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The Biology Of Platelet-Rich Plasma In Regenerative Medicine

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Abstract

Background: Platelet-rich plasma (PRP) is a blood derivative prepared via centrifugation, characterized by an elevated platelet concentration, typically 4 to 6 times higher than average.
Objective: To provide a comprehensive review of PRP, assessing its biological foundation, established applications, and emerging potential in regenerative medicine.
Methods: A critical analysis of literature from its inception in 1980, when PRP was first utilized for healing skin ulcers, encompassing diverse medical fields such as ophthalmology, otorhinolaryngology, maxillofacial, aesthetic surgery, surgical wounds, skeletal muscle disorders, burns, and peripheral nerve repair.
Results: PRP is rich in trophic factors, suggesting its potential in tissue repair and regeneration. However, despite extensive research and clinical evaluations, its efficacy remains inconclusive in several therapeutic areas. The current evidence underscores the necessity for methodologically rigorous clinical trials to bolster the evidence base supporting PRP's therapeutic potential.
Conclusion: While PRP shows promise in various applications within regenerative medicine, continued research and robust clinical trials are imperative to ascertain its efficacy definitively and optimize its therapeutic utilization.

Keywords: Platelet-rich plasma, regenerative medicine, osteoarthritis, burns, cosmetic surgery.

INTRODUCTION:

Platelets are cellular fragments originating from the cytoplasm of megakaryocytes in the bone marrow. The creation of the primary thrombus is their most well-known activity; nevertheless, they are also involved in a wide variety of other processes, including inflammation, immunology, tumor progression, and, of course,

thrombosis. Examining them with an electron microscope shows that platelets have several organelles, including mitochondria, peroxisomes, ribosomes, glycogen, and granules. Alpha, which contains fibrinogen, von Willebrand factor, platelet-derived growth factor, and other growth factors (Table I); Delta or dense, which has ADP, ATP, and serotonin; they are potent platelet agonists or activators (Table II); and Lambda, which contains lysosomes, which help dissolve the clot once it has served its purpose (Alvarez et al., 2020).
In addition to their traditional roles, platelets have recently been shown to have a system for protein synthesis, contain mRNA copies for almost one-third of the known proteins in the human genome, process mRNA, and efficiently translate a wide variety of proteins, despite lacking a nucleus and DNA. These findings shifted our understanding of platelets because they can produce proteins reacting to their surroundings. 1 They also Platelets lack a heart, but transcription factors are present; their non-genomic roles, such as in platelet activation signaling pathways and the synthesis of pro- and anti-inflammatory factors via de novo transcription, are now being investigated (Hernández-Ramírez et al., 2022).
Platelet granules have a high concentration of growth factors and can synthesize new proteins from scratch; they also have antimicrobial and inflammation-modulating properties, which all work together to speed the healing of wounds and other forms of tissue injury. These roles are why autologous platelet-rich plasma has been proposed for tissue regeneration and repair. The main objetive of this study is to conduct a comprehensive assessment of the first published bibliography on the biology, effects, and therapeutic indications of platelet-rich plasma in various clinical situations. Daily over the past five years (Table III).

METHODOLOGY:

Injecting a blood plasma high in platelets

Piastre-rich plasma is obtained by centrifugation of whole blood and has a higher piastrine concentration than normal plasma. The benefit of getting it directly from the patient reduces costs and eliminates the possibility of disease transmission. The piastre concentration in piastrine plasma is four to six times higher than in normal blood plasma. In theory, the piastre in suspension can maintain its viability for around seven days, which is long enough to protect the capacity of the expanding fat cells. Proteine plasmatic adhesives such as fibrin, fibronectin, and vitronectin are found in the rich plasma of the passerine, which is different from the rest of the piastrine (Garrido et al., 2019).

Due to the abundance of growth factors in pistachios, growth factor-rich plasma (or growth factor-rich plasma) has also been given the name growth factor-rich plasma or growth factor derived from pistachios. Currently, there isn't any agreement on the best way to obtain rich plasma, and no consistent literature is available on its production or application (López Barbeta et al., 2019).

Table I. Alpha platelet granule content and functionality

Content	Function
Chemokines, Cytokines Platelet factor 4β thromboglobulin RANTES Macrophage inflammatory protein 1α Interleukin 1, Interleukin 8	Regulation of inflammation, chemotaxis.
Adhesive proteins thrombospondin 1 and 2 fibrinogen fibronectin	Cellular interactions, coagulation
Growth factors Platelet-derived growth factor (PDGF) Transforming growth factor β (TGFβ) Epidermal or epithelial growth factor (EGF) Vascular endothelial growth factor (VEGF) Insulin-like growth factor I (IGF-I) Hepatocyte growth factor (HGF)	Cell proliferation and differentiation, chemotaxis, angiogenesis, synthesis of extracellular matrix.
Immunoglobulins IgA, IgE, IgM and IgG.	immune function
Coagulation factors (V and VIII)	thrombin production
von Willebrand factor	Platelet adhesion to the collagen of the subendothelium
Plasminogen activator inhibitor	Inhibition of fibrinolysis
P-selectin	Leukocyte-platelet interaction
The alpha granules have abundant growth factors, sticky proteins, and procoagulant factors. Expression and secretion of RANTES are regulated by proper T-cell activation.	

Table II. Content of platelet-dense granules
Serotonin
Adrenalin
Norepinephrine
Dopamine
Histamine
Divalent cations (Ca+2 and Mg+2)
ADP AND ATP
GDP and GTP
P-selectin (in the membrane)
Molecules that help activate piastrinica are concentrated in the granules (agonists piastrinici)—other passerine verranno starts to create a significant clot once the contents of these granules are released.

Table III. The most common medical contexts for using PRP and when to do so	
Clinical area	Applications
Musculoskeletal pathologies	tendinopathies Meniscopathies Ligament injuries Bone fractures Fasciitis Muscle tears Osteoarthritis
surgical wounds	Gynecological surgery (abdominal) Cardiovascular surgery (sternal and vascular access) Plastic surgery (skin flap)
Burns	Cutaneous and corneal
chronic ulcers	Vascular diabetics By pressure
Ophthalmology	Corneal ulcers, Dry eye
Otorhinolaryngology	tympanoplasty
cosmetic surgery	Facial expression lines, Hair implants
peripheral nerves	Peripheral nerve suture

Alternatively, several commercially available automated devices aim to achieve the ideal result in the piastre. Differential centrifugation is used to separate autologous blood for plasma rich in piastrine; a plastic test tube is recommended for this technique so that the other does not initiate the coagulation cascade. Suppose you promise to maintain strict hygiene standards to stop the spread of disease. Anticoagulants containing citrate and dysprosium or sodium citrate are indicated, whereas ethylenediaminetetraacetic acid is generally avoided it poses to the piastrinic membrane (Carrillo Poveda et al., 2022; Kabakci et al., 2022).

Centrifugation method best suited for obtaining piastrine-rich plasma; Studies published in this area have used a wide range of centrifugation protocols. Therefore it stands to reason that the number of piastres obtained would also vary widely. For therapeutically-prepared piastrine-rich plasma, A minimum reference point of 1 million piastrine/l in a 6 ml aliquot. No one seemed to agree on whether or not it was possible to use the primary piastre of the parrot application in conjunction with the quale agonist to activate the parrot in a prophylactic manner. Some experts recommend using calcium or thrombin to start piastre, while others use it without first activating it, arguing that doing so is unnecessary and yields no better results.

The release of growth factors in vitro is significantly enhanced when preactivated, as shown by the available data. Although some people still use bovine thrombin as an activator for passerine, others choose to use calcium chloride instead due to the hazards of producing anticorpi cross-reactive all thrombin and ad altri fattori Della coagulation. If the plasma is high in passerine and the blood is anticoagulated, the plasma should be used within 8 hours. This is because the piastre is essential, and the Fattoria di crescita are bioactive during this time (López Barbeta et al., 2019).

During degranulation, the piastre was either injured or broken, rendering it unable to secrete the necessary bioactive factors. I have demonstrated that certain aspects can secrete TGF during a riposo; also, I am aware that when plasma rich in piastrine arrives frozen, I sub Connor Danni, and I forgive the parrot's vitality. By using activators, you may obtain higher concentrations of growth factors, and different ratios will produce other effects. Several studies report the hematocrit and the piastrinic count for influenza or the piastrinic concentration of the plasma Ricco di piastre. There are no significant changes in the piastrinic concentration or in the concentration of legit growth fats at any time and in the summer. Anitua recommends getting rid of your leucocyte because their existence is linked to inflammatory effects that can cause fabric damage and prevent repair (Giménez et al., 2018).

Benefits and applications of high-piston-concentration plasma

Diseases of the skeletal and muscular systems

It has been proven to significantly alter the guarigione process, which aids in healing muscle tears. The cytokine implicated in neovascularization, tenocyte proliferation, fibroblast proliferation, and myositis has been found in vitro studies to be regulated by plasma high in piastre: chondrocytes, inhibition of proinflammatory cytokine IL-1 production, and anti-inflammatory and regenerating effects. Effective treatment for short- and long-term muscle injuries can be attributed to these mechanisms.

In acute injuries, fibrillar structure disintegration occurs alongside cellular life damage, an inflammatory response, and a phase of tissue remodeling and repair; chronic injuries show tissue remodeling and restructuring alongside degenerative fibrillar changes and a mild or absent inflammatory response. Injuries to the cruciate ligament, muscle strains, meniscal tears, broken bones and complications (delayed union, nonunion), herniated discs, plantar Fasciitis, cartilage repair, and arthritis in the knees and shoulders (Bertone et al.).

Osteoarthritis

Recent research suggests that osteoarthritis may be one of the most critical and consequential uses of platelet-rich plasma because of the prevalence of this degenerative condition and the associated high expenses of treating it. Platelet-rich plasma has been found to stimulate growth and glycosaminoglycan production in cultured chondrocytes in vitro. Compared to unexposed subjects, nos and type II collagen Human chondrocytes affected by osteoarthritis show decreased IL-1 beta expression, and NFKB activation has inhibitory effects. Despite the absence of a control group, a study employing hyaluronic acid as a control showed positive results in terms of pain and function in patients with early-stage osteoarthritis.

Platelet gel administered intraoperatively improved surgical wound healing, joint mobility, and length of hospital stay in patients undergoing total knee arthroplasty compared to those in control groups. Although this effect is more pronounced in the early stages of the disease, there are statistically significant differences between intra-articular platelet-rich plasma and hyaluronic acid with a 6-month follow-up regarding pain and function favoring the experimental group (Veronesi et al., 2018).

Gynecology

Major gynecological procedures have benefited from the Use of platelet-rich plasma gels for postoperative wound care, including reduced discomfort and fewer opioid prescriptions. However, the effects of platelet-rich plasma on factors like infection or trans and postoperative bleeding were not reported. The closure time of dehiscent abdominal surgical wounds in patients who received the gel was much shorter than in controls.

Alternatively, platelet-rich plasma has been employed as a "stopper" in managing premature rupture of membranes, with positive results in one case. Platelet-rich plasma's potential action of impermeably sealing flaws in biological membranes was demonstrated in an in vitro model of fetal membranes. Further testing and evaluation of this function are warranted (Chicharro Alcántara et al., 2018).

Open heart surgery

Several studies have indicated that the topical Use of platelet-rich plasma reduces the occurrence of chest infection in the care of wounds from cardiovascular surgical procedures, particularly those at the sternal level and those produced by peripheral vascular accesses. In addition to reducing the length of time a patient must spend in the hospital also helps with things like wound drainage, postoperative discomfort, and hemostasis. Some studies have found no substantial benefit from platelet-rich plasma in the treatment of wounds sustained after cardiovascular surgery.

Again, this discrepancy may be attributable to the wide variety of confounders and covariates in these investigations; thus, better-controlled clinical trials on a bigger scale are required to firmly confirm the significance of platelet-rich plasma therapy in cardiovascular surgery wounds (Román & Ferrer).

Surgical Procedures, Both General and Cosmetic

After applying autologous platelet-rich plasma to the operating bed in a recent clinical investigation, researchers found that patients undergoing aesthetic procedures involving the construction of a skin flap significantly reduced bleeding volume. Surgical bed capillary, less postoperative pain, inflammation, recovery time, and less need for drainage or compression bandages. In inguinal hernia repair, platelet-rich fibrin has been used as an adhesive for mesh installation, increasing material tolerance and postoperative pain and reducing the amount of suture material required for fixation.

Platelet-rich plasma was studied in pigs to determine if it could be used as an adjuvant in end-to-end anastomosis following a 50% tracheal resection. The results showed that transanastomotic blood flow was significantly increased, as measured by laser Doppler flowmetry. The tensile force required to cause anastomotic rupture was considerably more significant in the group receiving platelet-rich plasma.

Burn

There are currently only a few trials that conclusively show platelet-rich plasma is helpful in treating burns. Studies in the lab have demonstrated that applying a platelet-rich plasma gel to burns causes a robust inflammatory response characterized by an uptick in extracellular matrix proteins, fibroblast proliferation, collagen production, and granulation tissue. Wound epithelialization has not been shown to speed up in tests. Platelet-rich plasma was injected subconjunctivally in a trial including ten patients with ocular burns, and this resulted in considerably accelerated epithelialization of the cornea and conjunctiva.

In another investigation, significant improvement was seen with the Use of gel platelet-rich plasma in managing various wounds, including friction burns. The reported increase in the inflammatory reaction may stimulate the formation of hypertrophic scars in superficial burns. At the same time, this effect may be beneficial in deeper burns, which may explain why no further studies have been conducted to support the utility of platelet-rich plasma in managing burns. Currently, there is not enough data to help treat burns using platelet-rich plasma. Burn depth, burn thickness, application duration, effect on epithelialization, healing time and type, effect on grafts, infection rate, etc., are all clinically relevant characteristics that will need to be specified in future research (García-Salas et al., 2019).

Diabetic foot ulcers

Multiple studies and a meta-analysis have demonstrated that the administration of platelet-rich plasma to patients with chronic diabetic ulcers significantly accelerates the wounds' closure, decreases pain, and acts even in the most severe injuries without reporting significant adverse events (Altemir & Boixeda, 2022; López Barbeta et al., 2019). Platelet-rich plasma therapy has been shown to improve patient's quality of life and reduce treatment expenses compared to standard care over five years. Platelet-rich plasma treatment in diabetic ulcers is well-based, as there is no contradictory evidence for its efficacy in these chronic wounds; nevertheless, it is yet unknown whether this is an impact.

Platelet-rich plasma on chronic wounds, if its favorable benefits are maintained long-term, decreasing amputation rates, or if other wound variables, concomitant treatment, or the particular patient may impact the outcome. This was supported by recent research of 49 individuals with chronic wounds of varying etiologies (decubitus ulcers, venous ulcers, diabetics, etc.), which showed some degree of recovery (reduction of the area, volume, or closure of the wound), regardless of the source of the damage in 97% of cases.

Ophthalmology

Platelet-rich plasma has been shown in in vitro experiments to promote keratinocyte migration and proliferation and inhibit fibrotic processes by preventing the development of conjunctival myofibroblasts. Subconjunctival injection of autologous platelet-rich plasma dramatically enhanced the closure of a mechanically operated rabbit corneal defect, as seen by faster corneal epithelialization and reduced inflammation compared to controls in an experimental investigation. Meanwhile, in several clinical studies, platelet-rich plasma has been demonstrated to be effective in treating corneal ulcers and other ophthalmological disorders (Blugerman et al., 2021).

Platelet-rich plasma's topical ocular administration (drops or gel) was studied in a clinical trial for its effect on the healing of latent corneal ulcers. It was influential in promoting wound closure and reducing associated discomfort and inflammation. Platelet-rich plasma drops were utilized in comparable uncontrolled research on 18 patients with recurrent corneal ulcers of varying etiologies. In 85 percent of cases, the corneal defect was closed in a matter of weeks. Positive results in the treatment of neurotrophic ulcers using biological membranes have been shown in several case studies.

Finally, the effectiveness of topical administration of platelet-rich plasma in treating symptomatic dry eye was investigated in a trial involving 18 patients. After one month, 89% of participants in this study showed considerable improvement in their symptoms, and researchers also noted a reduction in tear meniscus thickness and conjunctival hyperemia. Platelet-rich plasma has shown encouraging results in preliminary studies, which opens up a wide area for investigation, including treating corneal ulcers of varying etiologies and Sjögren's syndrome keratoconjunctivitis sicca, for which there is now no satisfactory solution.

Otolaryngology

Platelet-rich plasma was administered topically to the eardrums of rats with a bilateral tympanic perforation of 3 mm in diameter. The animals were inspected visually every day until the defect healed. The membrane was observed to close at a faster rate. However, histological analysis showed no significant variations in inflammation and epithelialization characteristics between the groups for tympanic membranes treated with platelet-rich plasma (10 vs. 13 days) compared to controls.

A type 1 tympanoplasty using autologous platelet-rich plasma was recently performed on three patients with inactive central tympanic perforation, with successful results (including complete defect closure) and no adverse effects. There has to be more research done on the effectiveness of platelet-rich plasma in otolaryngology. Nasal dryness, otitis media, and nasal septum perforation are only some of the pathological problems that can be helped by this method.

Clinical Aesthetics and Dermatologic Surgery

Platelet-rich plasma has been used as an adjuvant in several dermatological applications based on experimental and clinical evidence for its stimulating effect in the proliferation of numerous epidermal and mesenchymal cell lines. Twenty-two women participated in a pilot trial that evaluated the effects of laser therapy plus topical administration of autologous platelet-rich plasma to those of just laser therapy alone. A patient satisfaction rating, an objective scale based on before-and-after images, biophysical examinations of the skin (hydration, roughness, and elasticity), and morphological analysis in a skin sample were all used to determine the study's outcomes.

Significant improvements in patient satisfaction, skin elasticity, and collagen density were found in the study. Another study found that when patients with hair implants were given autologous platelet-rich plasma, the thickness and growth of the transplanted follicular units were significantly increased. Dermal papilla cells exposed to platelet-rich plasma showed a significant increase in proliferation, linked to increased Akt and ERK signaling and the positive regulation of fibroblast growth factor-7 and beta-catenin, which are known to stimulate hair growth in experimental settings (Ruiz-Canela et al., 2022).

Also, 7-week-old shaved C57BL/6 mice were given subcutaneous injections of the phosphate-buffered solution, fetal bovine serum, or autologous platelet-rich plasma every three days and examined in vivo for new hair development. After three weeks of treatment, platelet-rich plasma recipients saw nearly full regrowth of hair in the shaved area. Psoriasis, vitiligo, alopecia, lichen planus, and other dermatological disorders, as well as other aesthetic uses, all have new avenues of treatment made possible by platelet-rich plasma. The specific function of platelet-rich plasma in skin and appendage diseases has to be investigated using a rigorous scientific approach.

Axons that travel outside the spinal cord and brain

The combination of suturing and topical administration of platelet-rich plasma significantly accelerated the recovery of facial mobility and electrophysiological parameters following facial nerve transections in rats compared to the recovery following remote administration of platelet-rich plasma or sutures. Platelet-rich plasma combined with mesenchymal stem cells and neurorrhaphy was examined in a similar study involving rats with experimental facial nerve lesions. The results showed considerable improvement, enhanced neurophysiological recovery, and myelination.

Yet another study found that when autologous platelet-rich plasma was used as an adjuvant after a neurotomy of the sciatic nerve was performed in rats, the nerve was anatomized using cyanoacrylate, and the number of axons in the distal segment rose dramatically. Finally, platelet-rich plasma's efficacy was investigated alongside the Use of two to six sutures in an end-to-end neurorrhaphy of rat sciatic nerves; this was followed by neuron conduction tests, which revealed a considerable decrease in latencies—comparing nerves treated with six sutures and PRP to those repaired with two sutures and no PRP. The effects of platelet-rich plasma platelets on various forms of peripheral neuropathies remain to be explored because their Use has not yet expanded beyond the experimental stage.

CONCLUSIONS:

Platelet-rich plasma has been a hot topic in Regenerative Medicine because of its promising therapeutic potential. The wide range and abundance of its possible applications in Platelet-rich plasma have attracted a lot of attention because of its good results in tissue repair, especially in fields like ophthalmology and aesthetic medicine; for nerve regeneration and articular cartilage repair. There has been a lot of research on the benefits

of platelet-rich plasma, and many articles have been written about it, but there are still just a few pieces of evidence to support its Use.

This is not necessarily due to a lack of positive evidence; instead, many clinical trials' methodology (self-controlled, non-randomized, with a small number of patients, reporting subjective improvements, etc.) prevents us from conclusively demonstrating the beneficial effect of platelet-rich plasma. However, basic investigations have shown that the procedures used to acquire and apply platelet-rich plasma might considerably affect the potential outcomes of the treatment. In the future, more adequately designed and controlled clinical trials will be needed to fully demonstrate the effects of platelet-rich plasma and basic and translational medicine studies that will allow for a better understanding of the pathophysiological mechanisms underlying its effects. , to standardize the methods of obtaining and applying platelet-rich plasma, thus allowing the correct comparison of the results obtained and the identification of the role of this type of innovative therapy in Regenerative Medicine.

REFERENCES:

1. Altemir, A., & Boixeda, P. (2022). [Translated article] Laser Treatment of Burn Scars. *Actas dermo-sifiliograficas*.
2. Alvarez, Y. T. S., González, T. H., & González, A. H. (2020). Platelet-rich plasma in facial aging. *Gaceta Médica Espirituana*, *22*(3), 8-17.
3. Bertone, P., Torretta, M., Boaglio, C., Ruiz, F., Suarez, A., Aramayo, A., & Espamer, D. Platelets rich plasma in the viability of skin flaps.
4. Blugerman, G., Schavelzon, D., Martínez, L., Bonesana, G., Chomyszyn, A., Pontón, A., & Izurrategui, N. (2021). The use of platelets rich plasma in fat graft. *Dermatología Cosmética, Médica y Quirúrgica*, *6*(3), 192-197.
5. Carrillo Poveda, J. M., Sopena Juncosa, J. J., Cuervo Serrato, B., Vilar Guereño, J. M., Hernández Guerra, Á. M., Peláez Gorrea, P., Rubio Zaragoza, M., & Santana, A. (2022). Platelet-rich plasma for the treatment of degenerative lumbosacral stenosis [Recurso electrónico]: a study with retired working dogs.
6. Chicharro Alcántara, D., Carrillo Poveda, J. M., Rubio Zaragoza, M., Cugat Bertomeu, R., Cuervo Serrato, B., Guil, S., Forteza, J., Moreno, V., Vilar, J. M., & Sopena Juncosa, J. J. (2018). Combined plasma rich in growth factors and adipose-derived mesenchymal stem cells promotes the cutaneous wound healing in rabbits/Deborah Chicharro, José M. Carrillo, Mónica Rubio, Ramón Cugat, Belén Cuervo, Silvia Guil, Jerónimo Forteza, Victoria Moreno, José M. Vilar and Joaquín Sopena. *BMC Veterinary Research, vol. 14 (2018).*
7. García-Salas, J. D., Carrillo-Gorena, J., Cisneros-Castolo, M., Sierra-Santiesteban, F., & Enríquez-Sánchez, L. (2019). Allogeneic activated platelet-rich plasma in skin grafts of patients with grade III burns. *Cirujano general*, *40*(4), 230-237.
8. Garrido, R. M., Iglesias, E. M., de Armas López, G., & Montiel, D. P. (2019). Use of regenerative therapy in the peripheral arterial disease and the ischemic diabetic foot. *Revista Cubana de Angiología y Cirugía Vascular*, *20*(2).
9. Giménez, D., Chicharro Alcántara, D., Rubio Zaragoza, M., Carrillo Poveda, J. M., Sopena Juncosa, J. J., Cuervo Serrato, B., López Barbeta, S., & Vilar, J. M. (2018). Can plasma rich in growth factors be safe for parental use?: a safety study in the canine model/Elena Damiá, Deborah Chicharro, Mónica Rubio, José M. Carrillo, Joaquín Sopena, Belén Cuervo, Sergio López and José M. Vilar. *International Journal of Molecular Sciences, vol. 19 (2018), n. 9.*
10. Hernández-Ramírez, H., Zárate-Flores, L. M., Peralta-Pedrero, M. L., Medina-Bojórquez, A., Jurado-Santa Cruz, F., & Morales-Sánchez, M. A. (2022). Efficacy and safety of intralesional platelet-rich plasma compared with topical minoxidil 5% in the treatment of male androgenetic alopecia with vertex involvement. *Revista del Centro Dermatológico Pascua*, *31*(1-2), 7-15.
11. Kabakci, A. G., Eren, D. S., Geylani, E. G., Eren, C. M., & Bozkir, M. G. (2022). Morphometric and Aesthetic Analysis of People Following Application of Platelet Rich Plasma for Neck Rejuvenation. *International Journal of Morphology*, *40*(3).
12. López Barbeta, S., Vilar, J. M., Sopena Juncosa, J. J., Giménez, D., Chicharro Alcántara, D., Carrillo Poveda, J. M., Cuervo Serrato, B., & Rubio Zaragoza, M. (2019). Assessment of the efficacy of platelet-rich plasma in the treatment of traumatic canine fractures. *International Journal of Molecular Sciences, vol. 20, n. 5.*

13. Román, G. M. R., & Ferrer, Ú. M. J. Biotecnología del plasma rico en plaquetas (PRP) aplicada a la regeneración tisular humana Biotechnology of platelet-rich plasma (PRP) applied to human tissue regeneration.
14. Ruiz-Canela, M., Guasch-Ferré, M., Razquin, C., Toledo, E., Hernández-Alonso, P., Clish, C. B., Li, J., Wittenbecher, C., Dennis, C., & Alonso-Gómez, Á. (2022). Plasma acylcarnitines and risk of incident heart failure and atrial fibrillation: the Prevención con dieta mediterránea study. *Revista Española de Cardiología (English Edition)*, *75*(8), 649-658.
15. Veronesi, F., Pagani, S., Torricelli, P., Filardo, G., Cavallo, C., Grigolo, B., & Fini, M. (2018). PRP and MSCs on tenocytes artificial wound healing: an in vitro study comparing fresh and frozen PRP.