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ORIGINAL ARTICLE

Outcome of Core Decompression Combined with Platelet Rich Plasma for Early Avascular Necrosis of the femoral Head

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Abstract

Background: ***Avascular necrosis of the femoral head(ANFH) is brought on when there is a disruption in the blood flow to the affected area. This leads to the death of cells in the trabecular bone and the marrow. This condition manifests as advanced osteoarthritis and subsequent surface collapse.***

Aim and objectives: ***To examine the clinical and radiological results of treating early avascular necrosis with core decompression combined platelet-rich plasma.***

Subjects and methods: ***This randomized clinical research was carried out on 30 individuals presenting with ANFH attending Orthopedic Clinics of Al-Hussein Hospital, Al-Azhar University, Cairo-Egypt. 4 Patients were bilateral and 26 patients unilateral patients divided into two groups: group A involved 15 cases received platelets rich plasma PRP following core decompression and group B (control group) involved 15 cases who received normal saline following core decompression from September 2022 until October 2023.***

Result: ***Group A comprised individuals aged 26 to 38 years, with a mean age of 31±3. With a range of 26 to 40 years, group B comprised individuals with an average age of 33 ± 4 years. Group A demonstrated significantly better modified Kerboul Angle and Ficat and Arlet stage than group B at the last follow-up ($P < 0.05$).***

Conclusion: ***PRP following CD for early-stage ANFH reduced pain and improved functional results. The PRP group had a significantly reduced rate of disease development measured by both necrosis & collapse.***

Keywords: Outcome; Core Decompression; Platelet Rich Plasma; Early Avascular Necrosis

1. Introduction

Trabecular bone and marrow cell death due to decreased blood flow is a hallmark of ANFH. This results in surface collapse, which is followed by secondary osteoarthritis. In most cases, functional disability and, ultimately, total hip arthroplasty at a young age result from the disease, which rarely regresses once the articular surface has collapsed.[1]

Males are the most impacted, with bilateral involvement occurring in fifty-nine percent of cases. Risk factors for developing avascular necrosis consist of long-term corticosteroid use, trauma, alcohol abuse, smoking & systemic illnesses such as systemic lupus erythematosus, hypercholesterolemia, sickle cell disease, and hypertriglyceridemia. There is speculation that organ transplantation, Caisson disease, and Gaucher disease all raise the risk.[2]

The objective of early disease treatment is to prevent joint degeneration; failure to do so will result in the development of severe pain and movement restrictions within two years.[3]

Increased intraosseous pressure is hypothesized to contribute to developing ANFH, the underlying pathology treated by core decompression. The purpose of core decompression is to alleviate intraosseous pressure and halt the progression of illness. Rerouting blood supply to the necrotic area utilizing drill channels relieves pain, and the area can be gradually replaced. The success rate of core decompression procedures varies widely amongst individual clinics.[4]

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Autologous mesenchymal stem cells derived from iliac crest bone marrow concentrate were injected alongside core decompression to enhance outcomes. These methods have dejectedly failed. Controversy surrounds preserving the femoral head after proximal femoral osteotomies and core decompression, whether or not a graft, vascularized bone grafting, stem cell augmentation, or biological adjuncts are utilized.[5]

Healing logistics and PRP therapy have advanced to the point that individuals with ANFH now have reason for optimism. The utilization of platelet-rich plasma (PRP) is supported by the notion that the increased concentration and release of numerous growth and differentiation factors at the site of injury will significantly enhance the natural healing process.[6]

Bioactive substances excreted by platelets involve platelet-derived growth factor, transforming growth factor-b, hepatocyte growth factor, insulin-like growth factor, endothelial growth factor, vascular endothelial growth factor, and platelet factor 4. These factors control mitogenesis, angiogenesis,chemotaxis, differentiation, and metabolism. [7]

The work aimed to assess the clinical and radiological results of early avascular necrosis treated with core decompression combined platelet-rich plasma.

2. Patients and methods

This prospective comparative research involved 30 individuals from the Orthopedic Clinics of Al-Hussein Hospital, Al-Azhar University, Cairo-Egypt. The cases were separated into two groups: the study group, which received PRP after core decompression(CD), and the control group, which received normal saline solution after CD.

Inclusion criteria: Patients had Avascular necrosis of the femoral head (ANFH) at stage I or II by Ficat and Arlet classification. This classification is used to evaluate the severity of the condition.

Exclusion Criteria: People who met the exclusion criteria had ANFH caused by joint inflammatory disease or trauma, other hip joint-affecting diseases, advanced stage of ANFH, suppression of bone marrow, pregnancy, malignancy, or immunosuppression.

Method: All patients underwent a thorough medical history assessment, including personal and family history, complaints, and past medical and surgical history. Investigational studies included routine laboratory tests and physical examinations to exclude systemic diseases. Preoperative radiographs and MRI were used to quantify the necrotic area. PRP was prepared from the participant's blood using a centrifugation process. WB will be obtained by venipuncture in acid-citrate dextrose tubes. The blood will centrifuged using a soft spin, and the supernatant plasma containing platelets transferred to another sterile tube will centrifuged at a higher speed (hard spin). The lower 1\3rd is platelet-rich plasma, and the upper 2\3rd is platelet-poor plasma. After P is removed, PRP will be suspended in (2-4 ml) and applied to the affected area. The control group similarly received normal saline.

Surgical Procedure: Surgical procedures were executed under regional spinal/epidural anesthesia. A lateral approach was utilized to perform core decompression, and a circular hole in the femoral cortex was created via a conical reamer. When the trephine alone wasn't enough to remove enough bone, a drill was utilized to widen the channel. PRP was injected into the channels in the study group, while the control group received normal saline.

Follow-up: Postoperative pain was evaluated via the visual analog score (VAS), which quantified pain intensity on a scale from 0 to 10. Cases were followed up at 3 and 6 months postoperatively with X-rays and an MRI. The follow-up MRI aimed to reassess the size and characteristics of the necrotic area and evaluate the healing progress.

Ethical Consideration: The study followed ethical protocols ensuring patient confidentiality and their right to withdraw from the study without affecting their care.

Statistical Analysis: Data analysis was performed by SPSS software, and various statistical tests were used, including mean, standard deviation, chi-square test, t-statistic, Z-test, odds ratio, sensitivity, specificity, and predictive values. The level of significance, indicated by the P-value, was set at 5%, and any results with a P-value of under 0.05 were considered significant.

3. Results

The study's main results revealed that The mean age of group A was 31 ± 3 years, ranging between 26 and 38 years. In group B, the mean age was 33 ± 4 years, ranging between 26 and 40 years. 14 (93.3%) patients of group A were males, while one (6.7%) was female. Similarly, group B included 13 (86.7%) males and two (13.3%) females. 10 (66.7%) group A patients were classified as ASA grade I, while five (33.3%) were classified as ASA grade II. Similarly, group B included nine (60%) patients classified as ASA grade I and six (40%) as ASA grade II. All enrolled patients were either stage I or stage II. In group A, three (20%) patients were classified as stage I, and 12 (80%) were classified as stage II. Four (26.7%) patients in group B were classified as stage I, whereas 11 (73.3%) were classified as stage II. In group A, central involvement was reported in nine (60%)

patients, lateral involvement was reported in four (26.7%), and medial participation was reported in two (13.3%) patients. In group B, seven (46.7%) patients had central affection, five (33.3%) patients had lateral affection, and three (20%) patients had medial affection. The area of involvement ranged from 15% to 30% in nine (60%) patients in both groups. In group A, two (13.3%) patients showed less than 15% involvement area, and five *26.7%) patients had more than 30%. In group B, three (20%) patients had less than 15% involvement area, and another three (20%) had more than 30%.

Steroid use was reported as a triggering factor in seven (46.7%) patients in group A and nine (60%) patients in group B. Group A has been followed for a mean duration of 7.3 ± 1.1 months, ranging from 6 to 9 months. Group B has been followed for a mean duration of 8 ± 1.4 months, ranging from 6 to 10 months. A statistically significant improvement was observed in the VAS of group A to a mean of 3.4 ± 1.1 at one month postoperatively and 2.8 ± 0.6 at three months postoperatively. Although the mean VAS increased to a mean of 3.1 ± 0.7 at six months, the change in VAS was not statistically significant. In group B, a statistically significant improvement was observed in the mean VAS to 4.2 ± 0.8 at one month postoperatively. The mean VAS increased to 4.6 ± 1.3 and 5 ± 1.4 at 3 and 6 months, respectively. A statistically significant improvement was observed in the HSS of group A to a mean of 87.4 ± 2.8 at one month postoperatively and 90.4 ± 3.5 at three months postoperatively.

Although the mean HHS declined to a mean of 85.3 ± 4.7 at 6 months, the change was not statistically significant. In group B, a statistically significant improvement was observed in the mean HHS to 83.4 ± 4.3 at one month postoperatively. The mean HHS declined to a mean of 80 ± 3 and 74.8 ± 4 at 3 and 6 months, respectively.

No statistically significant difference was found between groups regarding preoperative VAS and HHS (Independent sample t-test, P = 0.313 and 0.983). Group A demonstrated significantly lower pain levels and better hip function at 1, 3, and 6 months postoperatively compared to group B (Independent sample t-test, P < 0.05). In group A, three (20%) patients had an excellent hip function, 10 (66.7%) had a good hip function, two (13.3%) had a fair hip function, and none had a poor hip function. In group B, only two (13.3%) patients had good hip function, 10 (66.7%) had fair hip function, and three (20%) had poor hip function. No patients reported excellent hip function in group B.

Table 1. Baseline Demographic Data (N = 30).

VARIABLES	GROUP A (N=15)	GROUP B (N=15)	*P* VALUE
AGE, YEARS [A]	31 ± 3 (26-38)	33 ± 4 (26-40)	0.135*
GENDER [B]			0.543**
MALE	14 (93.3)	13 (86.7)	
FEMALE	1 (6.7)	2 (13.3)	
ASA [B]			0.705**
GRADE I	10 (66.7)	9 (60)	
GRADE II	5 (33.3)	6 (40)	
HIP INVOLVED [B]			0.713**
RIGHT	9 (60)	8 (53.3)	
LEFT	6 (40)	7 (46.7)	
FICAT AND ARLET [B]			0.666**
STAGE I	3 (20)	4 (26.7)	
STAGE II	12 (80)	11 (73.3)	
LESION LOCATION [B]			0.755**
CENTRAL	9 (60)	7 (46.7)	
LATERAL	4 (26.7)	5 (33.3)	
MEDIAL	2 (13.3)	3 (20)	
AREA INVOLVED, % [B]			0.842**
< 15	2 (13.3)	3 (20)	
15-30	9 (60)	9 (60)	
> 30	5 (26.7)	3 (20)	
STEROID USE [B]			0.464**
NO	8 (53.3)	6 (40)	
YES	7 (46.7)	9 (60)	
FOLLOW-UP, M [A]	7.3 ± 1.1 (6-9)	8 ± 1.4 (6-10)	0.153*

* Independent sample t test; ** Chi-square test
a: Data are presented as mean ± SD (Range);
b: Data are presented as No. (%)

Table 1 shows age, gender, American society of anesthesiologist ASA physical state, side of involved hip, Ficat and Arlet classification, location of lesion, area of involvement, steroid use and length of follow-up. In terms of baseline demographic information, there were no statistically significant distinctions among groups.

Table 2. Clinical Outcomes (N = 30).

VARIABLES	GROUP A		GROUP B		*P* VALUE*
	Mean	SD	Mean	SD	
VAS FOR PAIN					
PREOPERATIVE	6.2	1.2	5.7	1.2	0.313
3 MONTHS	2.8	0.6	4.6	1.3	0.000
6 MONTHS	3.1	0.7	5	1.4	0.000
P VALUE**	0.000		0.002		
HARRIS HIP SCORE					
PREOPERATIVE	54.2	6.9	54.1	9.6	0.983
3 MONTHS	90.4	3.5	80	3	0.000
6 MONTHS	85.3	4.7	74.8	4	0.000
P VALUE**	0.000		0.000		

Table 2 shows No significant variations were observed among the groups with regard to preoperative VAS and HHS (Independent sample t test, P = 0.313 and 0.983). Group A demonstrated significantly lower pain levels and better hip function at 1, 3, and 6 months postoperatively in contrast to group B.

Table 3. Radiological Outcomes (N = 30).

VARIABLES	GROUP A (N=15)	GROUP B (N=15)	*P* VALUE
KERBOUL ANGLE, DEG [A]			
PREOPERATIVE	199.7 ± 12.6	202.4 ± 10.1	0.517*
LAST FOLLOW-UP	187.2 ± 12.4	212.2 ± 10	0.000*
P VALUE***	0.000	0.000	
FICAT AND ARLET [B]			0.029**
STAGE I	3 (20)	0 (0)	
STAGE II	10 (66.7)	6 (40)	
STAGE III	2 (13.3)	6 (40)	
STAGE IV	0 (0)	3 (20)	

Table 3 shows that, no significant variation was found among groups regarding preoperative modified Kerboul Angle (Independent sample t test, P = 0.517). Group A demonstrated significantly better modified Kerboul Angle and Ficat and Arlet stage in comparison to group B at last follow-up.

Complications

Table 4. Postoperative Complications (N = 30).

VARIABLES	GROUP A (N=15)		GROUP B (N=15)		*P* VALUE*
	No.	%	No.	%	
SURGICAL SITE INFECTION	2	13.3	1	6.7	0.543
FEMORAL FRACTURE	0	0	0	0	-
THROMBOEMBOLISM	0	0	0	0	-
STAGE PROGRESSION	2	13.3	10	66.7	0.003
PLANNED FOR THA	0	0	4	26.7	0.032

* Chi-square test.

Table 4 shows that, in group A, only two (13.3%) patients had disease progression from stage II to III, and no cases were planned for THA. In group B, 10 (66.7%) patients showed progression from stage I/II to stage III/IV, and four (26.7%) patients were planned for THA. The THA and rate of progression of the two groups were significantly distinct (Chi-square test, P = 0.003 and 0.032).

4. Discussion

Due to the well-known negative effect of steroids on the skeletal system, reparative osteogenesis proved insufficient, especially in individuals on high doses of steroid treatment.[8]

Several adjuvant therapies were attempted in an attempt to improve the efficiency of core decompression: bone grafting[9], platelet-rich plasma, mesenchymal cells[10] & tantalum rod insertion.[11]

These supplementary treatments have shown promising results in many studies when applied in the early precollapse stages.[12]

In this research, as a biological stimulant connected to core decompression, PRP was employed in this procedure. PRP indicates platelet-rich plasma, the protein concentration obtained by isolating it from whole blood. Platelets include a wide variety of important bioactive proteins and growth factors (GFs) stored in the α granules of the platelets. Some of these growth factors consist of transforming growth factorβ (TGF-β), fibroblast growth factor (FGF), platelet-derived growth factor (PDGF), endothelial growth factor (EGF), as well as vascular EGF (VEGF). Once activated, platelets produce growth factors (GFs) that induce mesenchymal stem cell chemotaxis, neo-angiogenesis, and osteoblast precursor proliferation.[13] PRP has gained recognition for its significant regenerative capacity and encouraging clinical outcomes.[14,15]

At 1, 3, and 6 months postoperatively, core decompression, with or without the use of PRP, significantly decreased pain (as measured by the VAS score) compared to the preoperative pain score, consistent with the findings of this research. However, contrasted with the control group, the use of PRP after core decompression substantially increased pain relief at one, three, and six months postoperatively.

In concordance with the current study, Aggarwal et al.,[16] in-randomized clinical trial (RCT) study evaluated the efficiency of PRP instillation with CD in early-stage ANFH. The study enrolled 19 cases (25 hips) in the PRP+CD group and 21 cases (28 hips) in the CD-only group. Both groups were well-matched in baseline data. The PRP+CD group showed significantly greater pain reduction than the CD-only group at six weeks, six months, and the last follow-up.

Also, Lyu et al.,[17] examined the effectiveness of PRP in conjunction with β-tri-calcium phosphate (β-TCP) grafts in the early stages of ANFH following CD. The study enrolled 54 hips of 54 patients treated with either β-TCP+CD only (24 patients with 29 hips) or β-TCP+CD with PRP (21 patients with 25 hips). Both groups were well-matched in baseline data. The study showed that both β-TCP+CD with and without PRP significantly reduced VAS pain score at six months. At six months (2.9±0.7 vs. 1.9±0.6) and the final postoperative follow-up (2.8±1.2 vs. 2.2±0.7), the mean VAS scores in the control group were significantly higher than those in the PRP group (2.90 vs. 1.90).

In agreement with the current study, Aggarwal et al.,[16] revealed that the use of CD with or without PRP treatments resulted in a significant

increase in hip function (assessed by HHS), and the improvement was significantly better in the PRP+CD group in comparison to the CD only group at six weeks, six months, and at the last follow-up.

Also, Lyu et al.,[17] revealed that the use of in β-TCP+CD with and without PRP showed a significant increase in hip function (assessed by HHS). Furthermore, they reported that adding PRP resulted in a significantly better outcome (higher HHS) at six months and the last follow-up.

Similarly, Chen et al.,[18] showed that both β-TCP+CD with and without PRP treatments were effective in increasing hip function, with the combined PRP treatment superior.

Moreover, Grassi et al.,[8] in core decompression combined with PRP showed that the average preoperative HHS was sixty-four points, approximately eighty-four points two years after the procedure.

Moreover, Grassi et al.,[8] In a non-controlled trial that estimated the efficiency of core decompression in conjunction with PRP in the management of avascular osteonecrosis of the femoral head in 30 hips (22 individuals, 15-60 years), it was determined that PRP-based core decompression could be considered a treatment option for stages I and IIA of osteonecrosis due to its significant reduction in joint pain and postponement of THA.

Furthermore, Lai et al.,[19] in a meta-analysis & systematic review of 10 RCTs, confirmed the superiority of combined PRP with CD over the only technique in pain reduction among cases with osteonecrosis of the femoral head. These results were confirmed by another systematic review by Han et al.[20]

According to the systematic review by Han et al.,[20] By stimulating angiogenesis and osteogenesis, PRP helps speed bone repair for individuals with ONFH. It also reduces inflammatory reactions in necrotic lesions and protects cells from apoptosis caused by glucocorticoids. Regarding function of the hip assessed by Harris hip score (HHS), the current study showed that core decompression with or without PRP resulted in a significant increase in HHS at one, three & six months postoperatively compared to the preoperative pain score. In addition, the use of PRP after core decompression led to a significantly better improvement in hip function (HHS) at one, three, and six months postoperatively, contrasted with the group that did not get PRP. This was the case even though the control group did not receive PRP.

Furthermore, Lai et al.,[19], a systematic review & meta-analysis revealed a significant disparity between the treatment group, which received adjuvant therapy with PRP, and the control group.

This study was limited by its small sample size, single-center design, and short follow-up.

5. *Conclusion*

This research has indicated that PRP after CD in early-stage ANFH significantly reduced pain and improved functional results. The PRP group experienced a significant decrease in disease progression, as measured by necrosis and collapse area.

5.1 Recommendations

It is recommended that PRP be utilized after CD to improve functional outcomes, slow the development of necrosis and collapse, and increase hip survival after femoral head collapse and total hip replacement. More research is needed to corroborate our findings and uncover the predictors of THA, ideally with a larger sample size and more extensive follow-up.

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