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Research on the anti-inflammatory potential of autologous platelet-rich plasma in patients with knee osteoarthritis at The Vietnam National Institute of Maritime Medicine

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ABSTRACT

Objectives: To evaluate the anti-inflammatory potential of autologous Platelet-Rich Plasma (PRP) by determining the concentration of growth factors and cytokines within the inflammatory system in patients with primary knee osteoarthritis at the Vietnam National Institute of Maritime Medicine in 2024-2025. ***Subjects and Methods:*** A prospective, experimental study was conducted on 30 patients with primary knee osteoarthritis diagnosed according to the American College of Rheumatology (ACR) criteria. Blood samples were collected and separated into Platelet Poor Plasma (PPP), PRP, and Collagen Type II-activated PRP. The concentrations of TGF-β1, IL-1β, IL-6, and IL-10 were quantified by ELISA. ***Results:*** The mean platelet count in PRP (731.55 ± 101.17 G/L) was 3–4 times higher than the platelet count in whole blood (232.35 ± 30.5 G/L) with p<0.001. The concentration of TGF-β1 increased from 4.86 ± 4.39 ng/mL to 64.9 ± 16.1 and 85.1 ± 14.6 ng/mL in unactivated and activated PRP, respectively; IL-1β from 0.20 ± 0.10 pg/mL to 3.21 ± 1.43 and 3.66 ± 1.16 pg/mL; IL-6 from 0.05 ± 0.012 ng/mL to 0.42 ± 0.27 and 0.62 ± 0.21 ng/mL; and IL-10 from 0.053 ± 0.031 ng/mL to 0.222 ± 0.090 and 0.317 ± 0.092 ng/mL. The general trend showed that collagen activation significantly increased the concentrations of all cytokines. ***Conclusion:*** Autologous PRP has strong anti-inflammatory potential by modulating the concentration of pro-inflammatory and anti-inflammatory cytokines. This study provides scientific evidence to support the use of PRP as a safe and effective therapy for the treatment of knee osteoarthritis.

Keywords: *Platelet-Rich Plasma PRP, knee osteoarthritis, cytokine, growth factor*

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INTRODUCTION

Knee osteoarthritis (OA) is a common chronic degenerative joint disease in the elderly, causing persistent pain, limited mobility, and significantly impacting quality of life. The pathogenesis of OA involves a complex inflammatory cascade, where an imbalance between catabolic and anabolic factors leads to progressive cartilage damage. Current treatment methods, such as non-steroidal anti-inflammatory drugs (NSAIDs) or corticosteroids, often only provide temporary pain relief and can have side effects. Therefore, the search for safer and more effective biological therapies is a growing trend.

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Platelet-Rich Plasma (PRP) is a blood product prepared from a patient's own blood, which contains a platelet concentration that is several times higher than in whole blood. These platelets, when activated, release a multitude of growth factors (such as PDGF, TGF-β) and cytokines that play crucial roles in tissue regeneration and inflammation modulation. The anti-inflammatory effect of PRP is a topic of great interest, especially in the context of OA treatment, where inflammation is the primary driver of disease progression.

In Vietnam, the application of PRP therapy in orthopedic and regenerative medicine is becoming increasingly popular. However, research on the anti-inflammatory mechanism of PRP, particularly the direct measurement of growth factors and cytokines after injection, is still limited. Therefore, this study was conducted to evaluate the anti-inflammatory potential of PRP on patients with primary knee osteoarthritis at the Vietnam National Institute of Maritime Medicine. The results of this study will contribute to providing a scientific basis for the application of PRP in clinical practice, while also improving the effectiveness of treatment and quality of life for patients.

OBJECTIVES AND METHODS

Study Objectives:

An experimental, descriptive, and prospective study.

Study subjects: 30 patients with primary knee osteoarthritis were selected and diagnosed according to the ACR (American College of Rheumatology) criteria.

Inclusion criteria: Patients with primary knee OA (Kellgren-Lawrence grade II and III). Patients with persistent pain despite conservative treatment. Patients who agreed to participate in the study and signed an informed consent form.

Exclusion criteria: Patients with a history of joint infection, acute inflammatory arthritis, or tumors. Patients with systemic blood diseases or taking anti-coagulant medications. Pregnant or lactating women.

Research Equipment and Materials

Equipment: Biosafety cabinet Class II, centrifuge, ELISA plate reader and washer, computer, semi-automatic pipettes.

Materials: Tricell kit, hydrolyzed collagen (Arthrys), anticoagulant tubes (ACD-A), Fine Test ELISA kit.

Research Variables and Indicators

Variable Group	Variables	Indicators/Definitions/Classification	Data Collection Method
General Characteristics of Subjects	Platelet Count (G/L)	PPP / PRP	Complete blood count
Objective	Evaluating the anti-inflammatory potential of PRP by analyzing the	TGF-β1 IL-1β IL-6	PPP / PRP no activation	ELISA results

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concentration of growth factors and anti-inflammatory cytokines	IL-10	Activated PRP by collagen

Techniques, Tools, and Data Collection Procedures

Patients who meet the study criteria will have their medical information collected. A 50ml syringe containing 3ml of anticoagulant solution (ACD-A) will be used to draw 30ml of peripheral blood from the patient (for a total of 33ml). The blood is then placed into a Tricell Kit and centrifuged in two steps. The PRP portion is collected in a sterile chamber, and a PPP sample is taken from the plasma chamber. After collecting the PRP, it is activated with hydrolyzed collagen at a 2:1 ratio.

Data Processing and Analysis

The concentrations of TGF-β1, IL-1β, IL-6, and IL-10 are quantified using a sandwich ELISA method with a commercial Fine Test kit. The samples are read with a microplate reader at a wavelength of 450 nm. ELISA results are calculated using Curve Expert 1.4 software, and the collected data are processed using medical statistical methods with GraphPad Prism 9.5.0 software. Quantitative variables are presented as the mean ± standard deviation (mean ± SD).

Research ethics

The study was approved by the Ethics Committee of the Vietnam National Institute of Maritime Medicine.

RESULTS

Characteristics of the subjects

Table 1. Characteristics of study subjects by sex

Characteristic		Quantity (n=30)	Percentage (%)
Sex	Male	**12**	**40**
	Female	**18**	**60**

The study population of 30 patients was aged from 45 to 70 years, with a predominance of females. All patients were diagnosed with grade II and III knee OA.

Quality of PRP samples

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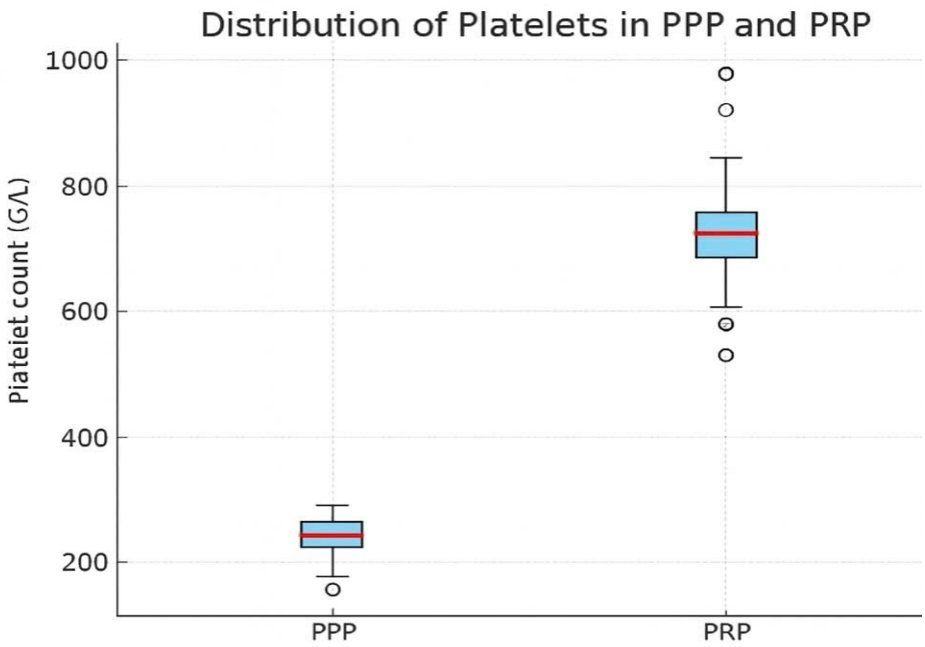

Figure 1. *Average platelets count of study subjects*

The mean platelet count in PRP (731.55 ± 101.17 G/L) was 3–4 times higher than that in whole blood (232.35 ± 30.5 G/L), with p<0.001. The average leukocyte concentration in the PRP was 5.5 x 10^9/L.

Anti-inflammatory potential of PRP:

Table 2. *General characteristics of growth factors and cytokines*

Factor	PPP (ng/mL)	Unactivated PRP (ng/mL)	Collagen-activated PRP (ng/mL)
TGF-β1 (Mean ± SD)	4.86 ± 4.39	64.9 ± 16.1	85.1 ± 14.6
IL-1β (pg/ml) (Mean ± SD)	0.2 ± 0.100	3.21 ± 1.43	3.66 ± 1.16
IL-6 (Mean ± SD)	0.05 ± 0.0115	0.42 ± 0.267	0.62 ± 0.212
IL-10 (Mean ± SD)	0.053 ± 0.031	0.222 ± 0.09	0.317 ± 0.092

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Cytokines consistently increased from PPP → PRP → collagen-activated PRP, with statistically significant differences.

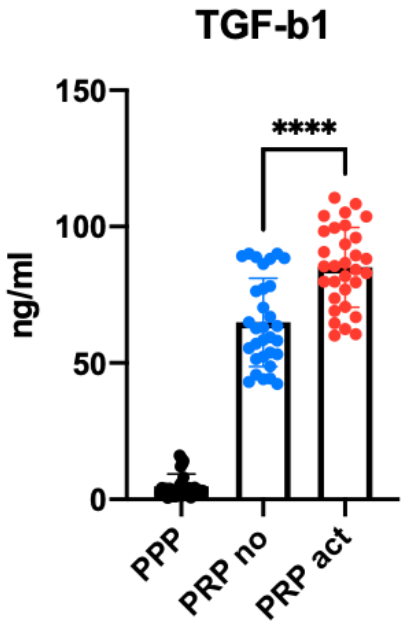

Figure 2. TGF-β1 concentration in study groups

Observation: The mean TGF-β1 value was 4.86 ± 4.39 ng/mL in PPP, increasing to 64.9 ± 16.1 ng/mL in unactivated PRP and reaching 85.1 ± 14.6 ng/mL in collagen-activated PRP. The difference between PRP and PPP was statistically significant ($p < 0.001$). Collagen-activated PRP yielded a higher TGF-β1 concentration compared to unactivated PRP ($p < 0.05$).

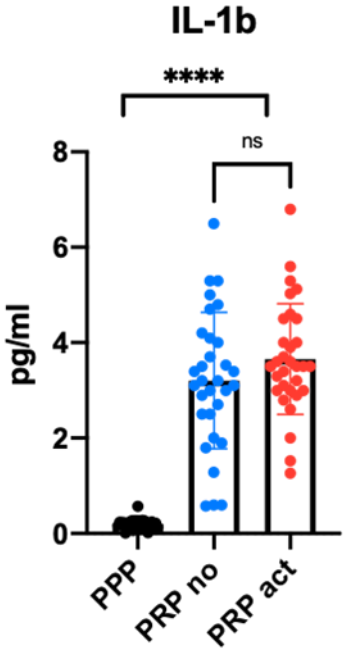

Figure 3. IL-1β concentration in study groups

Observation: The concentration of IL-1β in PPP was 0.2 ± 0.100 pg/mL, increasing to 3.21 ± 1.43 pg/mL in unactivated PRP and reaching 3.66 ± 1.16 pg/mL in collagen-activated PRP. Although the absolute values were low, an increasing trend was observed with the level of activation ($p < 0.05$).

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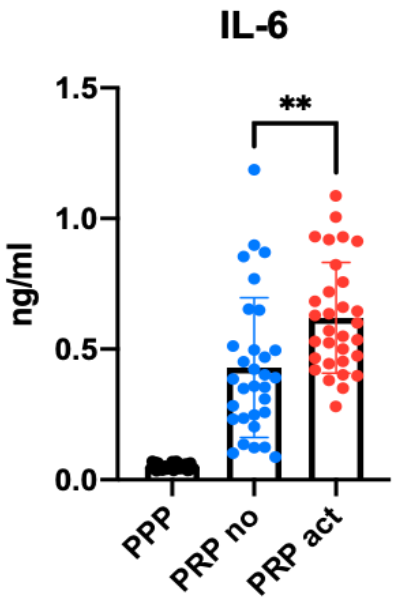

Figure 4. IL-6 concentration in study groups

Observation: IL-6 had a mean PPP concentration of 0.05 ± 0.0115 ng/mL. Unactivated PRP showed a value of 0.42 ± 0.267 ng/mL, and collagen-activated PRP increased significantly to 0.62 ± 0.212 ng/mL ($p < 0.001$).

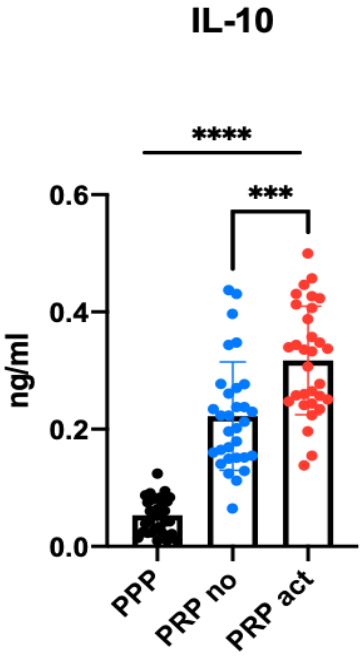

Figure 5. IL-10 concentration in study groups

Observation: The concentration of IL-10 also increased significantly from PPP (0.053 ± 0.031 ng/mL) to unactivated PRP (0.222 ± 0.09 ng/mL), and reached its highest level in collagen-activated PRP (0.317 ± 0.092 ng/mL). The difference was statistically significant ($p < 0.01$).

DISCUSSION

Our study found that PRP, especially when activated by collagen, significantly increases the concentration of TGF-β1 and IL-10. These two factors are crucial in the anti-inflammatory and tissue regeneration mechanisms, which aligns with previous studies reporting that platelet activation leads

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to the robust release of growth factors from α-granules (Andia & Maffulli, 2013; Sundman et al., 2014).

Notably, the concentrations of IL-1β and IL-6—which are considered pro-inflammatory cytokines—also increased after PRP activation. This can be explained by the presence of leukocytes in the PRP preparation, as they are a source of IL-1β and IL-6 production when stimulated. However, the increase in IL-1β remained at a low threshold, while IL-6 increased more significantly, reflecting its role as a "dual" cytokine: it both promotes the initial inflammatory response and stimulates tissue regeneration through mesenchymal stem cell activation.

The simultaneous increase in IL-10 suggests a balancing regulatory mechanism: collagen activation not only stimulates the release of pro-inflammatory cytokines necessary for the initial phase but also promotes the release of anti-inflammatory cytokines, thereby limiting the risk of excessive inflammation. This strengthens the hypothesis that collagen-activated PRP can create a state of "controlled inflammation," which helps initiate cartilage regeneration and simultaneously protects the tissue from secondary damage.

Compared to PPP, PRP clearly offers a superior advantage in the concentration of growth factors and cytokines. The use of collagen as an activator demonstrates high physiological efficiency, mimicking the natural mechanism of platelet activation upon contact with type II collagen at the site of cartilage injury.

CONCLUSION

Collagen-activated PRP in patients with primary knee osteoarthritis showed: The concentration of TGF-β1 and IL-10 significantly increased compared to unactivated PRP and PPP. The concentrations of IL-1β and IL-6 also increased, but IL-1β remained low while IL-6 increased markedly. Collagen-activated PRP creates a state of "controlled inflammation," where both pro-inflammatory and anti-inflammatory cytokines are regulated simultaneously, which may contribute to enhanced effectiveness in treating knee osteoarthritis. These results provide a scientific basis for the clinical application of collagen-activated PRP and suggest a direction for future research to standardize the optimal PRP product for treating joint diseases.

RECOMMENDATIONS

Clinical application: The findings confirm that PRP, particularly when activated with type II collagen, has the ability to create a “controlled inflammatory environment,” balancing pro-inflammatory and anti-inflammatory cytokines. Therefore, PRP should be considered a promising, safe, and minimally invasive therapeutic option for patients with primary knee osteoarthritis. In addition, it is necessary to standardize PRP preparation protocols, conduct larger studies with long-term clinical follow-up, and consider incorporating PRP into official treatment guidelines to optimize both efficacy and cost-effectiveness.

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ABBREVIATIONS

- **TGF-β1 (Transforming Growth Factor Beta 1):** a multifunctional

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cytokine belonging to the TGF-β superfamily.

- **IL-1β (Interleukin-1 beta):** a key pro-inflammatory cytokine involved in innate immunity and inflammatory responses.
- **IL-6 (Interleukin-6):** a multifunctional cytokine playing a pivotal role in acute inflammation and chronic immune regulation.
- **IL-10 (Interleukin-10):** a major anti-inflammatory cytokine, essential for maintaining immune homeostasis and limiting tissue damage caused by excessive inflammation.
- **PPP (Platelet-Poor Plasma):** plasma with a low platelet concentration.
- **PRP no (Non-activated Platelet-Rich Plasma):** platelet-rich plasma without activation.
- **PRP act** (Activated Platelet-Rich Plasma): platelet-rich plasma activated with type II collagen.
- **p-value indicators:**
  * = $p < 0.05$
  ** = $p < 0.01$
  *** = $p < 0.001$
  **** = $p < 0.0001$

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