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One-Year Clinical Outcomes of GPS Leukocyte-Rich Platelet-Rich Plasma Injection for Kellgren-Lawrence Grade II and III Knee Osteoarthritis: A Real-World Case Series

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Research Article

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Abstract

Background

Knee osteoarthritis (OA) is a major cause of pain, impaired walking ability, locomotive dysfunction, and future care dependency in older adults. Although medication, intra-articular hyaluronic acid injection, and rehabilitation are commonly used, some patients have persistent symptoms and may ultimately require total knee arthroplasty. However, surgery may not be feasible or acceptable for older patients because of age, comorbidities, surgical risk, or personal preference.

Methods

This retrospective real-world case series evaluated 15 patients with symptomatic Kellgren-Lawrence (KL) grade II or III knee OA who underwent a single intra-articular GPS leukocyte-rich platelet-rich plasma (L-PRP) injection and completed baseline and 1-year assessments. Knee OA was evaluated using radiography and magnetic resonance imaging. Pain was assessed using the numeric rating scale (NRS), knee-related symptoms and function using the Knee injury and Osteoarthritis Outcome Score (KOOS), and locomotive function using the 25-question Geriatric Locomotive Function Scale. Patient satisfaction and adverse events were recorded. Paired baseline and 1-year outcomes were compared using Wilcoxon signed-rank tests.

Results

The cohort included 15 knees from 5 male and 10 female patients. Among men, 2 had KL grade II and 3 had grade III disease; among women, 7 had KL grade II and 3 had grade III disease. Mean NRS pain score improved significantly from 4.6 +/- 2.4 at baseline to 2.7 +/- 2.1 at 1 year (P = 0.015). The KOOS quality-of-life subscale also improved significantly (30.0 +/- 17.1 to 45.4 +/- 23.8; P = 0.010). A satisfaction score of 5 was reported by 74% of patients, and 81% reported a score of 4 or higher. Three patients reported transient injection-site pain; no serious adverse events occurred.

Conclusions

GPS L-PRP injection was associated with significant 1-year improvement in pain and knee-related quality of life in patients with KL grade II or III knee OA, with high satisfaction and no serious adverse events. These preliminary findings support GPS L-PRP as a potential self-funded nonoperative option for selected patients who wish to avoid or delay surgery.

Background

Knee osteoarthritis (OA) is one of the most common musculoskeletal disorders in older adults and is a leading cause of chronic pain, reduced walking ability, and loss of independence. In Japan, knee OA is also clinically important as a component of locomotive syndrome, which is associated with declining mobility and the future need for nursing care. The Research on Osteoarthritis/Osteoporosis Against Disability (ROAD) study demonstrated that radiographic knee OA is highly prevalent in older Japanese adults and frequently coexists with knee pain [1]. These epidemiologic characteristics make the development of nonoperative strategies for symptomatic knee OA particularly relevant in an aging society [1, 2].

The standard nonoperative management of knee OA includes patient education, exercise therapy and rehabilitation, weight management, analgesic or anti-inflammatory medication, orthoses, and intra-articular injections such as hyaluronic acid or corticosteroids [3–5]. When these treatments provide insufficient relief, total knee arthroplasty (TKA) may be considered. TKA is effective for end-stage disease, but not all patients are appropriate candidates or willing to undergo surgery. Advanced age, medical comorbidities, perioperative risk, patient preference, and the desire to preserve activities with nonoperative care may all influence treatment selection. Therefore, additional options that may reduce pain and improve patient-reported outcomes are needed for selected patients with symptomatic KL grade II or III knee OA.

Platelet-rich plasma (PRP) is an autologous biological treatment that contains concentrated platelets and bioactive mediators involved in tissue repair and inflammatory modulation. In knee OA, PRP is used as a nonoperative orthobiologic therapy intended to reduce pain and improve knee-related function. Several systematic reviews and meta-analyses have reported that PRP may provide symptomatic benefit compared with placebo or hyaluronic acid in selected patients, although the literature remains heterogeneous because PRP preparations, leukocyte content, injection protocols, comparators, and follow-up intervals vary widely [6–9]. Conversely, the RESTORE trial reported no significant benefit of PRP over placebo injection for knee symptoms or medial tibial cartilage volume, underscoring the need for careful patient selection and transparent reporting of PRP preparation methods [10].

The Zimmer Biomet GPS III system is a leukocyte-rich platelet-rich plasma (L-PRP) separation and extraction kit. According to manufacturer information, the GPS III STD kit uses 52 mL of autologous blood with 8 mL of ACD-A solution and yields approximately 6 mL of L-PRP after centrifugation at 3200 rpm for 15 minutes [12]. The Minimum Information for Studies Evaluating Biologics in Orthopaedics (MIBO) recommendations emphasize that PRP studies should report preparation systems, leukocyte content, dosing, and treatment protocols to improve reproducibility and interpretation [13].

In Japan, GPS L-PRP injection for knee OA is performed as a regenerative medicine treatment in selected clinical settings and is commonly provided as self-funded care. However, Japanese real-world data on 1-year patient-reported outcomes and satisfaction after GPS L-PRP injection remain limited. The purpose of this study was to evaluate 1-year clinical outcomes, patient satisfaction, and safety after a single GPS L-PRP injection in patients with KL grade II or III knee OA.

Methods

Study design and ethics

This was a retrospective real-world complete-case analysis conducted at a single orthopaedic hospital in Japan. The study was approved by the Maeda Hospital Ethics Committee (approval No. P-1). The questionnaire and study-related assessments were explained orally, and oral informed consent was obtained according to the approved institutional procedure. This study is reported as a case series and follows relevant observational study reporting principles.

Patients

Patients with symptomatic knee OA were evaluated by plain radiography (X-P) and magnetic resonance imaging (MRI). Patients with KL grade II or III knee OA who underwent initial GPS L-PRP injection and had paired baseline and 1-year clinical outcome data were included. Patients without complete paired baseline and 1-year follow-up data were excluded from the complete-case analysis.

GPS L-PRP preparation and injection

GPS L-PRP was prepared in the hospital using the Zimmer Biomet GPS III system. Peripheral venous blood was collected and processed by centrifugation in the institution. For the GPS III STD kit, the manufacturer describes a protocol using 52 mL of blood and 8 mL of ACD-A solution to obtain approximately 6 mL of L-PRP after centrifugation at 3200 rpm for 15 minutes [12]. The final L-PRP was injected intra-articularly into the affected knee under sterile clinical conditions. The procedure was performed as a self-funded regenerative medicine treatment.

Outcome measures

Clinical outcomes were assessed at baseline and 1 year after the initial GPS L-PRP injection. The primary outcome was change in NRS pain score. Secondary outcomes included KOOS domains scored using the standard transformation to a 0-100 scale, with higher scores indicating better knee-related status, and the 25-question Geriatric Locomotive Function Scale. Patient satisfaction was assessed using a 5-point scale, where 5 indicated the highest satisfaction. Adverse events were reviewed from clinical records and questionnaires.

Statistical analysis

Continuous variables are reported as mean +/- standard deviation or median with interquartile range as appropriate. Paired baseline and 1-year outcomes were compared using Wilcoxon signed-rank tests because of the small sample size. Paired t tests were also calculated as supplementary analyses.

Responder analysis was performed using > = 30% and > = 50% reduction in NRS pain score. Statistical significance was set at $P < 0.05$.

Results

The complete paired GPS cohort included 15 patients (15 treated knees) with baseline and 1-year outcome data. The cohort consisted of 5 male and 10 female patients. Among male patients, 2 had KL grade II and 3 had grade III disease; among female patients, 7 had KL grade II and 3 had grade III disease. Baseline characteristics and KL distribution are summarized in Tables 1 and 2.

Table 1
Baseline characteristics and KL distribution of the GPS cohort

Characteristic	Value
Patients / treated knees included in paired GPS analysis	15 / 15
Disease severity	Kellgren-Lawrence grade II-III knee osteoarthritis
Imaging evaluation	Plain radiography (X-P) and MRI
Treatment	Zimmer Biomet GPS III L-PRP injection
Age, years	70.7 +/- 14.6
Sex	Men 5; women 10
Men, KL grade II / III	2 / 3
Women, KL grade II / III	7 / 3
Total KL grade II / III	9 / 6
Ethics approval	Maeda Hospital Ethics Committee, approval No. P-1
Consent	Oral explanation and oral consent for questionnaire-based assessment

Table 2
Sex-specific Kellgren-Lawrence grade distribution

Sex	KL grade II	KL grade III	Total
Men	2	3	5
Women	7	3	10
Total	9	6	15

NRS pain score improved from 4.6 +/- 2.4 at baseline to 2.7 +/- 2.1 at 1 year. The mean change was − 1.9 points, and the improvement was statistically significant by Wilcoxon signed-rank test ($P = 0.015$). The

KOOS quality-of-life subscale improved from 30.0 +/- 17.1 to 45.4 +/- 23.8 (P = 0.010). Other KOOS domains showed numerical improvement but did not reach statistical significance. Paired outcome comparisons are shown in Table 3 and Figs. 2 and 3.

Table 3
Paired baseline and 1-year outcome comparison

Outcome	n	Baseline mean (SD)	1 year mean (SD)	Mean change	Wilcoxon P
NRS pain	15	4.6 (2.4)	2.7 (2.1)	-1.9	0.015
KOOS Pain	12	62.0 (12.0)	68.7 (20.6)	+ 6.7	0.065
KOOS Symptoms	12	68.8 (12.0)	72.4 (20.1)	+ 3.5	0.413
KOOS ADL	12	74.8 (15.6)	77.3 (20.2)	+ 2.5	0.443
KOOS Sport/Rec	12	31.3 (20.7)	40.7 (35.9)	+ 9.3	0.194
KOOS QOL	12	30.0 (17.1)	45.4 (23.8)	+ 15.4	0.010
Locomo25	12	58.4 (17.3)	51.5 (17.7)	-6.9	0.124

In responder analysis, 7 of 15 patients (46.7%) achieved a > = 30% reduction in NRS pain and 6 of 15 patients (40.0%) achieved a > = 50% reduction. Pain worsened in 2 of 15 patients (13.3%). The responder distribution is shown in Fig. 4.

Patient satisfaction was high: 74% of patients selected the highest satisfaction score of 5, and 81% selected a score of 4 or 5. Injection-site pain occurred in 3 cases. No serious adverse events were observed. Satisfaction and safety data are summarized in Table 4 and Fig. 5.

Table 4
Patient satisfaction and safety

Item	Result	Comment
Satisfaction score 5	74%	5 = highest satisfaction
Satisfaction score 4	7%	
Satisfaction score 3	9%	
Satisfaction score 2	8%	
Satisfaction score 1	2%	
Satisfaction score 4 or 5	81%	High satisfaction
Adverse event	Injection-site pain: 3 cases	Transient; no serious adverse events reported

Discussion

The principal finding of this real-world complete-case analysis was that a single initial GPS L-PRP treatment was associated with statistically significant improvement in NRS pain at 1 year in patients with KL grade II or III knee OA. KOOS quality of life also improved significantly, while other KOOS domains showed numerical improvement. Patient satisfaction was high, and no serious adverse events were observed.

The clinical rationale for evaluating GPS L-PRP in Japan is closely related to the epidemiology of knee OA and locomotive syndrome. Knee OA is highly prevalent in older Japanese adults, and the ROAD study highlighted the burden of radiographic knee OA and its association with knee pain [1]. Locomotive syndrome is a Japanese concept describing musculoskeletal decline that can lead to reduced mobility and future care dependency [2]. In this context, treatment strategies that may reduce pain and maintain activity are clinically relevant, particularly for patients who have not obtained sufficient benefit from medication, hyaluronic acid injection, and rehabilitation, but who are not ready or appropriate for TKA.

Current knee OA treatment is stepwise and individualized. Exercise therapy, rehabilitation, weight control, analgesics, nonsteroidal anti-inflammatory drugs, orthoses, and intra-articular injections are recommended as nonoperative treatments [3–5]. However, persistent pain and functional limitation remain common. Although TKA is an effective surgical option for severe OA, older patients may decline surgery or have comorbidities that increase perioperative risk. Therefore, GPS L-PRP may have a role as an additional nonoperative option for selected patients with KL grade II or III disease who wish to avoid or delay surgery.

The present results are broadly consistent with several systematic reviews reporting symptomatic benefit of PRP for knee OA. Laudy et al. found that PRP reduced pain more effectively than placebo and improved function in knee OA [6]. Dai et al. reported that PRP improved pain and function compared with control treatments in randomized trials [7]. More recent meta-analyses have suggested that PRP may compare favorably with hyaluronic acid for some pain and functional outcomes [8, 9]. However, these findings should be interpreted carefully because PRP products differ substantially in leukocyte content, platelet concentration, activation, injection number, and rehabilitation protocols.

At the same time, the PRP literature remains controversial. The RESTORE trial, a rigorous randomized placebo-controlled trial, found no significant improvement in knee symptoms or medial tibial cartilage volume with PRP compared with placebo injection [10]. Clinical practice guidelines also differ in how strongly they recommend PRP, reflecting uncertainty in the evidence base [11]. The present study does not resolve these controversies because it lacks a control group; instead, it provides preliminary Japanese real-world data on GPS L-PRP in a defined KL grade II or III population.

GPS L-PRP has several features that should be clearly reported in orthobiologic research. The GPS III system is a leukocyte-rich PRP device; the manufacturer describes the GPS III STD protocol as 52 mL of blood with 8 mL of ACD-A solution, centrifugation at 3200 rpm for 15 minutes, and collection of

approximately 6 mL of L-PRP [12]. Reporting these parameters is important because differences in PRP preparation may influence clinical effects and safety [13].

Patient satisfaction was high in this cohort, with 74% of patients selecting the highest score and 81% selecting a score of 4 or 5. This is clinically relevant because patient satisfaction is influenced not only by pain reduction but also by treatment expectations, avoidance of surgery, and the perceived value of self-funded regenerative medicine. The safety profile was favorable. Injection-site pain occurred in 3 cases, and no serious adverse events were observed. This is consistent with the expected safety profile of intra-articular PRP, in which transient post-injection pain or swelling may occur, but severe complications are uncommon when aseptic technique is used [12, 14, 15].

Limitations

This study has several limitations. First, this was a retrospective case series without a control group, placebo group, hyaluronic acid comparator, or rehabilitation-only comparator; therefore, causal efficacy cannot be established. Second, the sample size was small, and some secondary outcomes had fewer complete observations. Third, the study was conducted at a single institution, which may limit generalizability. Fourth, satisfaction may be affected by patient expectations and the self-funded nature of regenerative medicine. Fifth, structural outcomes such as cartilage volume or progression of radiographic OA were not assessed longitudinally. These limitations mean that the findings should be interpreted as preliminary real-world evidence rather than definitive proof of treatment efficacy.

Conclusions

In this real-world complete-case analysis, GPS L-PRP injection for KL grade II or III knee OA was associated with significant improvement in NRS pain and KOOS quality of life at 1 year, high patient satisfaction, and no serious adverse events. GPS L-PRP may be a feasible self-funded nonoperative option for selected patients with symptomatic knee OA who wish to avoid or delay surgery. Further controlled studies with larger cohorts and standardized PRP characterization are needed.

Abbreviations

ACD-A
acid citrate dextrose solution A
ADL
activities of daily living
JOSR
Journal of Orthopaedic Surgery and Research
KL
Kellgren-Lawrence
KOOS

Knee injury and Osteoarthritis Outcome Score
L-PRP
leukocyte-rich platelet-rich plasma
MRI
magnetic resonance imaging
NRS
numeric rating scale
OA
osteoarthritis
PRP
platelet-rich plasma
TKA
total knee arthroplasty
X-P
plain radiography.

Declarations

Ethics approval and consent to participate

This study was approved by the Maeda Hospital Ethics Committee (approval No. P-1) and was conducted in accordance with the principles of the Declaration of Helsinki. The questionnaire and study-related assessments were explained orally to all participants. Oral informed consent was obtained from all participants according to the protocol approved by the Maeda Hospital Ethics Committee, and the requirement for written informed consent was waived by the ethics committee.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request, subject to institutional ethics approval, patient privacy protection, and applicable regulations.

Competing interests

The authors declare that they have no competing interests related to this study.

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Authors' contributions

HM conceived and designed the study, supervised clinical data collection, interpreted the data, and drafted the manuscript. TM and MM contributed to data acquisition, interpretation, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

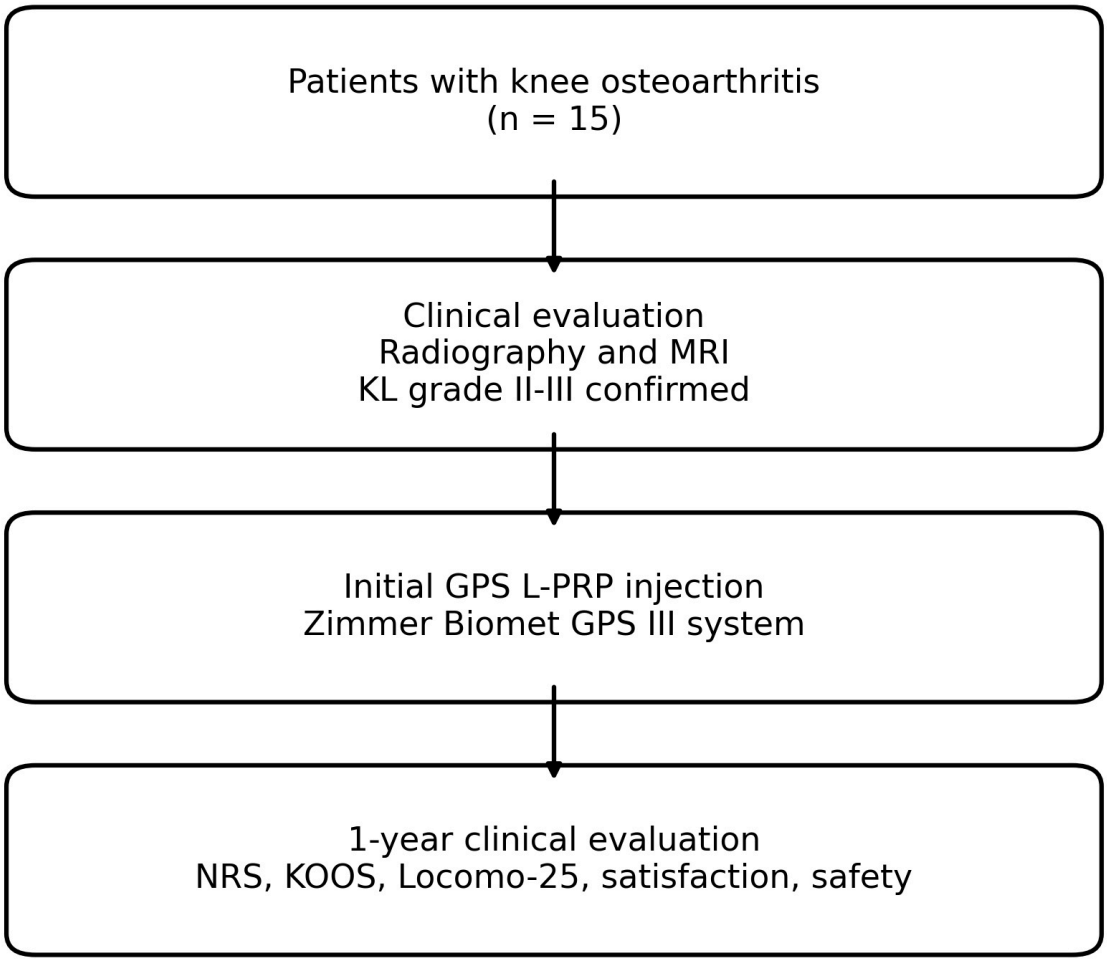


Figure 1

Study flow diagram for the GPS L-PRP cohort. Patients with symptomatic knee osteoarthritis were evaluated with radiography and magnetic resonance imaging, treated with initial GPS L-PRP injection, and reassessed at 1 year.

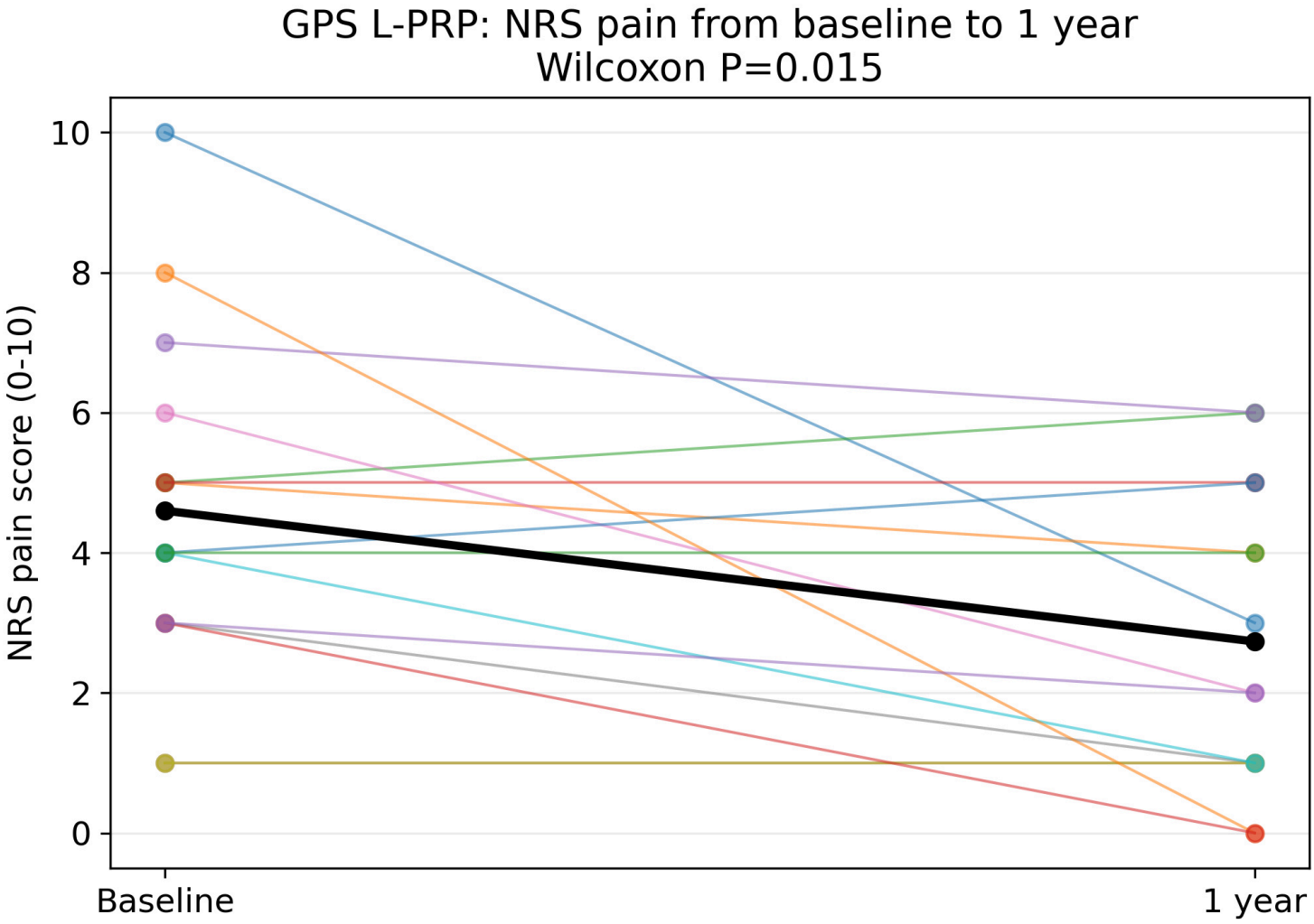


Figure 2

Paired change in numeric rating scale pain score from baseline to 1 year after GPS L-PRP injection. The thick line indicates the cohort mean. Wilcoxon signed-rank test, P = 0.015.

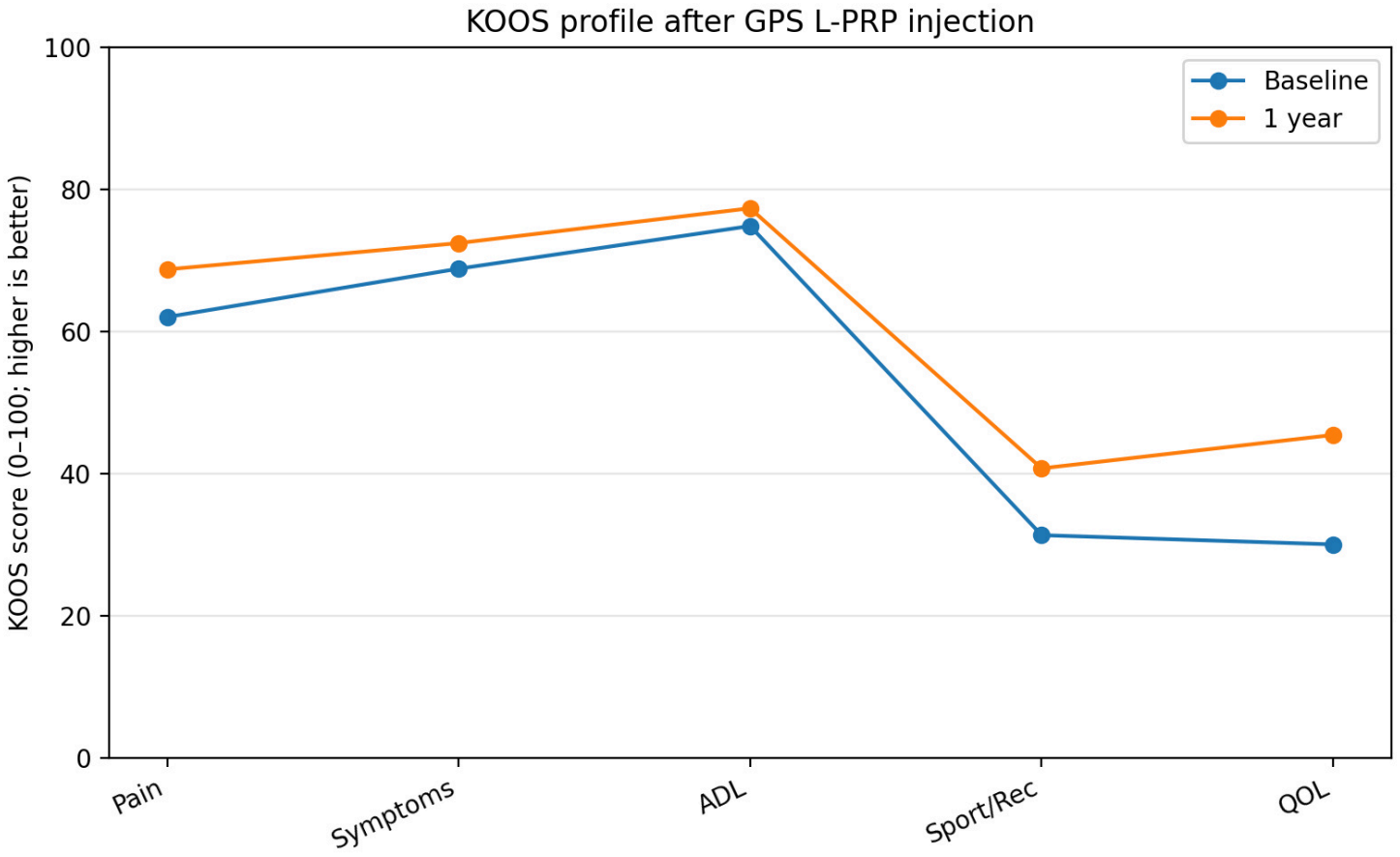


Figure 3

KOOS domain scores at baseline and 1 year after GPS L-PRP injection. Scores are presented on a 0-100 scale, with higher scores indicating better knee-related status.

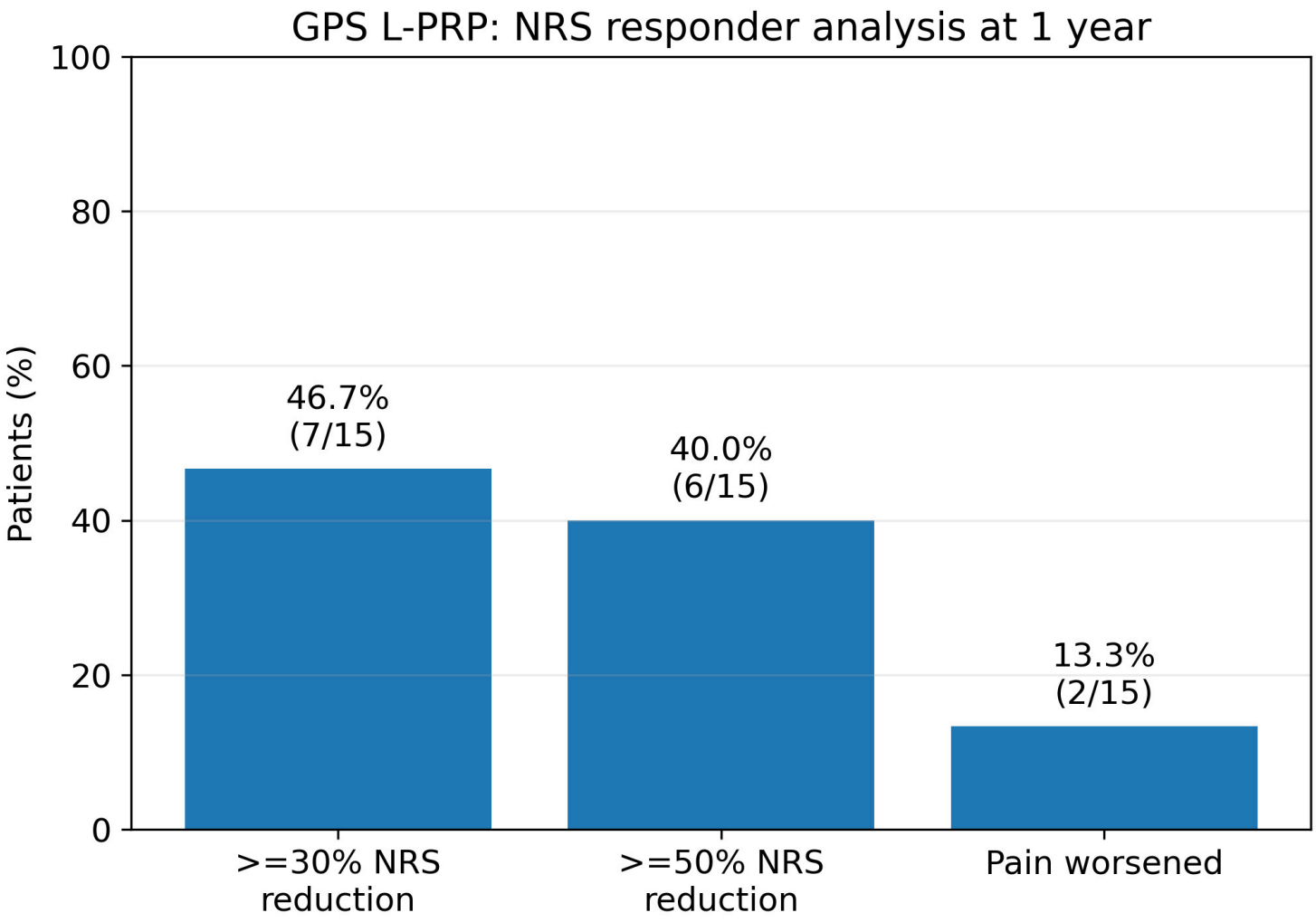


Figure 4

Responder analysis based on percentage reduction in numeric rating scale pain score at 1 year after GPS L-PRP injection.

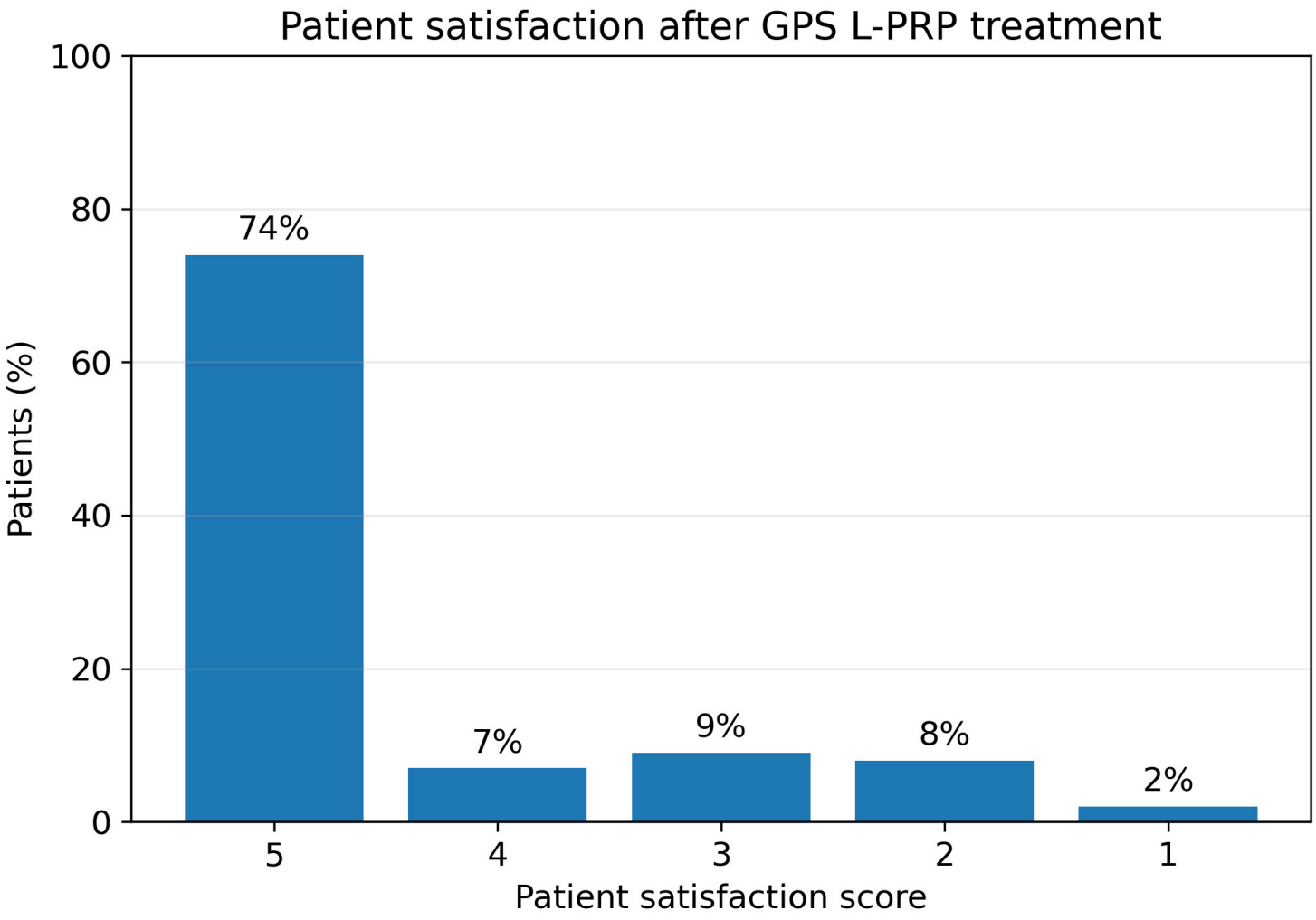


Figure 5

Patient satisfaction distribution after GPS L-PRP treatment. A satisfaction score of 5 was reported by 74% of patients, and a score of 4 or higher was reported by 81%.

Supplementary Files

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