ANNALS OF MEDICINE
2025, VOL. 57, NO. 1, 2524091
https://doi.org/10.1080/07853890.2025.2524091

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Comparative efficacy of platelet-rich plasma injection vs ultrasound-guided hyaluronic acid injection in the rehabilitation of hip osteoarthritis: an observational study

Guangjun Bian[a], Wei Zhao[b*] and Li Zhang[c]

[a]Department of Imaging, The First People's Hospital of Lianyungang, Lianyungang, Jiangsu Province, China; [b]Department of Orthopedic, Weifang Medical University, Weifang, Shandong, China; [c]Second Department of Orthopedics, Rehabilitation Hospital Affiliated to National Research Center for Rehabilitation Assistive Devices, Beijing, China

ABSTRACT

Background: Intra-articular platelet-rich plasma (PRP) injections have been the subject of extensive study in knee osteoarthritis (OA), yet their effectiveness in hip OA has not been explored.
Objective: To assess and evaluate the therapeutic effectiveness of autologous PRP and hyaluronic acid (HA) in treating hip OA.
Methods: Intra-articular injections were administered to 150 patients with hip osteoarthritis, and the patients were divided into two groups: PRP and HA. The evaluation of clinical outcomes was conducted using the Harris Hip Score (HHS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Visual Analogue Scale (VAS) at 3, 6, and 12 months. Outcomes were compared using regression analysis, repeated measure ANOVA, and Pearson correlation test.
Results: The PRP group showed greater improvements in all scores ($p < 0.05$) compared to HA. PRP injection significantly reduced VAS and WOMAC scores [VAS score (MD 2.238, 95% CI 0.065-3.21) and WOMAC score (MD 1.033, 95% CI 0.06-1.526)], while HHS score increased (MD 1.02, 95% CI 0.06-1.126). IL-10 and VAS score showed a moderate correlation in the PRP group ($r = 0.591$). While statistical significance is indicated by the results, it is suggested that the changes in scores are small and may not be representative of any clinical significance.
Conclusion: It has been demonstrated by the findings of this study that pain and joint discomfort may be decreased by the administration of PRP injections, which may aid in the management of hip OA. However, there was no clinical difference between PRP and HA treatments.

Abbreviations: PRP: Platelet-rich plasma; HA: Hyaluronic acid; VAS: Visual Analog Scale; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; HHS: Harris Hip Score

ARTICLE HISTORY
Received 4 September 2023
Revised 9 June 2025
Accepted 10 June 2025

KEYWORDS
Hip osteoarthritis; hyaluronic acid (HA); intra-articular injections; pain; platelet-rich plasma (PRP)

Introduction

Osteoarthritis (OA) is a condition characterized by joint pain and dysfunction due to the degradation of joints under continuous mechanical stress [1]. It predominantly impacts the elderly and occurs more frequently than other joint disorders. Osteoarthritis is observed with greater frequency in the knee and hip joints [2]. Hip osteoarthritis impacts approximately 7 to 25% of Caucasian individuals aged 55 and older [3]. The management of osteoarthritis involves weight reduction, activity modification, exercise, and the initial use of NSAIDs, which may be further supported by intra-articular injections of corticosteroids or hyaluronic acid to alleviate symptoms. However, these treatments do not produce lasting effects on symptoms [4–11].

The function of cartilage regeneration is attributed to platelet alpha-granules [12]. As a result, growing interest has been observed in the use of platelet-rich plasma (PRP), which is characterized by an increased presence of platelets and granules that contribute to cartilage repair. Autologous plasma is composed of PRP, which contains platelet concentrations that exceed the baseline [13]. Additionally, a high amount of growth

CONTACT Li Zhang zhangli2022osteo@gmail.com Second Department of Orthopedics, Rehabilitation Hospital Affiliated to National Research Center for Rehabilitation Assistive Devices, No. 76, Yanta West Road, Beijing 100176, China.
*Wei Zhao is now affiliated to Department of Orthopedic, Xiongan Xuanwu Hospital,No.1 Xili Road, Boot Pilot Area, Xiongan New Area 070001, China
Supplemental data for this article can be accessed online at https://doi.org/10.1080/07853890.2025.2524091.
© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

factors, including IGF-1, TGF-, EGF, PDGF, VEGF, and FGF, is present, all of which possess anabolic capabilities [14–16]. Cytokines and immunomodulatory bioactive molecules are also contained within it, which can inhibit inflammatory and catabolic compounds [17]. The efficacy of PRP intra-articular injections in treating knee osteoarthritis has been studied [18,19]. It was found that PRP injections led to improvements in osteoarthritis symptoms during these trials. In a similar manner, limited studies regarding the role of PRP in the treatment of hip OA have been conducted [20–22].

The crucial intervention of rehabilitation is aimed at supporting individuals in the recovery, sustenance, or improvement of essential skills needed for daily functioning. Consequently, it is deemed imperative that a viable rehabilitation approach is present. The aim of this study was to evaluate and compare the effectiveness of ultrasound-guided injections of PRP and hyaluronic acid (HA) in the rehabilitation of patients with hip OA. The improvement in several pain scores was assessed in the study, including visual analog scale (VAS) scores, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, and Harris Hip Score (HHS).

The null hypothesis was proposed by the researchers, indicating that no significant difference exists in terms of WOMAC score, Harris Hip Score, and VAS at different levels of follow-up in PRP and HA group.

Materials and method

Study design

Patients aged over 18 years who were admitted to the outpatient clinic due to joint pain and diagnosed with hip OA were included in this observational study. The 150 patients who were initially evaluated were treated conservatively with intra-articular injections from August 2018 to March 2021. A minimum follow-up period of 12 months was established for the study. The ethical standards set forth by the institutional and/or national research committee of The First People's Hospital of Lianyungang were adhered to in the research conducted on human participants. The study received approval from the ethic committee of 'Lianyungang University,' with approval number SDGHDX20180722DX. Informed consent for the use of their information in scientific studies was provided by all patients who received intra-articular injections.

Sample size calculation

The sample size is calculated as 186 using the following formula:

$$\text{Sample size}(n) = Z2^{*} p(1-p) / e2$$

Here, e = margin of error, p = population proportion, $Z = Z$ score.

Participants

A total of 186 patients was considered for inclusion in the current study. After the review, exclusions were made for 36 individuals: 15 did not meet the inclusion criteria, 11 chose not to participate, 5 received intra-articular corticosteroid treatment, 3 had systemic disease, and 2 had a history of bleeding conditions. Before intra-articular hip injections were administered, information about the PRP and HA treatments was provided to patients, and the injectable agent was selected based on each patient's preference. Each patient was administered a single dose of HA and PRP during the course of the study. To alleviate pain, it was advised that activity be limited, rest be taken, and cold compresses be applied for a duration of 24 h following the administration of these injections for patients in both groups. Until 6 months prior to this one, no other injections had been administered to any of the patients. During the trial, no further treatments were utilized, aside from the therapies specified.

Inclusion exclusion criteria

The following inclusion and exclusion criteria had to be fulfilled by patients to be included in the study sample (as listed in Table 1). The criteria for inclusion are as follows: Individuals aged over 18 years, diagnosed with hip OA classified as Grades 1 to 4 on the Kellgren Lawrence scale, were required to have a baseline pain level of at least mild intensity, indicated by a score exceeding 20 out of 100 on a 100-mm visual analog scale. Additionally, participants were those who had not shown a response to pharmaceutical interventions, including 500 mg of paracetamol, topical ibuprofen, and proton pump inhibitors. Intra-articular injections were considered for patients with persistent complaints. NSAIDs or pain killers and non-drug treatments such as transcutaneous electrical nerve stimulation and laser were prohibited for the included patients, with cessation occurring at least 48 h prior to the assessment. The error in the assessment of the patients was avoided due to confounding factors. The exclusion criteria are outlined as follows: patients who are less than 18 years of age; those who have undergone osteotomy of the hip or osteochondroplasty; individuals with extensive deformity in the hip area; patients diagnosed with rheumatoid arthritis; those with systemic diseases such

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Individuals aged above 18 years
	Hip osteoarthritis with Grades 1–4 on Kellgren Lawrence scale
	Pain intensity on a visual analogue scale >20
	Failure of pharmacologic treatment
	Written informed consent
Inclusion criteria	Patients less than 18 years of age
	Had osteotomy of hip or osteochondroplasty
	Extensive deformity in the hip area
	Rheumatoid arthritis
	Patients with systemic diseases like diabetes, bleeding disorder, cardiovascular disease, poor general health (as determined by body mass index general criteria below 18.5), intra-articular depot corticosteroid or HA injection, tidal lavage in the last 3 months.

as diabetes; individuals with bleeding disorders; patients with cardiovascular disease; and those in poor general health, as indicated by a body mass index below 18.5, which interferes with evaluations. Additionally, individuals who have received intra-articular depot corticosteroid or HA injections, as well as tidal lavage, within the last 3 months are excluded. The age, sex, body mass index (BMI), and clinical outcome of the patient were recorded.

Method of preparation of PRP

Venous blood was drawn from patients for the production of PRP. The permissible hemoglobin limit was established at 11 mg/l for both men and women, and it was required that the platelet count exceed 150,000/mm^3. The preparation of the platelet gel involved the centrifugation of 150 ml of peripheral blood for patients diagnosed with unilateral degenerative disease, while 300 ml was utilized for those with a bilateral degenerative condition. The initial centrifugation was conducted to separate erythrocytes from platelets at 1480 rpm for 6 min, followed by a second centrifugation aimed at concentrating the platelets at 3400 rpm for 15 min [23,24]. The process of centrifugation on whole blood results in the formulation of pure platelet-rich plasma (P-PRP), characterized by a low leukocyte count and low fibrin density, in accordance with Ehrenfest's classification. The PRP units were thawed in a thermostat at 37°C for 30 min prior to injections, and 1 mL of calcium chloride (10%) was added for the activation of the platelets [25]. Each patient received HA and PRP injections as a single dose during the study.

Inflammatory markers evaluation

The synovial fluid of both PRP and HA groups were randomly tested for pro-inflammatory and anti-inflammatory markers such as interleukin-6 (IL-6), tumor necrosis factor-a (TNFa), interleukin-1 receptor antagonist (IL-1RA), interleukin-10 (IL-10), tissue inhibitor of metalloproteinases-1 (TIMP1), transforming growth factor–b1 (TGF-b1), and vascular endothelial growth factor (VEGF) (human enzyme-linked immunosorbent assay kits creative diagnostic kits). A microplate reader, the Infinite F 50, was used to quantify the markers (TECAN Laboratories).

Schedule of the treatment

The treatment plan for these groups was determined using current literature. The intra-articular injection was delivered to individuals in a supine position at the anterolateral hip region under sterile conditions. A 2–5 MHz convex array ultrasound probe (TeleMed Medical Systems, C5-2R60HI-5 SmartUs) was placed against the femoral axis, and the 22-gauge spinal needle was inserted in the anterior capsular recess at the base of the femoral neck and moved around the medial to lateral and cranial to caudal directions. All patients were given post-operative instructions, which included limiting leg movements for a few days by avoiding stairs, walking for a longer duration, and avoiding functional overloading of the joints with local ice application to the treated area as the only form of anti-inflammatory treatment.

Follow-up

Patients were examined 1, 3, 6, and 12 months following their last injection. A subjective assessment, WOMAC, and VAS score were used each time, and the same surgeon always performed a clinical examination by completing the HHS.

Clinical outcome variables

Primary outcome variables

The primary outcome criteria were pain intensity reduction as evaluated by the 100-mm VAS for pain intensity; lower scores are linked with less pain.

Secondary outcome variables

The proportion of responders was a secondary end measure; patients were considered responders if their baselines to 12-month follow-up VAS and WOMAC pain sub scores were reduced by more than 30%. Furthermore, secondary outcomes were the HHS, WOMAC, measurements of the concentration of GFs in PRP, and the correlation between the clinical outcomes and the PRP composition.

Statistical analysis

Regression analysis and repeated measures ANOVA was used to measure the difference in HHS, WOMAC, and VAS scores at different time intervals with SIDAK Post hoc comparison. It was implemented using IBM SPSS version 23 at a 95% confidence level. Value of $p < 0.05$ was considered as statistically significant. Finally, the Pearson correlation test was carried out to measure the correlation between the between anti-inflammatory markerInterleukin-10 (IL-10) and VAS score of PRP and HA groups.

Results

One hundred fifty patients were treated and allocated to two groups; 75 were assigned to the PRP group and 75 were assigned to the HA group (Figure 1).

The demographics of the participants are summarized in Table 2. The PRP group was comprised of 42 males and 33 females, while the HA group was composed of 39 males and 36 females. The patients were predominantly elderly, with most being over the age of 40. The distribution of both treatment groups was found to be identical regarding Kellgren–Lawrence grade, with p values exceeding 0.05 suggesting homogeneity within each group. No significant difference was observed in pro-inflammatory and anti-inflammatory markers between the two treatment groups (PRP and HA), as the p value following the independent t test exceeded 0.05 for each marker, indicating that the characteristics of the patients were identical.

Table 3 presents the results of the comparative analysis that was conducted between the two groups at 3, 6, and 12 months.

Change in visual analog scale (VAS) score

The changes in VAS score between the PRP and HA groups are compared in Figure 2, which utilizes a box and whisker plot. A significant drop in the mean difference (MD) in VAS score within the PRP group was exhibited (MD: 2.143, 95% CI: 0.005–3.281; $p=0.04$) within 3–6 months. Additionally, a further drop was observed (MD: 3.381, 95% CI: 0.089–3.673; $p=0.006$) within 6–12 months. The overall change observed between 3 and 12 months was MD 2.238 (95% CI: 0.065–3.21; $p=0.004$). In the HA group, the mean difference in the VAS score was found to be 1 (95% CI: 0.012–3.012; $p=0.023$) within the 3–6-month period; a mean difference of 0.359 (95% CI: 0.144–0.573; $p=0.03$) was observed within the 6–12-month period. The overall change observed between 3 and 12 months was MD 0.167 (95% CI: 0.04–0.81; $p=0.012$).

Change in WOMAC score

In Figure 3, a comparison of the change in WOMAC scores between the PRP and HA groups is illustrated through the box and whisker plot. At various follow-up intervals, significant reductions in the WOMAC score were observed. The mean difference for the PRP group from 3 to 6 months was found to be 1.138 (95% CI: 0.79–1.487; $p=0.03$). The mean difference observed between 6 and 12 months was calculated to be 1.171 (95% CI 0.845–1.498; $p=0.02$). The overall mean difference observed between 3 and

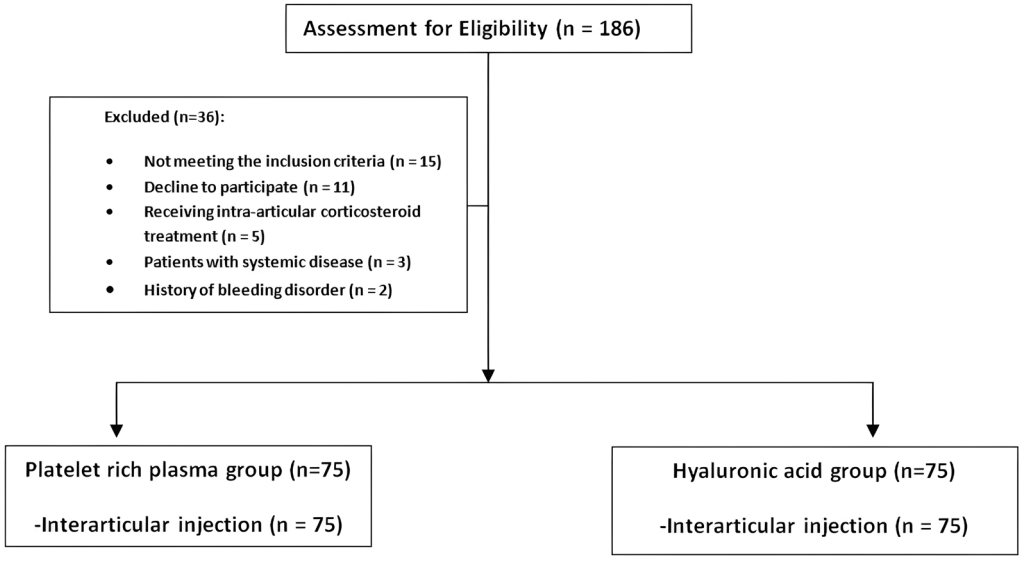


Figure 1. Flow diagram.

Table 2. Participants' demographics and baseline evaluations.

Groups	PRP ($n=75$)	HA($n=75$)
Age (years), mean ± SD	45.93 ± 9.54	43.22 ± 8.10
Sex (male/female)	42/33	39/36
Hip OA grade (2/3)	16/12	16/14
Involved hip (right/left)	19/12	16/13
Pain duration (months), mean ± SD	3.26 ± 1.03	4.59 ± 1.50
Height (m), mean ± SD	1.57 ± 0.10	1.45 ± 0.09
Weight (kg), mean ± SD	74.63 ± 10.05	72.54 ± 8.05
BMI (kg/m^2), mean ± SD	23.94 ± 2.80	22.45 ± 3.80
CBC		
Hb (g/dL), mean ± SD	12.54 ± 1.70	12.59 ± 1.78
WBC (×103/μL), mean ± SD	6.77 ± 1.12	6.13 ± 1.09
PLT (×103/μL), mean ± SD	277.90 ± 7.25	223.83 ± 37.93
History of physiotherapy (>1 month) (yes/no),	22/8	17/6
Difference in the proinflammatory and anti-inflammatory markers between the two groups		
Interleukin-6	23	30
Interleukin-1 receptor antagonist	521	527
Interleukin-10	1.9	1.8
Tissue inhibitor of metalloproteinases-1	901	953
vascular endothelial growth factor	320	301

Table 3. Statistical analysis comparing the changes in pain scores over different time periods between the PRP and HA groups.

	Time interval (months)	Mean difference (MD)	95% CI		p value
			Lower limit	Upper limit	
VAS score					
PRP	3–6	2.143	0.005	3.281	0.04
group	6–12	3.381	0.089	3.673	0.006
	3–12	2.238	0.065	3.21	0.004
HA group	3–6	1	0.012	3.012	0.023
	6–12	0.359	0.144	0.573	0.03
	3–12	0.167	0.04	0.81	0.012
WOMAC score					
PRP	3–6	1.138	0.79	1.487	0.03
group	6–12	1.171	0.845	1.498	0.02
	3–12	1.033	0.06	1.526	0.01
HA group	3–6	0.239	0.13	0.348	0.001
	6–12	0.69	0.491	0.889	0.002
	3–12	0.451	0.258	0.644	0.001
HHS score					
PRP	3–6	2.141	1.3	3.01	0.002
group	6–12	2.83	1.8	3.31	0.003
	3–12	1.02	0.06	1.126	0.002
HA group	3–6	2.01	1.201	3.56	0.004
	6–12	1.78	1.491	2.91	0.001
	3–12	0.91	0.32	1.612	0.001

12 months was found to be 1.033 (95% CI: 0.06–1.526; $p=0.01$). The MD in WOMAC score was found to be 0.239 (95% CI: 0.13 − 0.348; $p=0.001$) within the HA group at 3 to 6 months; an MD of 0.69 (95% CI: 0.491–0.889; $p=0.002$) was observed within 6–12 months. The overall change observed between 3 and 12 months was MD 0.451 (95% CI: 0.258–0.644; $p=0.001$).

Change in HHS score

The change in HHS scores between the PRP and HA groups is illustrated in Figure 4, as shown by the box and whisker plot. At various follow-up intervals,

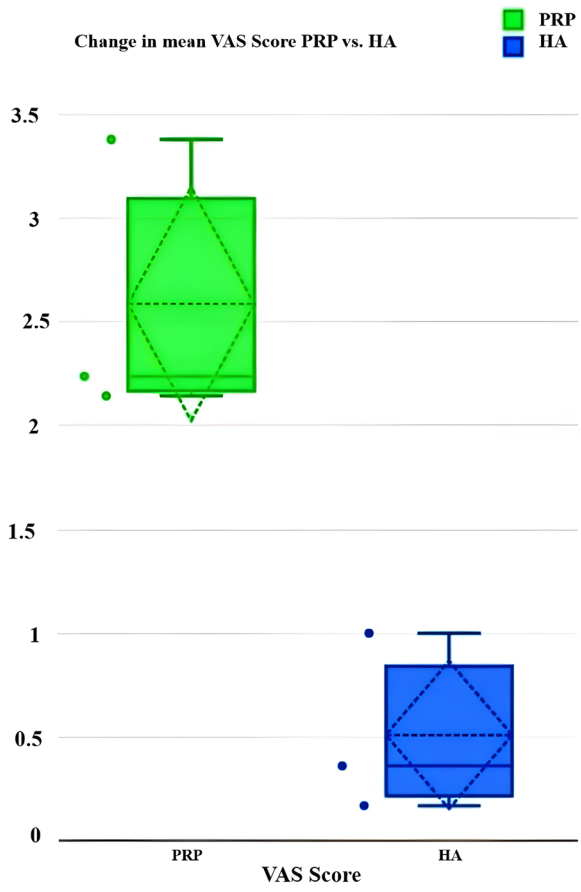


Figure 2. Box and whisker plot for VAS score.

significant reductions in the HHS score were observed. The mean difference for the PRP group from 3 to 6 months was found to be 2.141 (95% CI: 1.3 − 3.01; $p=0.002$). The mean difference observed between 6 and 12 months was calculated to be 2.83 (95% CI 1.8–3.31; $p=0.003$). The overall mean difference observed between 3 and 12 months was found to be 1.02 (95% CI: 0.06–1.126; $p=0.02$). In the HA group, the MD in HHS score was recorded as 2.01 (95% CI: 1.201 − 3.56; $p=0.004$) for the period of 3–6 months; an MD of 1.78 (95% CI: 1.491–2.91; $p=0.001$) was noted for the 6–12-month period. The overall change observed between 3 and 12 months was MD 0.91 (95% CI: 0.32–1.612; $p=0.001$).

It is suggested by the findings that significant improvement occurred in the change for all three parameters evaluated at each follow-up point in both the HA and PRP groups. However, it was observed that the magnitude of the change in mean scores was more significant in the PRP group when compared to the HA group. It is intriguing that all p values were observed to be less than the set threshold of 0.05.

It was shown in Table 4 that the correlation coefficient between the anti-inflammatory marker (IL-10) and the VAS was found to be moderate, with $r=0.591$

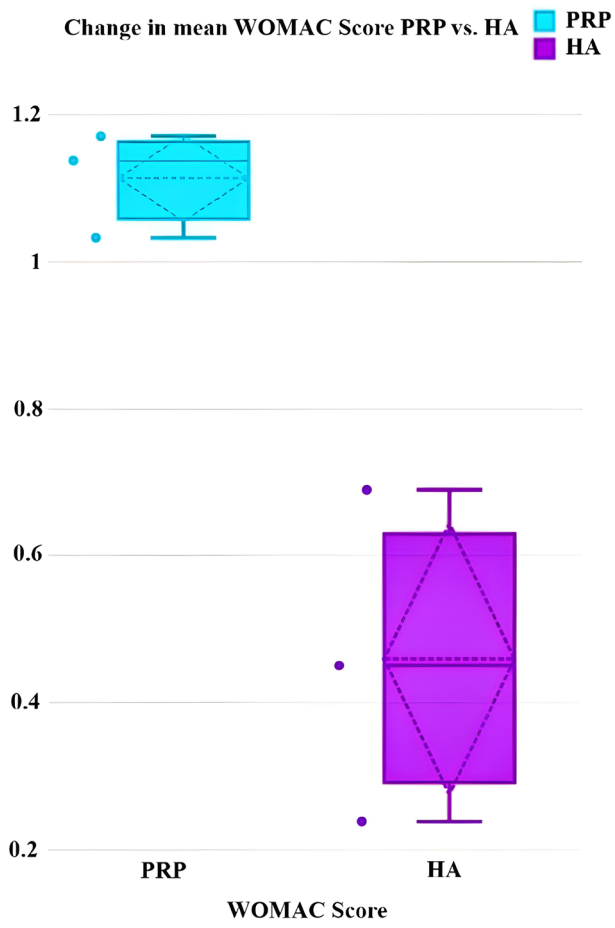


Figure 3. Box and whisker plot for WOMAC score.

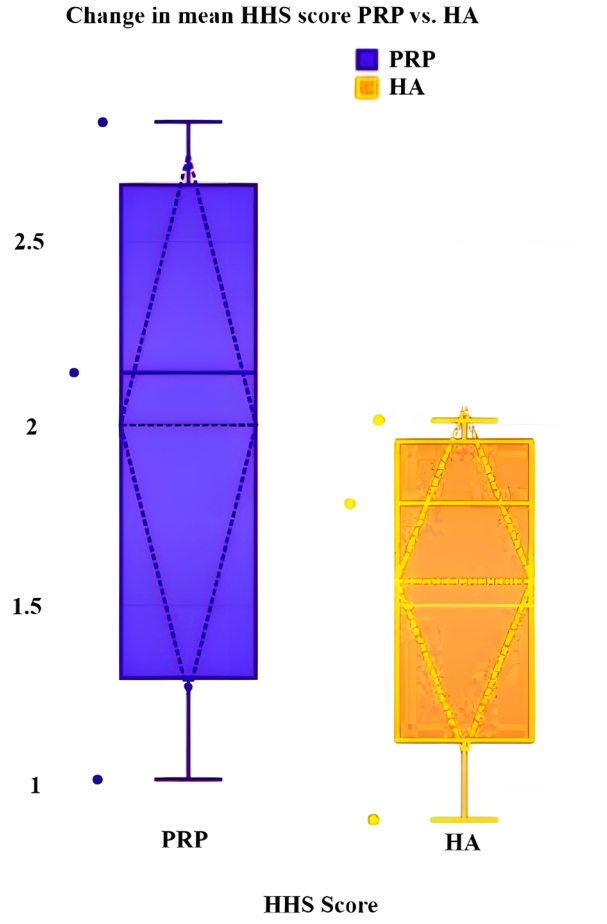


Figure 4. Box and whisker plot for HHS score.

in the PRP group, and weak, with $r = 0.238$ in the HA group.

Statistically significant findings ($p < 0.05$) are demonstrated by regression analysis, and a linear correlation for the variation in VAS, WOMAC, and HHS score is shown in Figure 5. The data presented in the picture suggests that a higher level of consistency is displayed by the alterations observed with PRP when compared to the HA group, as evidenced by the minimum residual errors.

Figure 6 is presented, illustrating a correlation pi plot that highlights the linear correlation coefficient between the average changes in pain levels observed in the PRP and HA groups. It is clearly revealed by the plot that the observed changes in the PRP group are greater than those in the HA group. While statistical significance is indicated by the results, it is noted that the changes in scores are minimal and may not reflect any clinical significance. The comparative line graphs are depicted in Figure 7, illustrating the clinical changes in VAS, WOMAC, and HHS scores in both the PRP and HA groups over a period of 12 months.

Table 4. Pearson correlation between IL-10 and VAS score.

Group	Pearson correlation	*p* value
PRP	0.591	0.015
HA	0.238	0.012

#$p < 0.05$ statistically significant.

Discussion

The primary goal of this study was to evaluate and compare the effectiveness of ultrasound-guided injections of PRP and hyaluronic acid (HA) in the rehabilitation of patients with hip OA. The study assessed the improvement in several pain scores, including visual analog scale (VAS) scores, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, and Harris Hip Score (HHS). The alternative hypothesis is supported by the findings of this study, indicating that a significant difference exists between the PRP and HA groups, leading to the cancellation of the null hypothesis. Improvements in VAS, HHS, and WOMAC scores were exhibited by the PRP group when compared to the HA group ($p < 0.05$); however, the changes in scores are small and do not represent

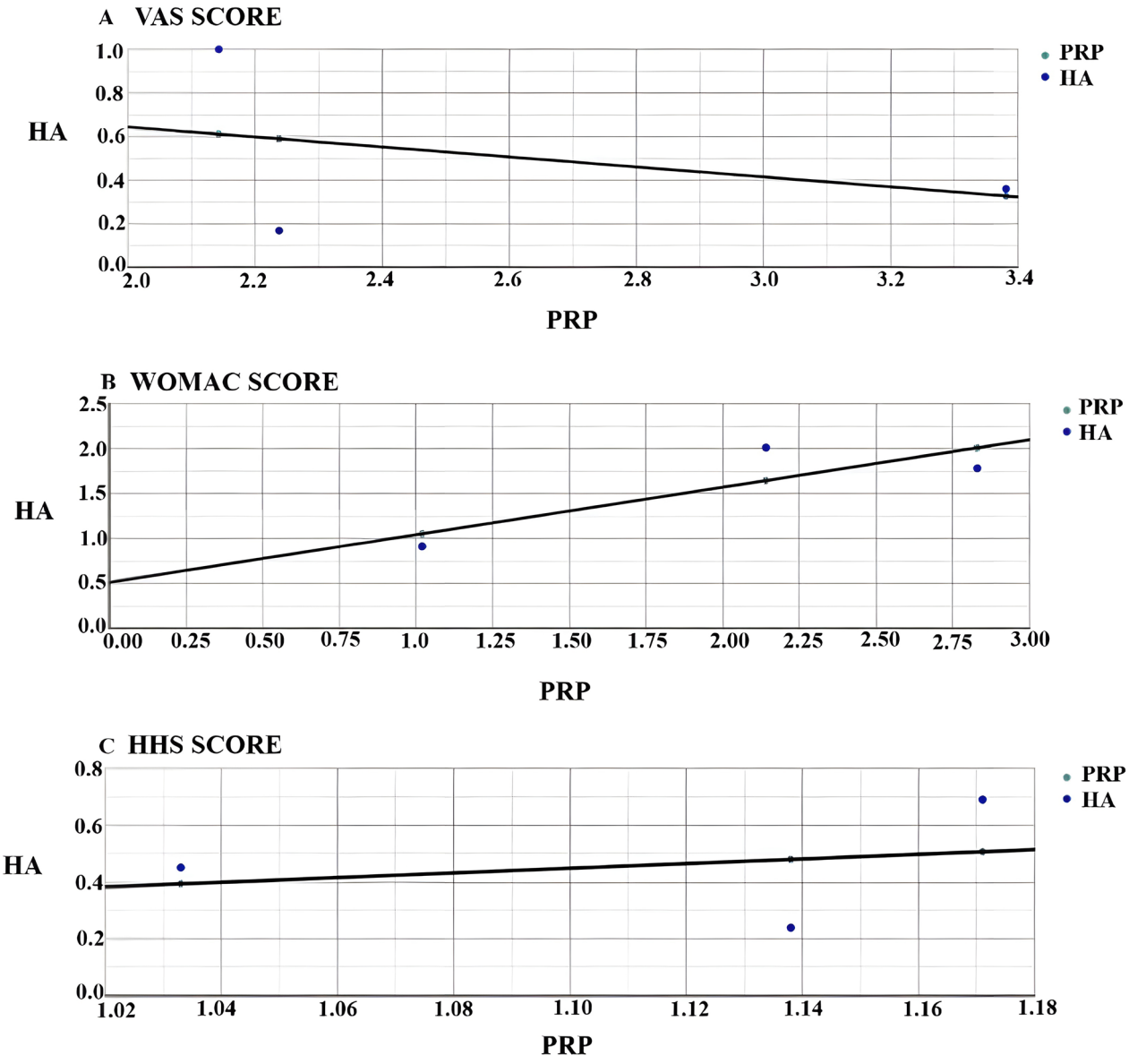


Figure 5. Regression line plot for change in (A) VAS score, (B) WOMAC score, (C) PRP score in PRP vs. HA group.

any clinically significant differences between the two treatments. In other words, it is indicated that, despite the statistical significance, no clinical difference is effectively observed between the two treatments. Furthermore, it has been suggested that the correlation between anti-inflammatory markers IL-10 and VAS scale ratings in the PRP therapy group indicates that the inhibitory properties of PRP on the inflammatory response may contribute to its effects. However, a clinically meaningful difference is not translated by this, and therefore, the choice between PRP and HA treatments may not be influenced by these findings.

The effectiveness of intra-articular injections in mitigating pain and improving knee function in individuals with OA has been established. HA and PRP injections are utilized for the enhancement of physical performance and the alleviation of pain associated with OA through the regulation of the viscoelastic properties of synovial fluid [24]. The potential of platelet-rich plasma (PRP) to restore joint lubrication is suggested through various mechanisms [25]. The growth of chondrocytes and synoviocytes is first induced by the compound, along with the creation of hyaluronic acid, which is utilized to lubricate the synovial fluid [26]. The influence of superficial zone protein (SZP), commonly referred to as lubricin, on lubrication is exerted through the process of platelet-rich plasma (PRP) [27]. It has been observed that temporal factors, platelet concentration, and leukocyte (L-PRP) levels are variables that impact synovial inflammation. Pro-inflammatory effects have been observed to be induced by cytokines, including

TNF, 2-macroglobulin, and vitamin D binding protein, when present in alpha-granules and platelet-rich plasma (PRP) [28]. It has been observed in *in vitro* research that detrimental pro-inflammatory effects are associated with interleukin-1 (IL-1), leading to a prolonged reduction in the inflammatory response. The inhibition of the NF-B pathway, which is recognized as a critical component in the pathogenesis of osteoarthritis, is associated with the manifestation of anti-inflammatory properties. The creation of insulin-like growth factor (IGF) and hepatocyte growth factor (HGF) by synoviocytes may facilitate the process, as it has been shown that the NF-B pathway is inhibited by these factors [29,30]. The *in vitro* anti-inflammatory effectiveness of PRP is not yet fully understood. To further scientific knowledge and develop effective treatments, the conduction of *in vitro*, *in vivo*, and therapeutic trials is deemed necessary.

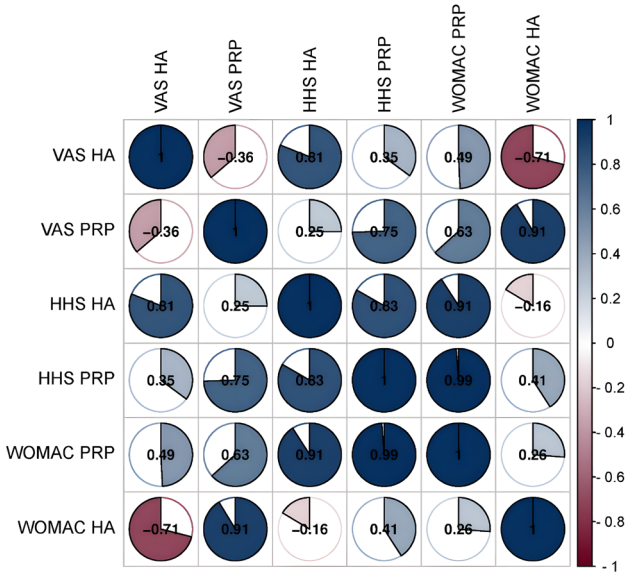


Figure 6. Correlation pi plot for change in pain scores in PRP vs. HA group.

It has been reported by various studies that superior performance was demonstrated by PRP compared to HA throughout the 6-to-12-month timeframe for knee OA. A thorough meta-analysis of 12 trials was conducted by Kon et al. [31] to elucidate the role of platelet-rich plasma (PRP), with a detailed description of its efficiency for knee OA being presented. However, the specific role of PRP in the treatment of hip OA remains not fully understood. Similar findings were obtained by Hohman et al. [32], indicating efficacy over a duration of up to 12 months in the present investigation. Upon analysis of the outcome metrics, as measured by the WOMAC score, it was determined that in 11 trials, a superior advantage of PRP over HA was demonstrated. Improved clinical outcomes following the administration of PRP treatment for degenerative knee injuries have been independently shown by Filardo et al. [33] and Spakova et al. [34]. A notable positive trend in terms of efficacy was observed by Filardo et al. when the effects of PRP and HA were compared at 6- and 12-month follow-up periods. Furthermore, it has been indicated by Battaglia et al. [35,36] that HA injections exhibit superior efficacy in alleviating pain and enhancing joint mobility when compared to PRP injections. It has been indicated by these studies that a regulatory effect on inflammation and angiogenesis is exerted by PRP, resulting in increased pain alleviation. Interference with chondrocyte death by the PRP molecule has been reported, thereby aiding in the facilitation of cartilage repair.

The findings of the present study are aligned with the results published by Dallari et al. [24]; however, distinctions are exhibited by the current investigation when compared to other studies conducted by Battaglia et al. [35], Battaglia et al. [36], and Sanchez et al. [18] regarding the specific formulations of PRP employed. However, certain risks may be posed by injections of intra-articular corticosteroids into the hip

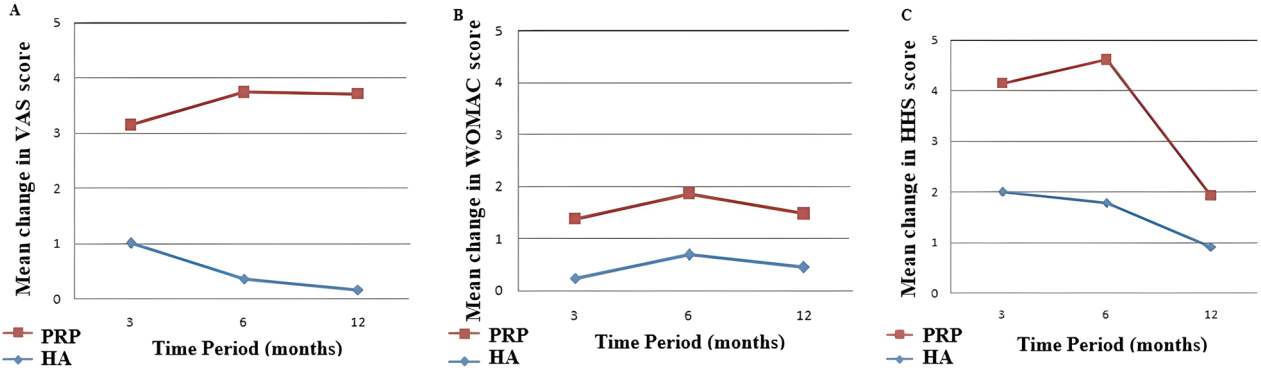


Figure 7. Comparative clinical changes in VAS, WOMAC, and HHS scores in PRP and HA groups over 12 months.

joint. Numerous detrimental effects of intra-articular injections have been documented in the scientific literature, including infections, cartilage injury, avascular necrosis, infection of the native joint, and subsequent complications involving prostheses. Therefore, caution should be exercised both during and after these inter-articular administrations.

Limitations

The limitation of the study at first is that this study did not analyse radiological changes and MRI results in patients, thus it's difficult to ascertain if the observed functional and pain-related improvements were connected to the pathology's clinical features. Secondly, there is the absence of the standardization and quantification of PRP. Thirdly, since the duration of the follow-up is limited and there is only a change of 2–3 points on the VAS as the MD, further studies can be performed to see PRP's long-term beneficial effects. Lastly, this is a single-center study; therefore, multi-centre trials would be required to come to a definite conclusion.

Conclusions

It has been demonstrated by the current study that pain levels and joint discomfort are substantially reduced by platelet-rich plasma (PRP) injections, as indicated by the statistically significant results; however, it should be noted that the small changes in scores may not be translated into clinically significant improvements. It is suggested by this study that intra-articular PRP injections may be effective in the management of hip osteoarthritis. However, further investigation through clinical trials and meta-analyses is necessitated by the limited existing literature on this topic to fully evaluate the effectiveness of intra-articular PRP injections in treating hip OA.

Ethics approval and consent to participate

The research conducted on human participants adhered to the ethical standards set forth by the institutional and/or national research committee of *The First People's Hospital of Lianyungang, Lianyungang University, approval number SDGHDX20180722DX* and ethical committee of the 'Lianyungang University' has approved the study. Additionally, it is imperative to adhere to the ethical guidelines outlined in the 1964 Helsinki Declaration and its subsequent revisions, or similar ethical standards. Moreover, written informed consent was obtained from all patients.

Consent to publish

Not applicable

Acknowledgments

None declared.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors contribution

CRediT: **Guangjun Bian**: Conceptualization, Supervision, Writing – review & editing; **Wei Zhao**: Formal analysis, Investigation, Methodology; **Li Zhang**: Data curation, Investigation, Methodology, Writing – original draft.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

No Funding was received.

References

[1] Buckwalter JA, Martin JA. Osteoarthritis. Adv Drug Deliv Rev. 2006;58(2):150–167. doi: 10.1016/j.addr.2006.01.006.
[2] Abate M, Pelotti P, De Amicis D, et al. Viscosupplementation with hyaluronic acid in hip osteoarthritis (a review). Ups J Med Sci. 2008;113(3):261–277. doi: 10.3109/2000-1967-233.
[3] Juhakoski R, Heliövaara M, Impivaara O, et al. Risk factors for the development of hip osteoarthritis: a population-based prospective study. Rheumatology (Oxford). 2009;48(1):83–87. doi: 10.1093/rheumatology/ken427.
[4] Hochberg MC, Altman RD, Brandt KD, et al. Guidelines for the medical management of osteoarthritis. Part I. Osteoarthritis of the hip. American College of Rheumatology. Arthritis Rheum. 1995;38(11):1535–1540. doi: 10.1002/art.1780381103.
[5] Loeser RF. Aging and osteoarthritis: the role of chondrocyte senescence and aging changes in the cartilage matrix. Osteoarthritis Cartilage. 2009;17(8):971–979. doi: 10.1016/j.joca.2009.03.002.
[6] Milas M, Rinaudo M, Roure I, et al. Comparative rheological behavior of hyaluronan from bacterial and animal sources with cross-linked hyaluronan (hylan) in aqueous solution. Biopolymers. 2001;59(4):191–204. doi: 10.1002/1097-0282(20011005)59:4<191::AID-BIP1018>3.0.CO;2-M.
[7] Chen YQ, Chou PL, Cheng CY, et al. Microrheology of human synovial fluid of arthritis patients studied by dif-

fusing wave spectroscopy. J Biophoton. 2012;5(10):777–784. doi: 10.1002/jbio.201100128.
[8] Goldring MB, Goldring SR. Articular cartilage and subchondral bone in the pathogenesis of osteoarthritis. Ann N Y Acad Sci. 2010;1192(1):230–237. doi: 10.1111/j.1749-6632.2009.05240.x.
[9] Madry H, van Dijk CN, Mueller-Gerbl M. The basic science of the subchondral bone. Knee Surg Sports Traumatol Arthrosc. 2010;18(4):419–433. doi: 10.1007/s00167-010-1054-z.
[10] Brandt KD, Dieppe P, Radin E. Etiopathogenesis of osteoarthritis. Med Clin North Am. 2009;93(1):1–24, xv. doi: 10.1016/j.mcna.2008.08.009.
[11] Anitua E, Andia I, Ardanza B, et al. Autologous platelets as a source of proteins for healing and tissue regeneration. Thromb Haemost. 2004;91(1):4–15. doi: 10.1160/TH03-07-0440.
[12] Marx RE. Platelet-rich plasma (PRP): what is PRP and what is not PRP? Implant Dent. 2001;10(4):225–228. doi: 10.1097/00008505-200110000-00002.
[13] Sun Y, Feng Y, Zhang CQ, et al. The regenerative effect of platelet-rich plasma on healing in large osteochondral defects. Int Orthop. 2010;34(4):589–597. doi: 10.1007/s00264-009-0793-2.
[14] Sundman EA, Cole BJ, Karas V, et al. The anti-inflammatory and matrix restorative mechanisms of platelet-rich plasma in osteoarthritis. Am J Sports Med. 2014;42(1):35–41. doi: 10.1177/0363546513507766.
[15] Zhu Y, Yuan M, Meng HY, et al. Basic science and clinical application of platelet-rich plasma for cartilage defects and osteoarthritis: a review. Osteoarthritis Cartilage. 2013;21(11):1627–1637. doi: 10.1016/j.joca.2013.07.017.
[16] Sundman EA, Cole BJ, Fortier LA. Growth factor and catabolic cytokine concentrations are influenced by the cellular composition of platelet-rich plasma. Am J Sports Med. 2011;39(10):2135–2140. doi: 10.1177/0363546511417792.
[17] Cerza F, Carnì S, Carcangiu A, et al. Comparison between hyaluronic acid and platelet-rich plasma, intra-articular infiltration in the treatment of gonarthrosis. Am J Sports Med. 2012;40(12):2822–2827. doi: 10.1177/0363546512461902.
[18] Sánchez M, Guadilla J, Fiz N, et al. Ultrasound-guided platelet-rich plasma injections for the treatment of osteoarthritis of the hip. Rheumatology (Oxford). 2012;51(1):144–150. doi: 10.1093/rheumatology/ker303.
[19] Dold AP, Zywiel MG, Taylor DW, et al. Platelet-rich plasma in the management of articular cartilage pathology: a systematic review. Clin J Sport Med. 2014;24(1):31–43. doi: 10.1097/01.jsm.0000432855.85143.e5.
[20] Hepper CT, Halvorson JJ, Duncan ST, et al. The efficacy and duration of intra-articular corticosteroid injection for knee osteoarthritis: a systematic review of level I studies. J Am Acad Orthop Surg. 2009;17(10):638–646. doi: 10.5435/00124635-200910000-00006.
[21] Trigkilidas D, Anand A. The effectiveness of hyaluronic acid intra-articular injections in managing osteoarthritic knee pain. Ann R Coll Surg Engl. 2013;95(8):545–551. doi: 10.1308/rcsann.2013.95.8.545.
[22] Ryan TP. Sample size determination and power. 1st ed. United States: John Wiley & Sons; 2013. p. 17.
[23] Sánchez M, Anitua E, Azofra J, et al. Intra-articular injection of an autologous preparation rich in growth factors for the treatment of knee OA: a retrospective cohort study. Clin Exp Rheumatol. 2008;26(5):910–913.
[24] Dallari D, Stagni C, Rani N, et al. Ultrasound-guided injection of platelet-rich plasma and hyaluronic acid, separately and in combination, for hip osteoarthritis: a randomized controlled study. Am J Sports Med. 2016;44(3):664–671. doi: 10.1177/0363546515620383.
[25] Sampson S, Reed M, Silvers H, et al. Injection of platelet-rich plasma in patients with primary and secondary knee osteoarthritis: a pilot study. Am J Phys Med Rehabil. 2010;89(12):961–969. doi: 10.1097/PHM.0b013e3181fc7edf.
[26] Roffi A, Filardo G, Assirelli E, et al. Does platelet-rich plasma freeze–thawing influence growth factor release and their effects on chondrocytes and synoviocytes? Biomed Res Int. 2014;2014:692910–692913. doi: 10.1155/2014/692913.
[27] Sakata R, McNary SM, Miyatake K, et al. Stimulation of the superficial zone protein and lubrication in the articular cartilage by human platelet-rich plasma. Am J Sports Med. 2015;43(6):1467–1473. doi: 10.1177/0363546515575023.
[28] Gato-Calvo L, Magalhaes J, Ruiz-Romero C, et al. Platelet-rich plasma in osteoarthritis treatment: review of current evidence. Ther Adv Chronic Dis. 2019;10:2040622319825567. doi: 10.1177/2040622319825567.
[29] Corvelli M, Che B, Saeui C, et al. Biodynamic performance of hyaluronic acid versus synovial fluid of the knee in osteoarthritis. Methods. 2015;84:90–98. doi: 10.1016/j.ymeth.2015.03.019.
[30] Laudy AB, Bakker EW, Rekers M, et al. Efficacy of platelet-rich plasma injections in osteoarthritis of the knee: a systematic review and meta-analysis. Br J Sports Med. 2015;49(10):657–672. doi: 10.1136/bjsports-2014-094036.
[31] Kon E, Di Matteo B, Delgado D, et al. Platelet-rich plasma for the treatment of knee osteoarthritis: an expert opinion and proposal for a novel classification and coding system. Expert Opin Biol Ther. 2020;20(12):1447–1460. doi: 10.1080/14712598.2020.1798925.
[32] Hohmann E, Tetsworth K, Glatt V. Is platelet-rich plasma effective for the treatment of knee osteoarthritis? A systematic review and meta-analysis of level 1 and 2 randomized controlled trials. Eur J Orthop Surg Traumatol. 2020;30(6):955–967. doi: 10.1007/s00590-020-02623-4.
[33] Filardo G, Kon E, Buda R, et al. Platelet-rich plasma intra-articular knee injections for the treatment of degenerative cartilage lesions and osteoarthritis. Knee Surg Sports Traumatol Arthrosc. 2011;19(4):528–535. doi: 10.1007/s00167-010-1238-6.
[34] Spaková T, Rosocha J, Lacko M, et al. Treatment of knee joint osteoarthritis with autologous platelet-rich plasma in comparison with hyaluronic acid. Am J Phys Med Rehabil. 2012;91(5):411–417. doi: 10.1097/PHM.0b013e3182aab72.
[35] Battaglia M, Guaraldi F, Vannini F, et al. Platelet-rich plasma (PRP) intra-articular ultrasound-guided injections as a possible treatment for hip osteoarthritis: a pilot study. Clin Exp Rheumatol. 2011;29(4):754.
[36] Battaglia M, Guaraldi F, Vannini F, et al. Efficacy of ultrasound-guided intra-articular injections of platelet-rich plasma versus hyaluronic acid for hip osteoarthritis. Orthopedics. 2013;36(12):e1501–e1508. doi: 10.3928/01477447-20131120-13.