameniscal cyst and patellar chondral abnormality
April 2015	Repeat left-knee MRI	Persistent meniscal tear with worsening patellofemoral degenerative changes
November 2017	Bilateral pre-treatment MRI	Left medial meniscal tear, parameniscal cyst, and grade III chondromalacia; right grade IV chondromalacia
December 2017	BMAC followed by SCP/PLM	Pre-treatment pain up to ~9/10; walking tolerance ~0.2 miles*
February 2018	Bilateral SCP/PLM treatment	—
March 2018 (~3 months after BMAC)	Follow-up period	~30% improvement*
March–June 2018 (3–6 months after BMAC)	Follow-up period	~60% improvement*
September 2018 (~9 months after BMAC)	Follow-up period	Near-complete improvement*
December 2021	Bilateral SCP/PLM treatment	—
July 2023	Bilateral SCP/PLM treatment	—
December 2024	Bilateral SCP/PLM treatment	—
September 2026	Repeat SCP/PLM	Pre-injection findings: Verbal pain rating of 0/10 during routine activity; reported walking ~2.4 miles/day and could walk up to ~5 miles/day.

TABLE 1: Timeline of imaging, interventions, and clinical follow-up.

BMAC: bone marrow aspirate concentrate; SCP: super-concentrated platelets; PLM: platelet lysate.

* Improvement percentages are retrospective patient-reported estimates rather than measurements obtained using a validated functional outcome instrument.

Pretreatment pain intensity, walking tolerance, and subsequent improvement percentages were based on retrospective patient recall rather than prospectively collected standardized assessments. Approximate follow-up intervals do not represent confirmed clinical visit dates. A dash (—) indicates that no corresponding outcome was documented.

Clinical progression before intervention

By December 2017, the patient retrospectively described bilateral medial knee pain reaching approximately 9/10 with prolonged activity, although he reported no pain at rest. Pain intensity was expressed using a 0-10 numerical rating, a method described in the literature [7].

He recalled previously being able to walk approximately 2.4 miles. The patient retrospectively reported that, before treatment, knee pain limited his walking tolerance to approximately 0.2 miles.

The left knee was reported to be symptomatically worse. Pre-treatment MRI demonstrated different structural pathology between the knees, with a persistent medial meniscal tear and grade III chondromalacia

patella on the left and grade IV chondromalacia patella without an apparent meniscal tear on the right.

Intervention

In December 2017, the patient underwent bilateral bone marrow-based orthobiologic treatment.

On the first day of the December 2017 treatment sequence, both knees received a pre-injection proliferative solution through a suprapatellar approach. The prepared solution consisted of 2 mL of 50% dextrose, 2 mL of 0.2% ropivacaine, and 4 mL of normal saline (total prepared volume: 8 mL; final dextrose concentration: 12.5%). The volume administered to each knee was not documented.

On the second day, bone marrow aspiration was performed from the posterior iliac/posterior superior iliac spine (PSIS) region under fluoroscopic guidance. Four landmarks were identified along the posterior superior iliac spine. A total of 90 mL of bone marrow aspirate was obtained, comprising 50 mL from the left and 40 mL from the right.

The aspirate was processed to produce BMAC using a proprietary concentration methodology, the specific technical details of which were not disclosed. The final BMAC preparation volume was 6 mL. Laboratory records documented a reported concentration factor of 15-fold, cell viability of 92%, and a cell count of 4.47 × 10^8 cells (447 million cells) for the entire preparation. The specific cell population represented by this count was not identified in the available laboratory records. As BMAC contains a heterogeneous population of cells, the reported count should not be interpreted as a mesenchymal stromal cell count. Detailed processing parameters, including centrifugation steps, were not available for review.

Approximately three to four hours after aspiration, the patient returned for fluoroscopy-guided administration of the BMAC preparation. Using a 25-gauge, 3½-inch spinal needle, 3 mL of BMAC was administered to each knee. Documented injection targets included the right upper patellar region, left upper patellar region, and left medial meniscus. The specific region of the left medial meniscus targeted and the distribution of the 3 mL between the left-sided injection sites were not documented. No immediate procedural complications were documented, and the patient was provided with knee bracing and crutches.

On the third day, the patient underwent bilateral treatment with super-concentrated platelets (SCP) and platelet lysate (PLM), derived from a platelet preparation with a reported 16-fold concentration factor. The specific platelet-processing methodology was proprietary and was not disclosed. Absolute platelet counts, leukocyte content, platelet activation or lysis methods, and injection volumes per knee were not available in the reviewed procedural records. The platelet products were administered intra-articularly through a suprapatellar approach. No immediate complications were documented.

An additional bilateral SCP and PLM treatment was performed in February 2018.

Clinical course and long-term follow-up

Following treatment, the patient used crutches and knee bracing and participated in progressive walking and rehabilitation.

Early functional improvement was assessed retrospectively based on patient recall. The patient estimated approximately 30% overall improvement by three months, approximately 60% improvement between three and six months, and near-complete improvement by approximately nine months after treatment. No major treatment-related complications were documented in the available records. The patient retrospectively reported brief, mild injection-site pain following BMAC and platelet-based injections, lasting approximately 15-20 minutes.

During subsequent long-term follow-up, the patient reported no major reinjury and underwent no knee surgery. He continued periodic clinical follow-up. Following the December 2017 index treatment and additional SCP and PLM treatment in February 2018, subsequent SCP and PLM treatments were performed in December 2021, July 2023, December 2024, and September 2026.

According to the treating physician, subsequent bilateral SCP/PLM injections were administered periodically as maintenance therapy, with the intention of providing additional platelet-derived growth factors as part of the ongoing treatment strategy. Standardized pain assessments were not consistently documented before maintenance injections. The patient reported that knee symptoms became more noticeable when longer intervals elapsed between treatments, particularly when approximately three years had passed, which also contributed to subsequent repeat treatments at shorter intervals.

No post-treatment knee MRI or other post-treatment imaging was available for review.

Current clinical status

At clinical assessment immediately before the September 2026 bilateral SCP and PLM treatment, approximately eight years and nine months after the initial December 2017 intervention and approximately 21 months after the previous platelet-based treatment in December 2024, the patient verbally reported a pain intensity of 0/10 during routine daily activities when assessed by the treating physician.

The patient reported currently walking approximately 2.4 miles daily and estimated that he could walk approximately 5 miles when necessary. He reported being able to climb two flights of stairs repeatedly and continued to exercise at the gym. After exceptionally prolonged walking of approximately five to six hours, he reported knee pain of approximately 3-4/10. Leg-extension exercise could also provoke knee pain.

He denied current swelling, locking, catching, or giving way and reported no regular requirement for analgesic medication. He estimated his current overall improvement at approximately 95% compared with his condition immediately before the 2017 intervention. A prior follow-up assessment documented a pain score of 3/10; the specific assessment method could not be confirmed.

Weight change

Weight reduction was recommended by the treating physician as part of the long-term management strategy, with the aim of reducing mechanical loading on the knee joints and potentially improving symptoms and function.

The patient's reported weight decreased from approximately 216 lb in January 2018 to 184 lb by March 2024 and approximately 162 lb by September 2026, representing an overall reduction of approximately 54 lb, or 25% of his initial body weight. The patient reported achieving this weight reduction through dietary modification.

Given the established association between weight loss and improvement in knee osteoarthritis symptoms, this substantial reduction in body weight may have independently contributed to the patient's reported improvement in pain and walking tolerance.

Discussion

This case describes a prolonged period of favorable patient-reported pain and functional outcomes following an initial bone marrow-based orthobiologic intervention and subsequent intermittent treatment with SCP and PLM. The patient had longstanding bilateral knee symptoms, persistent medial meniscal pathology, and patellofemoral degenerative changes documented on serial pre-treatment MRI examinations.

The clinical improvement reported in this case is broadly consistent with published studies describing improvements in pain and function following BMAC treatment for knee osteoarthritis. A systematic review of eight randomized controlled trials involving 937 patients reported significant improvements from baseline following BMAC treatment. Although BMAC demonstrated statistically favorable pain outcomes compared with hyaluronic acid at certain follow-up intervals, these differences did not exceed the minimal clinically important difference, and BMAC did not demonstrate consistent superiority over other injectable therapies [4]. An earlier systematic review also reported improvements in pain and patient-reported outcomes following BMAC treatment but emphasized heterogeneity among studies and the absence of clear superiority over other orthobiologic treatments [8]. These findings provide clinical context but do not establish that BMAC was responsible for the improvement observed in this patient, particularly given the subsequent platelet-based treatments and concurrent lifestyle changes.

Evidence regarding platelet lysate is considerably more limited than that available for conventional PRP. An early prospective study of intra-articular autologous platelet lysate in patients with early-to-intermediate knee osteoarthritis reported improvements across multiple Knee Injury and Osteoarthritis Outcome Score (KOOS) domains through 52 weeks [9]. A subsequent review identified only three eligible clinical studies evaluating platelet lysate for knee osteoarthritis and reported potentially favorable pain and functional outcomes, while emphasizing the need for adequately powered controlled studies with longer follow-up [10]. The present case adds a longer period of clinical observation following intermittent platelet-based treatments; however, the repeated interventions and concurrent changes in weight and physical activity prevent attribution of the long-term outcome to any individual treatment.

A notable feature of this case is the availability of serial pre-treatment MRI examinations documenting persistent medial meniscal pathology and patellofemoral degenerative changes before treatment. However, the absence of post-treatment MRI prevents assessment of subsequent structural changes. Furthermore, degenerative MRI abnormalities do not necessarily correlate with symptom severity. Therefore, the reported improvements in pain and walking tolerance should be interpreted as clinical outcomes rather than evidence of meniscal healing or cartilage regeneration.

The observed clinical improvement should also be considered in the context of the natural history of knee osteoarthritis, regression to the mean, and placebo-related responses to intra-articular injections.

Longitudinal studies have demonstrated that knee osteoarthritis pain may follow variable trajectories, including periods of fluctuating symptom severity [11]. Regression to the mean may contribute to apparent improvement when treatment is administered during a period of heightened symptoms. Additionally, a systematic review and meta-analysis by Previtali et al., involving 73 studies and 5,895 patients, reported statistically and clinically significant improvements in pain and function following placebo intra-articular saline injections, particularly during the first six months of follow-up [12]. These findings highlight the importance of considering natural symptom variation and nonspecific treatment responses when interpreting outcomes following intra-articular interventions. Although these factors cannot be established as explanations for this patient's prolonged clinical course, they limit causal attribution to the initial BMAC intervention.

At the most recent assessment, approximately eight years and nine months after the initial intervention, the patient reported substantially improved functional status compared with his pre-treatment condition, including a verbal pain rating of 0/10 during routine daily activities and no subsequent knee surgery. These findings represent patient-reported clinical outcomes rather than independently verified evidence of sustained treatment efficacy.

However, causal interpretation requires considerable caution. The patient's long-term outcome cannot be attributed solely to the initial BMAC intervention because he received intermittent bilateral SCP and PLM treatments during follow-up. In addition, his body weight decreased by approximately 25% through dietary modification. The IDEA randomized clinical trial demonstrated that intensive dietary weight loss, particularly when combined with exercise, can improve pain and function in patients with knee osteoarthritis [13]. A systematic review also demonstrated that exercise therapy can improve pain and physical function in patients with knee osteoarthritis [14]. The patient's continued physical activity and gym participation therefore represent additional potential contributors to his reported functional improvement, although the independent effects of these activities cannot be determined. He also continued using removable shoe insoles for bilateral pes planus throughout follow-up. Continued orthotic use may have influenced lower-limb biomechanics, knee loading, and associated symptoms, representing another conservative co-intervention. Collectively, these factors complicate attribution of the favorable long-term clinical course to any individual treatment.

No major treatment-related complications were documented in the available clinical records. The patient retrospectively reported mild, pinching-type pain at the injection site following both BMAC and platelet-based injections, lasting approximately 15-20 minutes after each procedure. These symptoms were not assessed using a standardized pain scale, and contemporaneous documentation was unavailable. Other minor adverse events, including bone marrow aspiration-site discomfort, transient joint swelling, and post-injection inflammatory flares, were not systematically documented. A systematic review and meta-analysis found no significant difference in complication rates between BMAC and comparator injectable therapies for knee osteoarthritis [15].

The clinical outcome reflects a longitudinal treatment strategy consisting of an initial BMAC-based intervention followed by periodic SCP/PLM maintenance therapy, rather than the isolated effect of a single intervention. Consequently, the relative contributions of BMAC, subsequent platelet-based treatments, weight reduction, physical activity, continued orthotic use, and natural symptom variation cannot be determined. This case highlights the importance of systematically documenting repeated interventions, changes in body weight, physical activity and exercise patterns, and longitudinal outcomes using validated pain and functional assessment measures. Such comprehensive reporting is essential to distinguish treatment-associated improvement from potential confounding factors and to avoid attributing long-term clinical outcomes to a single intervention.

Limitations

This case report has several limitations. The absence of post-treatment MRI prevents assessment of structural changes in the menisci or articular cartilage. Although historical knee radiographs were documented, weight-bearing radiographs and sufficient information to assign a Kellgren-Lawrence grade or assess lower-limb alignment were unavailable. Furthermore, although physical examination findings from January 2012 were available, standardized knee examination findings immediately before the December 2017 intervention and during subsequent follow-up were not documented, limiting objective assessment of clinical changes over time.

The BMAC and SCP/PLM preparations involved proprietary processing methodologies, the specific technical parameters of which were not disclosed, limiting procedural reproducibility and independent evaluation. The cell population represented by the reported BMAC cell count was also unspecified. Furthermore, clinical outcomes were not assessed by an independent evaluator, introducing potential assessment bias. The interventions were performed in a commercial clinical setting, which should be considered when interpreting the reported outcomes.

Pretreatment pain intensity, walking tolerance, and early symptomatic improvement were based on retrospective patient recall, introducing potential recall bias. Serial validated outcome measures, such as the

KOOS or Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), were unavailable. Pain scores were documented at only two follow-up assessments, including a verbally reported pain intensity of 0/10 to the treating physician immediately before the most recent platelet-based injection. Assessment methods were not consistently documented, limiting evaluation of longitudinal pain trajectories and introducing potential reporting bias.

Repeated SCP/PLM treatments, substantial weight reduction, changes in physical activity, continued use of shoe insoles for bilateral pes planus, and natural symptom variation represent important potential confounding factors. The pre-injection solution contained ropivacaine, a local anesthetic for which concentration- and exposure-dependent chondrotoxicity has been demonstrated in experimental studies. However, ropivacaine at concentrations of 0.5% or lower has generally demonstrated lower chondrotoxicity than other commonly studied local anesthetics [16]. In the present case, 2 mL of 0.2% ropivacaine was incorporated into an 8-mL prepared solution, corresponding to a calculated final ropivacaine concentration of 0.05%. The effects of this preparation on articular cartilage and subsequently administered marrow-derived cells were not evaluated, and its clinical significance remains uncertain. As a single-patient observational report without a control group, this case cannot establish a causal relationship between the initial BMAC intervention and sustained symptomatic or functional improvement.

Conclusions

This case describes nearly nine years of follow-up after bilateral bone marrow-based orthobiologic treatment followed by intermittent therapy with SCP and PLM in a patient with longstanding knee pain, imaging-confirmed medial meniscal pathology, and degenerative patellofemoral changes. The patient reported substantial and sustained improvement in pain and function, no subsequent knee surgery, and a higher level of physical activity compared with his pre-treatment status. However, subsequent platelet-based treatments, substantial weight reduction, changes in physical activity, continued use of shoe insoles for bilateral pes planus, and natural symptom variation may have contributed to the favorable clinical course. Retrospective outcome assessment, the absence of standardized functional measures, and the lack of post-treatment imaging further limit interpretation. Symptomatic improvement cannot be considered evidence of meniscal healing or cartilage regeneration, and the independent contribution of the initial intervention cannot be determined.

Long-term prospective studies incorporating standardized patient-reported outcomes, serial imaging, detailed characterization of orthobiologic preparations, and documentation of subsequent interventions and lifestyle modifications are needed to better evaluate the durability of clinical outcomes. This case emphasizes the importance of interpreting long-term improvement in the context of the complete treatment course rather than attributing it to a single intervention.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Shravani Vanka, Venkatesh Movva

Drafting of the manuscript: Shravani Vanka

Critical review of the manuscript for important intellectual content: Shravani Vanka, Venkatesh Movva

Concept and design: Venkatesh Movva

Supervision: Venkatesh Movva

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** Dr. Venkatesh Movva is affiliated with RegenOrthoSport, a clinical practice that provides regenerative orthopedic and orthobiologic treatments, including interventions similar to those described in this case report. This professional relationship is disclosed for transparency regarding potential perceived conflicts of interest.

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