ORIGINAL RESEARCH PAPER

Orthopaedics

EFFECTIVENESS OF PLATELET RICH PLASMA IN PAIN MANAGEMENT OF OSTEOARTHRITIS KNEE: RANDOMIZED COMPARATIVE STUDY

KEY WORDS:

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ABSTRACT

Background: Intra-articular injections of platelet-rich plasma to treat symptoms of knee osteoarthritis have been successfully used in young patients. However, in most of these studies the control and test knees were present in different patients thus incorporating a large amount of bias in the results. Therefore, the present study was designed in which patients with bilateral osteoarthritis knee were included and platelet-rich plasma was administered in one knee and normal saline in another knee of same patient. **Methods:** 20 patients aged 30---65 years with bilateral osteoarthritis knees (ASA class I and II) of either gender were included in the study. Patients were randomized to receive platelet-rich plasma and normal saline in one of the two knees. The primary outcome was VAS and WOMAC score at 6 months after procedure. The secondary outcome included changes in joint stiffness, physical function, any adverse effects noted during the course of study.p **Results:** The baseline VAS score in platelet-rich plasma knee was 8.7±0.1which improved significantly to 6.4±0.11 ($p < 0.001$) at 6 months as compared to normal saline knee ($p = 0.017$). The WOMAC pain score also improved from baseline (17.7±0.15) to over 6 month 14.0±0.11 (< 0.001) in platelet-rich plasma knee while in the normal saline knee, no significant change occurred from baseline to six months (14.4±0.1 to 14.4±0.1). There was also significant decrease in stiffness and improvement of physical activity in the platelet-rich plasma knee as compared to normal saline knee. **Conclusion:** The present study showed significant decrease in pain and stiffness and improvement of physical functions of knee joint with intra-articular platelet-rich plasma injection as compared to normal saline.

INTRODUCTION

Osteoarthritis (OA) is the most common chronic joint disorder, and it causes detrimental effects on the quality of life and functional status.[1] The proportions of people affected with symptomatic knee OA is likely to increase with increasing rate of obesity in the general population.[2] Several methods are used for alleviating the pain of patients with knee OA, which includes medications and supplements (NSAIDs, glucosamine and chondritin sulfate), intra-articular injections (glucocorticoids, hyaluronic acid), physical agents (braces, shoes and insoles, exercise therapy, application of cold and heat modalities, etc.) and surgical intervention.[3,4,5] Since osteoarthritis alters the normal joint metabolism and decreases anabolism, the administration of Platelet Rich Plasma (PRP) containing numerous growth factors such as Hepatocyte Growth Factors (HGF), Vascular Endothelial Growth Factor (VEGF), Platelet Derived Growth Factor (PDGF) and Transforming Growth Factor (TGF) has been known to alter joint milieu in OA.[6]

Various studies have found positive results for Platelet Rich Plasma (PRP) in early Osteoarthritis (OA) knee in the past few years.[1] However most of these studies had moderate to high degree of bias in their results. Therefore, the present study was planned which included patients of bilateral OA knee (Grade 1 and 2) where PRP was administered in one knee and normal saline in another knee of same patient. The same patient served as both test and control.

Such a study was expected to nullify a great number of confounding factors while keeping the baseline characteristics same as regard to BMI, height, weight, ASA class and thus eliminates the chance of selection bias and observer bias in the results.

Methodology

This was a randomized comparative study conducted at Career institute of medical sciences, Lucknow. Institute ethics committee approval and written informed consent from all patients was obtained.

Inclusion and exclusion criteria

Patients aged 30---65 years with bilateral OA knees (ASA class I and II) of either gender, with history of pain or swelling in the knee >4 months, those with imaging findings (X-ray or MRI) of degenerative changes of the joint without significant deformity (diagnosed by KL classification (Grade 1 and 2)) were included in this study.

Patients with history of diabetes mellitus, immunosuppressive drugs, collagen vascular disorders, cancer or malignant disorders and those with or active infection/wound of the knee were excluded. Also, patients with autoimmune and platelet disorders, treatment with anticoagulant and antiplatelet medications 10 days before injection or use of NSAIDs 2 days before injection or history of knee articular injection of corticosteroid during previous 3 months or use of systemic corticosteroids 2 weeks before PRP injection were excluded. Patients with genu valgum/varum greater than 20 degrees and Human Immunocompromised Virus/Hepatitis B virus/Hepatitis C virus/Venereal Disease Research Laboratory virus positive cases were also excluded.

Patient randomization

The knees were randomly allocated into two groups with the use of a computer-generated random number table. They were assigned into either of the two groups: Knee (P), it included the knee receiving 8 mL of platelet rich plasma; Knee (N), it included the knee receiving 8 mL of normal saline as control knee.

There was a gap of 30 min between the injections in two knees. One investigator performed all the knee injections (VG). The

patient and investigators collecting the data were unaware of which knee got what treatment.

Interventional procedure

The patient was placed in a supine position. Under aseptic conditions, ultrasound guided 8 mL of either normal saline or platelet concentrate was injected into a supra-patellar pouch through a supra lateral approach with an 18-gauge needle. In the knee receiving PRP, 2 mL of $CaCl_2$ (M/40) was injected and same on another knee. The knees were immobilized for 10 min after injection. Data collected included baseline VAS (Visual Analog Scale) score and WOMAC scoring (Western Ontario and McMaster Universities Osteoarthritis Index) by an independent observer in each knee.

Co-interventions and post-intervention medications

Patient lied down in supine position for 2 h and monitored for HR, BP, SPO_2 and any adverse events. All participants were receiving conservative management (adjuvant drugs: NSAIDs and/or a therapeutic exercise program) before joining the study. They were instructed to stop all the pain medication 2 days prior to the injection and thereafter. Participants who showed substantial improvement with the study intervention reduced or stopped their drugs; for the other patients, dosages were increased or continued at the same dosages. Acetaminophen 500 mg was advised as first line rescue analgesia and oral tramadol as second rescue analgesia if required. Exercises and job attendance continued. No other additional treatments, such as physical therapy (ultrasound therapy, microwave diathermy, moist heat) or other interventions, other than the assigned study intervention was offered.

Primary and secondary outcomes

≥We de□ned the approach as "effective" when pain relief was 50% from baseline. The primary outcomes of the study were the percentage change in Visual Analog Score (VAS) at 6 months following the procedure. The secondary outcomes included changes in Western Ontario and McMaster osteoarthritis index (WOMAC) scores, joint stiffness, physical function, any adverse effects noted during the course of study. The nature, time of onset, duration, severity and relationship of the adverse effect to treatment were noted at each visit.

Follow-up

Patients were evaluated on the day of injection, 2 weeks, 1.5 month, 3 months and 6 months by an observer for intensity of pain in VAS and WOMAC score. Any adverse event reported by the patient during the study was recorded at each visit.

Table 1 - Demographic characteristics of study population

Age (Yrs)	46.8±21.3
Gender (%)	70% Female;30% Male
Weight(Kg)	61±10.2
ASA Status(%)	80% ASA 1;20% ASA2
Hemoglobin (g.dl)	11.2±1.3
Platelets count	213.21±6.9
Total Leukocyte count	5250±893

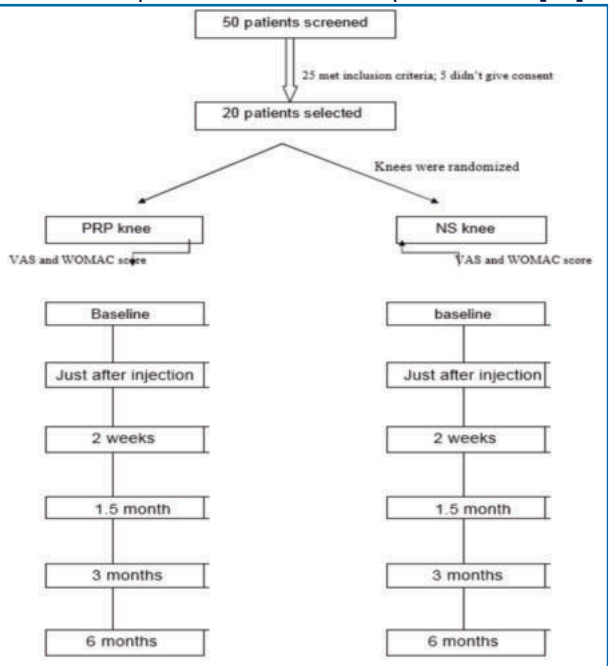

Figure 1 Flowchart of patients in this study (no losses in follow up).

PRP preparation

The platelet rich plasma required for injection was prepared on the day of the intervention procedure. About 50---60 mL of blood was drawn from the antecubital vein of the patient using aseptic precautions with efforts to avoid irritation and trauma to the platelets, which are in a resting state. The blood was collected in a blood bag with Citrate Phosphate Dextrose and Adenine (CDPA1) as anticoagulant preservative solution. These blood bags had 49 mL of anticoagulant and also contained an empty satellite bag connected with the primary bag through an internal seal. Before collecting the patient's blood, 40 mL of CDPA1 was diverted to the satellite bag from the primary bag and the connecting tubing was sealed using a portable tube sealer. Thus the primary bag in which the patient's blood was collected contained 9 mL of CDPA1 suf□cient to provide anticoagulation for 50---60 mL patient's blood. The whole blood was then transferred from the blood bag into sterile tubes using a blood transfusion set, inside a biosafety cabinet, class IIA. These tubes were then centrifuged for 15 min at 1300 rpm inside a tabletop centrifuge. The whole blood was separated into Platelet Rich Plasma (PRP) and Residual Blood Cell (RBCs) with the buffy coat. The tubes were then again brought inside the biosafety cabinet. The PRP was pipetted and transferred to another sterile tube. It was again subjected to a second centrifugation for 5 min at 2200 rpm inside a tabletop centrifuge. After this the supernatant platelet poor plasma was pipette inside the biosafety cabinet into another tube so as to leave behind 8---10 mL along with the platelet pellet at the bottom. The platelet pellet was then re-suspended in the remaining plasma as the final PRP and was dispensed in a sterile syringe; 1 mL of calcium chloride ($CaCl_2$) (M/40) for every 4 mL of final PRP was also dispensed in a separate syringe for injection with the final PRP. The platelet counts of patient's peripheral blood as well as the final PRP was also done using a hematology analyzer The mean platelet count achieved by our method was 3106.10 10^3/mL, and the mean quantity of platelets injected per knee was×× 216.56 10^7. The product is type 4B as per the Mishra classification.[7]

Statistical analysis

Data are presented as mean SD. Data were analyzed for normality using Kolmogorov---Smirnov *Z* test. Demographic data were analyzed using Student "*t*" test or y^2 test. Categorical data including primary endpoint were analyzed by y^2 test.

Two-way repeated measures analysis of variance was conducted to analyze VAS and WOMAC score over time. For this, the data were tested for normality, homogeneity, and equal covariance by Kolmogorov---Smirnov *Z* test, Levene test for equality of error variances, and Box Test of Equality of Covariance Matrices, respectively. The assumption of sphericity was tested by Mauchly test. If the Mauchly test was significant indicating violation of the assumption of sphericity, we used the Greenhouse---Geisser test with adjustment for time factor, time group interaction and between subject effects for VAS and WOMAC. If found significant, follow-up analysis was performed with Bonferroni correction for multiple comparisons. Computer statistical software SPSS version 17.0 (SPSS Inc., Chicago, IL) was used for analysis; $p < 0.05$ was considered significant.

Sample size calculation

Our sample size was based upon an assumed study power of 80%, ¸ of 0.05, and expecting a minimum of 50% decrease in the VAS score in the treatment group (difference of standard deviation = 2.5). Using these parameters, we required approximately 10 patients per treatment arm.

RESULTS

Total 40 patients were screened for eligibility criteria (Fig. 1); 25 met inclusion criteria, out of which 5 patients did not give consent for the procedure. Therefore a total of 20 patients with bilateral early osteoarthritis knee were selected on the basis of pre-de□ned inclusion criteria after written informed consent. Demographic characteristics of study population are presented in Table 1.

Table 2 The VAS and WOMAC Score at different time intervals

		Outcome measures				
Treated Groups	Follow-ups	VAS Mean ±SEM	W. Total Mean±SEM	W. Pain Mean±SEM	W. Stiffness Mean±SEM	W. Function Mean±SEM
	1 BASELINE	8.7±0.1	37.7±0.1	14.7±0.1	5.5±0.1	17.7±0.15
	Just after injection	8.4±0.14	36.7±0.14	13.5±0.12	5.3±0.12	17.7±0.15
	2 weeks	7.4±0.12	32.4±0.1	10.4±0.1	4.4±0.1	15.4±0.11
PRP GROUP	1.5 Month	7.1±0.14	32.4±0.14	10.4±0.14	4.3±0.14	15.4±0.11
	3 months	6.4±0.1	26.2±0.13	8.4±0.14	3.4±0.14	14.4±0.1
	6 months	6.4±0.11	26.1±0.14	8.4±0.11	3.4±0.11	14.0±0.11
	2 BASELINE	7.4±0.12	27.4±0.12	10.4±0.1	4.4±0.2	14.4±0.1
	Just after injection	7.4±0.1	27.4±0.1	10.4±0.12	4.4±0.1	14.4±0.12
	2 weeks	7.3±0.11	27.4±0.12	10.4±0.12	4.3±0.14	14.4±0.16
NS GROUP	1.5 Month	7.3±0.12	27.3±0.12	10.4±0.1	4.3±0.12	14.4±0.15
	3 months	7.3±0.11	27.2±0.1	10.4±0.1	4.3±0.12	14.4±0.13
	6 months	7.4±0.12	27.2±0.12	10.4±0.12	4.3±0.1	14.4±0.1

Value are present as Mean±Standard deviation
VAS: Visual analog Scale, W: WOMAC

Pain parameter in VAS and WOMAC score

Between-knee analysis revealed that VAS and WOMAC pain scores were significantly lower in the PRP knee compared with the NS knee at different time intervals except baseline (Table 2). Follow up within group analysis also revealed significant decrease in VAS and WOMAC score at all time intervals compared to baseline in the PRP knee. Results of repeated measures analysis of variance revealed time factor ($p < 0.001$ for both VAS and WOMAC) and time group interaction ($p < 0.001$ for VAS and $p < 0.001$ for WOMAC). Between-knee effect was also significant ($p = 0.001$ for VAS and $p = 0.001$ for WOMAC).

Analysis of trend in overall stiffness

WOMAC score for stiffness was analyzed on 2 aspects (morning and day time stiffness). Each aspect was given×a score between 0 and 4 and value of each of them was added up. The result was presented as overall score out of 8. Between-group analysis revealed significant decrease in stiffness in the PRP knee compared with the NS knee at different time intervals except baseline (Table 2). Results of repeated measures analysis of variance revealed time factor ($p < 0.001$ for overall stiffness).

Analysis of trend in overall daily physical activity

WOMAC score for difficulty in daily physical activity was analyzed on aspects (going downstairs, going upstairs, getting up from sitting position, standing, bending to floor and walking on flat surface). Each aspect was given a score between 0 and 4 and the value of each of them was added up. The result was presented as overall score out of 24. Between-group analysis revealed significant decrease in stiffness in the PRP knee compared with the NS Knee at different time intervals except baseline (Table 2). Results of repeated measures analysis of variance revealed time × factor ($p < 0.001$ for daily physical activities).

Analysis of trend change in total WOMAC score

WOMAC score for each aspect was added up and result was presented as overall score out of 52 (Table 2). In PRP knee, there was gradual reduction in total WOMAC score ranging from 1% (immediately post injection), to 25% at 2nd week which persisted up to 1.5th month. There was further improvement at 3rd and 6th month which was about 51%. In NS knee, there was 30% decrease in overall score at end of 6th month.

Satisfaction level

For PRP knee 68% were satisfied with treatment, 12% were partially satisfied and 20% were not satisfied. While for NS knee, only 10% were satisfied and 90% unsatisfied ($p = 0.001$) (Table 3).

Table 3 - Comparison of patient's level of satisfaction with treatment received

			Group	
n=20			PRP	NS
Satisfaction	Not Satisfied	% Within group	20%	90%
	Partially Satisfied	% Within group	12%	0%
	Satisfied	% Within group	68%	10%
Total		% Within group	100%	100%

Value are expressed as absolute number or percentage

Complications

Two patients in PRP knee group developed severe infiam mation, swelling and stiffness immediately post injection. It persisted for 2 weeks after which the pain and stiff ness improved. No significant adverse effect was seen in NS group.

DISCUSSION

This is a double blinded randomized controlled study where the same patient has been taken as test as well as control group. We selected patients of bilateral early osteoarthritis knee where we injected PRP in one knee and normal saline in other knee serving as physiological control. To the best of our knowledge this is first study of its kind where same patient has been used as control as well as study group. This eliminates a lot of confounding variables related to individual patient. Our study showed decrease in mean pain score after 2 weeks of injection in PRP knee. Pain relief was 24% and 50% at 2nd week and 3rd month respectively. In NS knee, no improvement of pain was seen in VAS scale at 2nd week, 1.5th month and 3rd month. At 6 months, pain reduction in PRP knee was 49%, as compared to only 21% decrease in NS knee. Intra-articular injection of autologous PRP has been considered as one of the treatment option in OA knee. Most of the studies on autologous PRP injection has been focusing on the reduction of pain and improvement of quality of life. Patel et al. performed a randomized control trial in 78 patients with OA knee.8 Patients were divided randomly into 3 groups where 1st group received a single injection of PRP, the 2nd group received 2 PRP injections 3 weeks apart and 3rd group received a single injection of NS. Clinical outcome evaluated using WOMAC questionnaire. Statistically significant improvement seen in all WOMAC parameters in the 1st and 2nd group within 2---3 weeks and lasted up to the final follow up at 6 month. In the NS group, the mean WOMAC score deteriorated from the baseline to final follow-up. Their study also showed similar VAS scores in patients receiving either one or more PRP injections. Therefore we have employed only single PRP injection in test knees. Sampson et al., in their pilot study of 13 patients also showed improvement in pain and daily physical activity on the scales of Knee Injury and Osteoarthritis Outcome Scores (KOOS) with intra-articular PRP injection. Their study lacked a control group.9 Wang et al. also showed improvement with intra-articular PRP on VAS, SF-36, WOMAC and Lequesne index. Their study also lacked a

control group. 10 Filardo et al. showed positive effects in IKDC and VAS score at the end of their 2 year follow-up study. 4 Their study also lacked a control group. PRP has also been compared with other modalities of treatment like HA and TENS. Sanchez et al. performed a retrospective cohort study comparing intra-articular PRGF and HA and reported better improvement in pain and quality of life with PRGF injection. 11 However their study was not randomized and lacked blinding of control groups.

Kon et al. compared intra-articular PRP injection with low and high molecular weight hyaluronic acid (HA).[12] Evaluation was done with IKDC and VAS score. They found better results with PRP injection as compared to HA. However their study failed to use a randomized double-blinded method. Our PRP preparation technique was standardized by our transfusion medicine department, and no commercial filters were used. We were able to get a standardized leukocyte- free concentration of platelets for all cases, and per the Mishra classification,[7] this was Type 4B. The number of platelets injected in our series was an average of 2.5 billion compared with 6.5 million used by Kon et al.[8] (almost 400 times higher).

Raeissadat et al. evaluated WOMAC and SF36 question- naires in PRP and HA group. They found better results with PRP at 12 month follow up.9 Angoorani et al. did a comparative study between intra-articular PRP and TENS plus exercise in 54 patients. Though significant reductions in VAS scores were found in both groups till the end of study, the mean time to feel intolerable knee pain dur- ing treadmill work out of PRP group increased significantly from baseline.10 Jubert et al. have tested the efficacy of intra-articular PRP injection in late stages of OA knee (KL Grade 3 and 4) and reported no statistically significant result with PRP compared to intra-articular corticosteroid injection. 11

Literature reports numerous systemic reviews and meta-analysis describing improved eficacy of PRP compared from hyaluronic acid, corticosteroids and normal saline.[12–16] Most of randomized controlled trials recruited in these systemic reviews reported moderate to high degree of bias. Our study also demonstrated similar results, but since one patient acted as both study and control, confounding variables related to the individual patient were removed. However, our study should be read in light of few limitations which may be brought out for the benefit of researchers planning similar studies in future. In our study same patient received different treatment in his two knees, which made the procedure cumbersome. Though we could assess for WOMAC pain and stiffness separately for each knee, assessment of physical activity of each knee separately may have been affected by pathology in another knee. Moreover, our follow up duration was 6 months which is not enough for adequately evaluating a chronic condition like OA knee. We evaluated only clinical parameters by using WOMAC and VAS scoring system. No radiographic follow up was done. Our study included only early OA knee with KL Grade 1 and 2. So results cannot be applicable to KL Grade 3 and 4.

The present study showed significant improvement in pain, stiffness and physical functions of knee joint with intra-articular PRP injection as compared to NS. The greatest strength of our study is that same patient served as control as well test knee. Though one patient developed pain and infiammatory swelling following PRP injection, it is difficult to determine exact relation between occurrence of complications and PRP administration. Therefore, we recommend judicious administration of PRP for OA knee.

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