Journal of Medicine in Scientific Research

Volume 7 | Issue 3 Article 6

Subject Area: Orthopedic Surgery

Clinical Study of Combined Arthroscopic Drilling and Platelet Rich Plasma Injection in Knee Osteochondral Lesions in Middle-aged Patients

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Recommended Citation

Mohamed, Mohamed Salah Labib and Gafar, Mohamed Abd elmoneam (2024) "Clinical Study of Combined Arthroscopic Drilling and Platelet Rich Plasma Injection in Knee Osteochondral Lesions in Middle-aged Patients," *Journal of Medicine in Scientific Research*: Vol. 7: Iss. 3, Article 6.
DOI: https://doi.org/10.59299/2537-0928.1379

ORIGINAL STUDY

Clinical study of combined arthroscopic drilling and platelet rich plasma injection in knee osteochondral lesions in middle-aged patients

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Abstract

Background: **Osteochondral lesions commonly occur in the knee joints and cause detrimental effects on the quality of life. Arthroscopic drilling is the treatment option for mild to moderate lesions. However, it is debatable whether regenerated cartilage from arthroscopic drilling surgery is durable. It is speculated that induction of chondrocyte differentiation from subchondral mesenchymal stem cells is facilitated by platelet rich plasma (PRP), which is a rich source of diverse growth factors.**

Aim: **To evaluate the procedures of combined arthroscopic drilling and PRP injection intra-articularly for mild to moderate knee osteochondral lesions management.**

Patients and methods: **This randomized prospective study involved 100 cases (40−60 y) treated in Banha Teaching Hospital from April 2021 to December 2023. They were randomly categorized equally into two groups: group A who were managed by arthroscopic drilling alone and group B who were managed by combined arthroscopic drilling and PRP injection intra-articularly. All the studied cases were assessed before intervention and at 3 and 12 months after intervention using the visual analog scale (VAS) score and Lysholm score.**

Results: **Significant gradual improvement in both scores throughout treatment (at 3 and 12 months after intervention), was observed in all the cases ($P < 0.01$). Demographic data and evaluation scores before intervention were comparable between both groups. At 3 and 12 months after intervention, group B exhibited significant higher improvement in both Lysholm and VAS scores ($P < 0.01$). There was a significant positive correlation of the patient's BMI with VAS score and a negative correlation with Lysholm scores.**

Conclusion: **Arthroscopic drilling combined with autologous PRP injection serves a vital role in pain reduction, life quality enhancement, and gradual improvement of knee function of patients suffering from mild to moderate severe knee osteochondral lesions especially in patients with low BMI.**

Keywords: Arthroscopic drilling, Autologous platelet rich plasma, Knee joint, Osteochondral lesions

1. Introduction

Osteochondral lesions of the knee are subchondral bone lesions that may involve a fragment of articular cartilage that has been partially or completely separated from the articular surface [1]. They are a major cause of knee hurt and dysfunction. Chondrocytes are incapable of aiding in the restoration or healing of damaged tissue, as the articular cartilage lacks vascular, nervous, and lymphatic tissue [2]. When the subchondral bone is involved in the chondral defects leading to bleeding, fibroblasts or mesenchymal stem cells stimulate the fibrocartilaginous repair. Osteoarthritis (OA) ultimately occurs because of the biomechanical inferiority of fibrocartilage in comparison to hyaline cartilage [3,4].

Articular cartilage defect treatment aimed to regenerate hyaline-like cartilage, and hence osteoarthritis prevention [5]. The arthroscopic drilling technique is a traditional mean of osteochondral lesion repair. It is a simple, minimal invasive

Received 11 May 2024; revised 11 May 2024; accepted 11 June 2024.
Available online 1 August 2024

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https://doi.org/10.59299/2537-0928.1379

technique with relatively low cost. However, during drilling, when a fraction of the bone marrow and blood escape through the apertures, a thrombus is generated. Blood stem cells are capable of undergoing chondrocyte differentiation, which in turn promotes the process of cartilage repair [6]. However, drilling surgery generates fibrous cartilage, which is structurally and functionally distinct from natural hyaluronic cartilage. Fibrocartilage is less elastic, rigid, and resistant to wear than natural hyaluronic cartilage [7]. Therefore, it is imperative to proactively explore alternative techniques that may improve the quality of the repaired cartilage and postpone arthritis development.

Platelet rich plasma (PRP) is an autologous blood-derived concentrated platelet extract. Constituting an assortment of vital growth factors, its purpose is to promote the transformation of subchondral mesenchymal stem cells into chondrocytes [8]. Moreover, it induces the cartilage defects repair, inhibits chondrocyte and mesenchymal stem cell apoptosis, and stimulates collagen II and proteoglycan synthesis within the chondrocyte [9–11]. Additionally, PRP is composed of coagulation factors and fibrinogen, which are capable of being activated to generate transient fibrin scaffolds that facilitate chondrocyte adhesion, proliferation and migration. Inflammatory factors, including interleukins, which have a catabolic effect on cartilage, can also be mitigated by PRP [12]. All these factors provide a worthy repair environment for knee cartilage injury. In recent years, PRP intra-articular injection has gained attention as a potentially effective therapeutic approach for cartilage injuries. Nevertheless, the combined use of PRP and arthroscopic drilling for knee joint injuries continues to be a subject of debate regarding its efficacy.

We aimed to investigate the clinical effects of the combination of PRP intra-articular injection with arthroscopic drilling technique in knee osteochondral lesions management in the patients of middle age that may provide a new reference for clinical management.

2. Patients and methods

This prospective randomized controlled trial was carried out in the Orthopedics and Traumatology departments at Banha Teaching Hospital from April 2021 to December 2023, after approval by the Ethical Committee of General Organization of Teaching Hospitals and Institutes code NO: HB 000113. We included 100 cases (40–60 years old), diagnosed with osteochondral lesions by clinical examination and radiological assessment and had knee pain.

Patients with a history of surgery or fractures or knee trauma, with arthritis secondary to autoimmune diseases or suffering from any hematological disorders like thrombocytopenia, who were treated with extra or intra-articular injection of corticosteroids or antiplatelet drugs during the last 3 months and those with BMI greater than 30 kg/m^2, were excluded from the study.

The included cases were assigned randomly into two equal groups: group-A (Arthroscopy group) included 50 cases who were treated with arthroscopic drilling and group-B (combined arthroscopic drilling and PRP group) included 50 cases who were managed with arthroscopic drilling in combination with autologous PRP intra-articular injection.

The participants were subjected to thorough medical history taking, general and clinical investigations, Knee local examination, laboratory investigations, and radiological assessment.

2.1. Methods

2.1.1. Arthroscopic drilling for group A

Patients underwent pre-anesthetic evaluation, then taken into the operation theatre. The patients were transferred to the operating table following the administration of suitable anesthesia and were positioned in a supine position, with both legs dangling below the table. A tourniquet was applied to the thigh region; however, it remained deflated until significant hemorrhage transpired. The diagnostic evaluation of the synovium and other vascularized tissue is complicated by the blanching caused by tourniquet inflation. Following limb exsanguinations, the tourniquet was inflated. During routine procedures, the tourniquet duration was restricted to no more than 90 min in order to mitigate the risk of deep vein thrombosis.

Under aseptic condition, limb amputation and immobilization were performed. Every mandatory and discretionary portal was marked. In general, the procedure involved defining the patella and patellar tendon outlines, defining the posterior contours of the medial and lateral femoral condyles, and palpating, and marking lateral and medial joint lines with the fingertip. Anteromedial and anterolateral portals were predominantly utilized.

Approximately 1 cm laterally to the patellar tendon margin and 1 cm above the lateral joint line was the location of the anterolateral portal. By palpating the patella inferior pole, it is possible to ascertain whether the anterior portals are situated at an excessively elevated level. Specifically, the portal should be positioned around 1 cm inferior to the patella. The anteromedial portal, similar to the anterolateral portal, is located at a distance of 1 cm below the patellar tendon line, 1 cm medial to the boundary of the patellar tendon, and 1 cm medial to the medial joint line.

Following the insertion of a scope cannula with a trocar through the anterolateral portal, normal saline was used to distend the joint. The trocar was extracted following adequate joint distention, and a scope equipped with a TV camera was introduced into the joint. The knee was subsequently examined in the compartmental order listed as; patellofemoral joint and suprapatellar sac, medial gutter and compartment, intercondylar notch, the posteromedial compartment, lateral compartment, and gutter and posterolateral compartment.

A comprehensive normal saline wash, removal of loose bodies and segments of articular cartilages, frayed meniscal margins, and articular cartilages were all components of the drilling procedure. A min indent was performed in the underlying defective bone cartilage. Articular cartilage degeneration was graded intraoperatively utilizing the Outerbridge grading system. The postoperative protocol restricted the patient to toe touching, weight-bearing, and CPM for the subsequent four weeks. Following a dressing on day two postoperatively, the patient was discharged. On the day 11th postoperatively, the patient requested suture removal. It was advised that patients perform quadriceps, knee and hamstring exercises.

2.1.2. Arthroscopic drilling combined with PRP injection for group B

Patients underwent the same steps as group A then, 3 days after arthroscopic drilling, patients were injected with 5 ml autologous PRP once/week three times.

PRP preparation: A 10 cm^3 sample of venous blood was collected using a sterile sodium-citrated tube after a vein was punctured with a 10 ml syringe featuring a needle diameter of 21 G. The collected blood was subsequently subjected to the double spin technique. The initial 15 min of centrifugation at 1600 rpm generated three distinct layers: a lower layer of red blood cells, an intermediate layer of white blood cells, and an upper plasma layer. After the initial two layers were gathered in a plain tube, a subsequent 10 min of centrifugation at 3500 rpm produced two distinct layers: the platelet-poor superficial layer was withdrawn, leaving the platelet concentrate at the base (second layer); from which a more concentrated platelet layer (PRP) was obtained [13].

PRP injection: For facilitation and pain reduction, the patient was instructed to assume a supine position and relax. Using betadine, the injection site was disinfected. Then, using a 5 ml syringe and a 21 G needle, 3 cm^3 of PRP was injected into the disinfected site at the anteromedial aspect of the knee joint while the knee was flexed. For each patient, the period from blood collection till is ~30–35 min. All patients received two injections separated by three weeks. To permit the PRP dispersion via the joint region, the patient was instructed to actively flex and extend the knee for 15 min [13].

2.2. Follow-up

Using the Lysholm knee scoring scale and visual analog scale (VAS) score, patients were evaluated at 3 and 12 months following the most recent procedure, as well as prior to the intervention. The VAS score is ten points. A greater VAS score indicates more severe pain [14]. The range of Lysholm scores was 0–100. Better knee function corresponds to a higher score [15].

Ethical considerations: All participants provided informed consent before the data collection or implementation of any intervention.

2.3. Statistical analysis

Using IBM SPSS 20.0, the data was reviewed, coded, tabulated, and analyzed. Results for parametric numerical data are presented as mean ± SD. When comparing the means of the two groups, we used an independent sample *t*-test. To determine if there was a statistically significant change in a parametric variable between the pre- and post-intervention means of the same research group, a paired sample *t*-test was used. The degree of linear association between two quantitative variables was measured using the Pearson correlation coefficient (r). To investigate the relationship between two qualitative variables, we used either Fisher's exact test or a χ^2 test. Significance is determined by a *P* value that is lower than 0.05.

3. Results

In both groups, male to female distribution was 48: 52%. Age and BMI were comparable between both groups (Table 1).

Table 2 shows that outer bridge grade was insignificantly different between both groups.

In group A, there was a significant gradual improvement in Lysholm and VAS scores when studying paired differences throughout treatment ($P \leq 0.01$) where scores improved at 3 m after

Table 1. Comparison between both groups regarding sex, age and BMI.

Variables	Intervention		Chi-square test	*P* value
	Group A (Arthroscopic drilling) N (%)	Group B (Arthroscopic drilling combined with PRP) N (%)		
Sex				
Male	24 (48.0)	24 (48.0)	0.000	1.000
Female	26 (52.0)	26 (52.0)		
Age	Mean ± SD	Mean ± SD	Independent sample *t*-test	*P* value
	46.98 ± 5.79	46.62 ± 5.17	0.328	0.744
BMI	24.45 ± 1.73	24.58 ± 1.78	−0.376	0.708

Table 2. Comparison between both groups regarding outer bridge grade.

Variables	Intervention		Chi-square test	*P* value
	Group A (Arthroscopic drilling) N (%)	Group B (Arthroscopic drilling combined with PRP) N (%)		
Outer bridge grade				
II	16 (32.0)	18 (36.0)		
III	21 (42.0)	21 (42.0)	0.284	0.867
IV	13 (26.0)	11 (22.0)		

intervention and more improvement occurred 12 m after intervention (Table 3, Fig. 1a and b).

The same results were found regarding scores among patients in group B (Table 4, Fig. 2a,b).

Pre-intervention Lysholm scores were insignificantly different between both groups, while at 3 m and 12 m postintervention, Lysholm scores were significantly higher in group B (Arthroscopic drilling combined with PRP) than group A (Arthroscopic drilling) ($P < 0.001$) (Table 5, Fig. 3).

Preintervention VAS was insignificantly different between both groups, while at 3 m and 12 m post-intervention, VAS was significantly lower in group B (Arthroscopic drilling combined with PRP) than group A (Arthroscopic drilling) ($P < 0.001$) (Table 6, Fig. 4).

There was a significant positive correlation between BMI and VAS (Pre intervention, 3 m and 12 m). There was a significant negative correlation between BMI and Lysholm scores (Preintervention, 3 m and 12 m). Meanwhile, an insignificant correlation was found between BMI and age (Table 7, Fig. 5).

4. Discussion

Knee osteochondral lesion treatment has historically been a critical concern in Orthopedics. Arthroscopic drilling, which was first implemented in clinical settings 40 years ago, is a highly safe minimally invasive technique. However, the durability of the regenerated cartilage after arthroscopic drilling surgery is controversial. This work aimed to evaluate the value of the management of knee osteochondral lesions with arthroscopic drilling combined with autologous PRP injection and comparing it with management with arthroscopic drilling only.

The current findings showed that throughout treatment (at 3 months and 12 month after intervention), both groups exhibited significant improvement in both VAS and Lysholm scores ($P < 0.01$). In both groups, VAS scores decreased gradually with time while Lysholm scores increased,

Table 3. Comparison of Lysholm scores, visual analog scale throughout treatment in group A (Arthroscopic drilling).

Variables	Significance (2-tailed)				Paired differences	t
	Mean	SD	95% CI of the Difference			
			Lower	Upper		
Pair 1						
Score (Pre) − Score (3 m)	−9.76000	3.58318	−10.77833	−8.74167	−19.260	0.000[a]
Pair 2						
Score (Pre) − Score (12 m)	−20.18000	4.96391	−21.59073	−18.76927	−28.746	0.000[a]
Pair 3						
Score (3 m) − Score (12 m)	−10.42000	3.26447	−11.34775	−9.49225	−22.570	0.000[a]
Pair 4						
VAS (Pre) − VAS (3 m)	1.22000	0.95383	0.13489	0.94892	1.49108	0.000[a]
Pair 5						
VAS (Pre) − VAS (12 m)	3.00000	1.35526	0.19166	2.61484	3.38516	0.000[a]
Pair 6						
VAS (3 m) −VAS (12 m)	1.78000	0.78999	0.11172	1.55549	2.00451	0.000[a]

[a] Highly statistically significant at *P* less than or equal to 0.01.

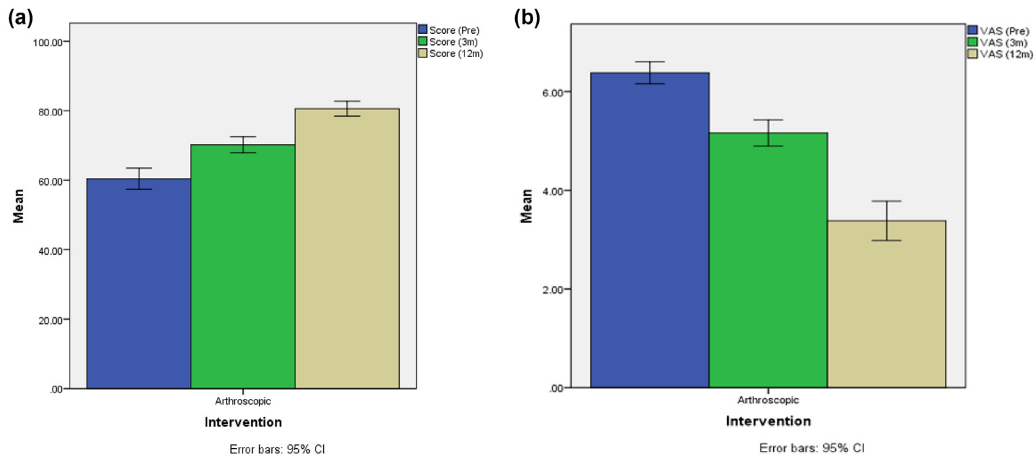

Fig. 1. a: Improvement of Lysholm scores in group A. b: Improvement of VAS scores in group A.

Table 4. Improvement in scores in group B (Arthroscopic combined with PRP).

Variables	Paired differences				t	Significance (2-tailed)
	Mean	SD	95% CI of the difference			
			Lower	Upper		
Pair 1						
Score (Pre) − Score (3 m)	−22.94000	6.65601	−24.83162	−21.04838	−24.371	0.000[a]
Pair 2						
Score (Pre) − Score (12 m)	−27.56000	7.20306	−29.60709	−25.51291	−27.055	0.000[a]
Pair 3						
Score (3 m) − Score (12 m)	−4.62000	2.59426	−5.35728	−3.88272	−12.593	0.000[a]
Pair 4						
VAS (Pre) − VAS (3 m)	3.52000	0.78870	3.29586	3.74414	31.559	0.000[a]
Pair 5						
VAS (Pre) − VAS (12 m)	4.46000	0.78792	4.23608	4.68392	40.026	0.000[a]
Pair 6						
VAS (3 m) − VAS (12 m)	0.94000	0.58589	0.77349	1.10651	11.345	0.000[a]

[a] Highly statistically significant at P less than or equal to 0.01.

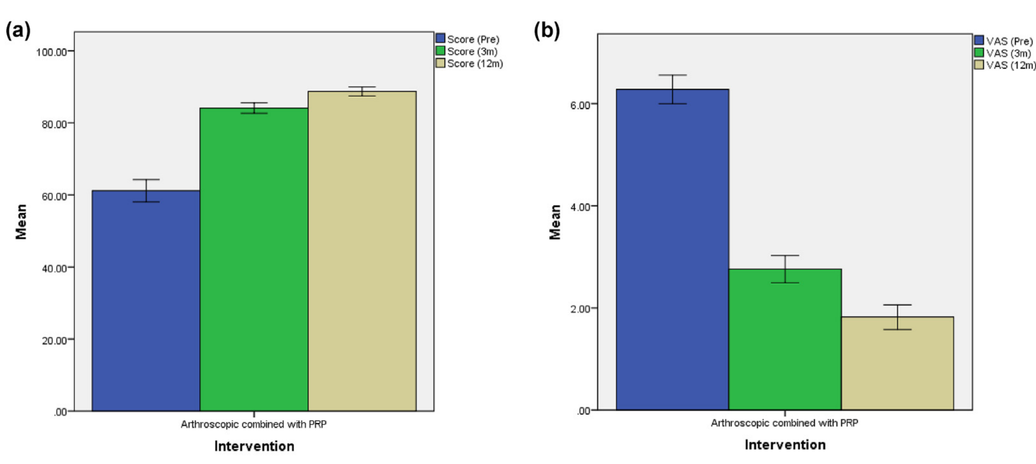

Fig. 2. a: Improvement of Lysholm scores in group B. b: Improvement of VAS scores in group B.

Table 5. Comparison between both groups regarding Lysholm scores (Preintervention, at 3 m and 12 m).

Variable	Intervention		Independent sample *t*-test	*P* value
	Arthroscopic drilling	Arthroscopic drilling combined with PRP		
	Mean ± SD	Mean ± SD		
Score (pre intervention)	60.42 ± 10.66	61.16 ± 10.93	−0.343	0.733
Score (3 m)	70.18 ± 8.17	84.10 ± 5.10	−10.226	0.000[a]
Score (12 m)	80.60 ± 7.56	88.72 ± 4.44	−6.546	0.000[a]

[a] Highly statistically significant at *P* less than or equal to 0.01.

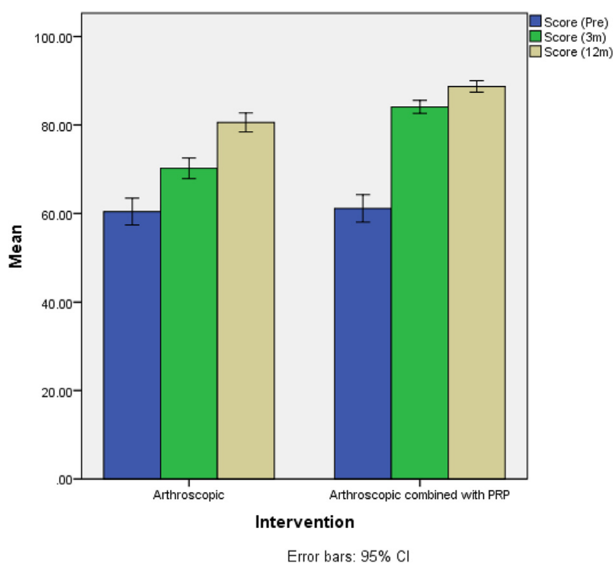

Fig. 3. Comparison between both groups regarding Lysholm scores (Pre intervention, 3 m & 12 m).

which indicates improvement of knee function and reduction of pain sensation in both groups.

By comparing Lysholm scores and VAS scores between both groups throughout management, our study revealed that group B showed more improvement in both scores (*P* value < 0.01). This result indicates that arthroscopic drilling combined with PRP injection provide superior improvement in knee function and knee pain than sole arthroscopic drilling. There was a highly significant positive correlation of the patient's BMI with VAS score and negative correlation with Lysholm scores. This means that improvement of lesions after the intervention was high in patients with low BMI.

In line with our findings, Gu and colleagues demonstrated that Lysholm scores exhibited a temporal pattern of increase in both groups, with a statistically significant increase in the first group,

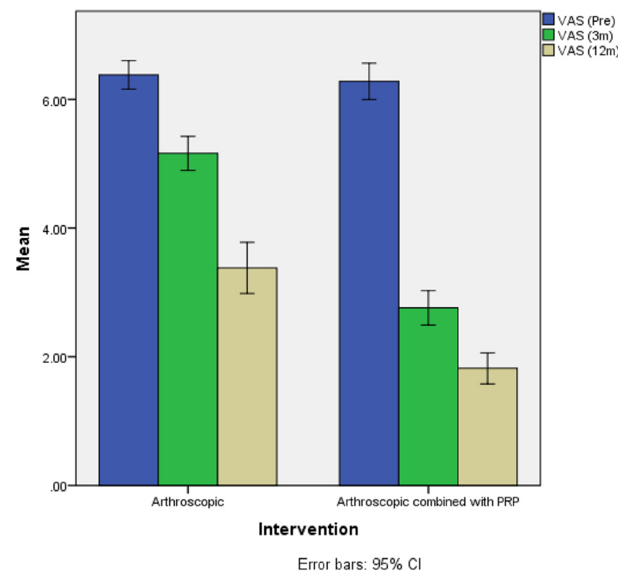

Fig. 4. Comparison between both groups regarding VAS (Pre intervention, 3 m & 12 m).

Table 7. Correlation between BMI, score and visual analog scale.

Variables	BMI	
	r	*P* value
Age	0.029	0.774
Score (Preintervention)	−0.779	0.000[a]
Score (3 m)	−0.449	0.000[a]
Score (12 m)	−0.541	0.000[a]
VAS (Preintervention)	0.608	0.000[a]
VAS (3 m)	0.374	0.000[a]
VAS (12 m)	0.414	0.000[a]

[a] Highly statistically significant at P less than or equal to 0.01.

Table 6. Comparison between both groups regarding visual analog scale (Preintervention, 3 m and 12 m).

Variable	Intervention		Independent sample *t*-test	*P* value
	Arthroscopic drilling	Arthroscopic drilling combined with PRP		
	Mean ± SD	Mean ± SD		
VAS (preintervention)	6.38 ± 0.78	6.28 ± 0.99	0.561	0.576
VAS (3 m)	5.16 ± 0.93	2.76 ± 0.94	12.822	0.000[a]
VAS (12 m)	3.38 ± 1.40	1.82 ± 0.85	6.742	0.000[a]

[a] Highly statistically significant at P less than or equal to 0.01.

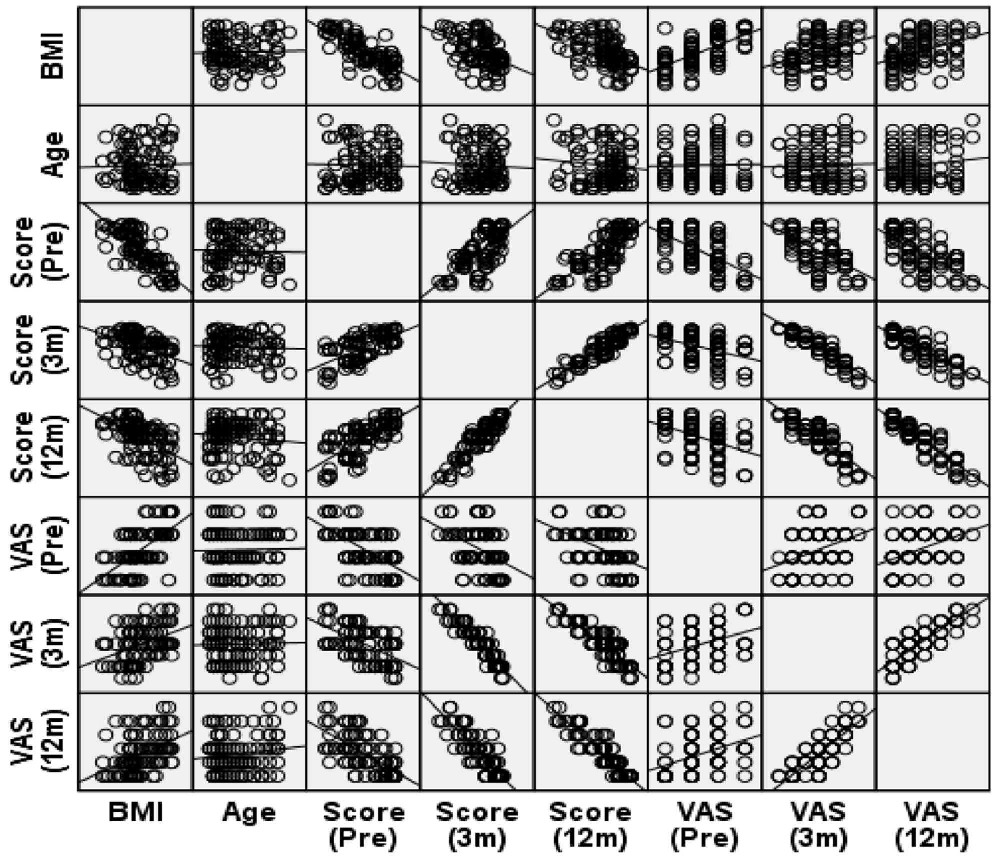

Fig. 5. Correlation between BMI with Lysholm scores and VAS.

whereas VAS scores exhibited a temporal pattern of decrease in both groups, with a significant decrease in the first group. Moreover, the areas of bone marrow defects and volumes of subchondral bone marrow edema were comparatively smaller in the first group than the second group at the 12-month following the intervention. Furthermore, the repaired cartilage thicknesses in the first group were considerably greater than those in the second group ($P < 0.05$). Authors declared that the regenerated cartilage after PRP treatment is nearly similar to normal cartilage histologically and biomechanically [2].

PRP had a brilliant potential role in the management of knee cartilage injuries as revealed by Migliorini and colleagues they demonstrated that the introduction of PRP into in vitro cultures of mesenchymal stem cells and chondrocytes facilitated the integration of normal and repaired cartilage, subsequently inducing chondrocyte cell proliferation and chondrogenesis [16]. Liang and colleagues mentioned that PRP can bypass patients' pain and restore local cartilage defects in the knee joint [17]. By controlling the synthesis of endogenous sodium hyaluronate, which lubricates the joint cavity and reduces friction, PRP can indirectly alleviate the discomfort of the patient [18].

All these works augment the precious role of PRP in management of various orthopedic diseases. PRP has the benefits of being self-derived and lacking risk of transmission of infectious diseases or developing immune response, which subsequently increases the safety of PRP.

4.1. Conclusion

This study suggested that arthroscopic drilling combined with autologous PRP injection plays a crucial role in the gradual improvement of knee function, reducing pain, and enhancement life quality of patients suffering from mild to moderate knee osteochondral lesions, especially in patients with low BMI.

4.2. Recommendation

We recommend the application of arthroscopic drilling in combination with autologous PRP in the treatment of mild to moderate knee osteochondral lesions. It is simple, has minimal associated adverse events and its response may persist for a maximum duration of 12 months. Also, we recommend studying the role of combined treatment over a larger scale of patients and follow-up with them for longer periods.

Authors contribution

The authors contributed in the manuscript equally.

Ethics information

The study was approved by the Research Ethical Committee of General Organization of Teaching Hospitals and Institutes.

Funds

There are no funds.

Institutional review board (IRB) approval number

HB000113.

Conflicts of interest

There are no conflicts of interest.

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