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The Role of Platelet-Rich Plasma Therapy in Treating Sports Injuries

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Abstract:

Introduction: Sports injuries are a significant health problem for both professional and recreational athletes. Standard treatment methods, including physiotherapy, pharmacotherapy, and surgical interventions, often fall short in cases of severe soft tissue damage. This has led to a growing interest in alternative therapies, such as platelet-rich plasma (PRP). In recent years, there has been growing interest in platelet-rich plasma (PRP) therapy due to its potential regenerative properties. PRP is increasingly used in the treatment of sports injuries, with the aim of accelerating tissue regeneration and facilitating a return to full physical fitness. This paper attempts to analyze available scientific studies to assess the effectiveness of PRP in the treatment of sports injuries.

Purpose of the work: The aim of this study is to assess the effectiveness and safety of platelet-rich plasma (PRP) therapy in treating sports-related muscle, tendon, ligament, and joint injuries, and to compare its efficacy with other established treatment modalities, such as physiotherapy and pharmacotherapy.

Materials and methods: In order to analyze the role of platelet-rich plasma (PRP) therapy in the treatment of sports injuries, a detailed literature review was conducted on the Google Scholar platform. The authors focused particularly on the most recent publications on the use of PRP in the treatment of sports injuries, covering the years 2010 to 2023. The search was conducted using the keywords "Platelet-Rich Plasma", "PRP", "sport injuries", "muscle injuries", and "tendon injuries".

Results: Platelet-rich plasma (PRP) therapy has been shown to be highly effective in treating sports injuries, particularly muscle and tendon injuries. PRP accelerates tissue regeneration and shortens the time to return to physical activity, but the effectiveness of the therapy depends on the proper preparation protocol and individual patient characteristics. Compared to other treatment methods, PRP has a favorable safety profile and a lower risk of complications. Despite promising results, further studies are needed to better determine the long-term effectiveness and optimal conditions for using this therapy.

Keywords: PRP, sport injuries, tissue regeneration, muscle injuries, tendon injuries

Introduction

Platelet-rich plasma (PRP) is a blood-derived autologous preparation that contains a high concentration of platelets suspended in a small volume of plasma. In medicine, PRP is used in fields such as maxillofacial surgery, orthopedics, traumatology, and reconstructive surgery, as well as in the treatment of burns, ulcers, and hard-to-heal wounds[1]. It is typically used in the treatment of muscle belly damage, degenerative joint changes, enthesopathy, tendinopathy, and delayed bone healing. PRP is increasingly used in sports medicine to treat musculoskeletal system damage.

The plasma fraction with a platelet concentration above reference values is obtained in the process of whole blood centrifugation, by fractionation and separation of individual elements depending on their weight[4]. PRP preparation (concentration) is relatively cheap, fast and can be performed in the presence of the patient[3]. With a physiological range of 150-350 thousand platelets in 1 mm^3 of whole blood, after an appropriate preparation process, it is possible to obtain even more than 8-fold platelet concentration, which allows obtaining more than 1 million platelets in 1 mm^3 of plasma concentrate[2].

Platelets contain physiologically active proteins, called growth factors (GFs), which accelerate the regeneration of damaged tissue[3]. The most important of them are: transforming growth factor b1 (TGF-b1), transforming growth factor b2 (TGF-b2), platelet derived growth factor (PDGF), epidermal growth factor (EGF), insulin-like growth factor (IGF), fibroblast growth factor (FGF), hepatocyte growth factor (HGF), vascular endothelial growth factor (VEGF)[3,4,5,6,7].

Types of platelet preparations

Platelet-rich plasma (PRP) is a preparation in which platelets have not yet been activated. Properly prepared PRP should contain only minimal amounts of leukocytes and erythrocytes and can be found in various forms. The most common forms are the injections and fibrin gels. In order for the preparation to perform therapeutic functions, platelets must be activated either naturally through endogenous collagen or by stimulation with external factors (activators): thrombin or calcium chloride[3, 4]. The consequence of activation is the initiation of the clotting process and the secretion of growth factors from platelet granules. A preparation with activated platelets, which has the consistency of a gel, is referred to as platelet-rich gel (PRG).

In addition to platelet-rich plasma preparations, platelet-rich fibrin (PRF) preparations are also distinguished. Unlike PRP, external activators are not used during PRF application. The method of preparation for both of these preparations is also different. PRP and PRF can be further divided into subgroups based on the leukocyte concentration and fibrin structure. These include pure platelet-rich plasma (P-PRP), leukocyte- and platelet-rich plasma (L-PRP), pure platelet-rich fibrin (P-PRF) and leukocyte- and platelet-rich fibrin (L-PRF)[3, 8]. The literature also describes injectable platelet-rich fibrin (i-PRF), advanced platelet- -rich fibrin (A-PRF)[3, 9], platelet-rich concentrate (PRC)[3, 10], plasma-rich in growth factors (PRGFs)[3, 11], autologous platelet-rich plasma (aPRP)[3, 12].

Mechanism of action

The mechanism of action of PRP is based on the release of growth factors from α-granulocytes by activated platelets. Growth factor secretion begins within 10 minutes of clotting onset. More than 95% of growth factors are released within an hour of platelet activation. Then, for several days, platelets synthesize and secrete additional amounts of growth factors[3, 10, 39].

Marx et al. (1998) described the mode of action of PRP using the example of the process of regeneration of bone tissue in the mandible after cancellous bone transplantation[3, 40]. Bone regeneration is closely related to the difference in oxygenation between the defect site and healthy tissue. Defect areas are characterized by lower oxygenation levels and acidosis, which attracts macrophages that play a key role in wound cleansing and growth factor secretion. The regeneration process is initiated by the release of factors such as PDGF, TGF-β1 and IGF from platelets, which stimulate osteogenic cell proliferation, angiogenesis and bone matrix formation. TGF-β and IGF-1 are responsible for fibroblast proliferation and migration, enhancing collagen synthesis, while PDGF stimulates tissue remodeling and the production of other growth factors. VEGF is crucial for the induction of angiogenesis[4, 40].

PRP-clot release (PRCR) therapy supports the differentiation of tendon stem cells (TSC) into tenocytes, which are characterized by high proliferation and the ability to produce collagen[4,42]. Platelet-rich plasma supports the growth and differentiation of stem cells (MSC) and plays an important role in therapy using them[4].

The initially formed bone, referred to as phase I bone, is disorganized and lacks structural integrity. Within 4 weeks of bone grafting, it gradually resorbs and transforms into mature phase II bone, which is characterized by the presence of Haversian canals. This process is controlled by IGFs and BMPs, released during bone remodeling.

Regenerative mechanisms based on growth factors are adaptive, allowing for effective mobilization of repair cells in response to injury[3, 41]. The effectiveness of this regeneration depends on the parameters of platelet-rich plasma preparation, including the conditions of blood collection and processing and platelet activation[3, 39].

Application and effectiveness

Platelet-rich plasma is used in the treatment of many diseases and injuries, which is why it has been used in sports medicine. The increase in the number of people practicing sports at an amateur level and the increasing intensity of training in professional athletes cause a higher frequency of damage to tendons and their bone attachments. It is estimated that tendon injuries constitute 30-50% of sports injuries[4]. The natural healing process of the tendon is long (due to poor vascularization), which translates into a long break in training[4,31]. As a result, alternative methods of treating enthesopathy and tendinopathy have been sought. The indication for the use of PRP in tendon injuries is considered to be chronic forms lasting more than 3 months[4,32].

In 2016, the effectiveness of using autogenous L-PRP in the treatment of "jumper's knee", i.e. patellar tendon tendinopathy - an overload-degenerative injury. It occurs most often in people practicing sports such as volleyball, basketball and handball, because in these sports disciplines an inherent element is a jump with subsequent landing on the feet[13, 15, 16]. The research involved 43 men aged 16-40. Before the symptoms of "jumper's knee" appeared,

18.6% of the participants practiced sports professionally, 69.8% recreationally, and 11.6% declared that they did not engage in regular physical activity. PRP used in the study was prepared using the Curasan method, thanks to which 2.5 ml of platelet-rich plasma enriched with leukocytes was obtained[13, 14]. In order to obtain reliable results, six control tests were performed, during which the functional capabilities of the patient and knee function (on the KSS scale) were assessed. In addition, the patient made a subjective assessment of the knee joint function using the IKDC-2000 scale and assessed satisfaction with the knee joint function on the VAS scale. The first examination took place before treatment, the next ones after 3, 6, 9, 12 and 24 months after injection of the pathologically changed areas of the patella. It was observed that the point values of the scales increased with time up to 6 months, and then stabilized at a level similar to the values obtained after six months. Importantly, better results were achieved by people with shorter duration of symptoms. After the two-year observation period, normalization of knee function and significant improvement in their function were observed in the subjects. On this basis, it was concluded that a single injection of autogenous L-PRP is an effective method of treating "jumper's knee" that provides lasting results [13].

The high effectiveness of a single PRP injection in the treatment of patellar tendinopathy was also demonstrated by Gosens et al., who in 2012, as part of their investigation, assessed the improvement in the knee function of participants after using PRP using the Visa P scale. Moreover, the authors noted better results in patients who had not previously been treated with corticosteroids and had not undergone surgery compared to patients who had previously undergone these forms of therapy[13,16].

In 2015, Zayni et al. compared the effectiveness of the treatment of "jumper's knee" with a single and double injection of PRP. The authors used the Visa P, Tegner and VAS scales to assess the results. Better results were achieved by patients who had undergone two injections[13,15].

Filardo et al. in 2013 conducted a study on 43 patients whose knees had been injected three times at two-week intervals. To reliably assess the results, they used the Visa P, EQ-VAS and Tegner scales. In the EQ-VAS scale, the greatest improvement was noted up to 6 months, while the results stabilized later. Of the research participants, as many as 81.4% returned to sports. In the investigation, patients with bilateral patellar tendinopathy and those reporting a longer duration of disease symptoms achieved worse results[13, 17].

In the same year, Ferrero et al. performed two PRP injections in 28 people suffering from "jumper's knee". The first follow-up examination of the participants was conducted after 20 days, and the second after 6 months. After 20 days, there was only minimal improvement, while after six months the results expressed on the Visa P scale were significant. Patients participating in the study returned to sports on average 6 weeks after the second injection[13, 18].

In 2014, Charousset et al. administered three injections of PRP to the knees of 28 study participants, who were active athletes. The authors noted significant symptom relief and improved knee function, which allowed the subjects to return to their full physical condition prior to the period of disease symptoms. By using magnetic resonance imaging to assess treatment outcomes, the researchers also demonstrated a positive effect of PRP on the correct fibrillar structure of the patellar ligament[13, 19].

Another application of PRP therapy was reported in 2018 by Le et al., who analyzed scientific papers on the effectiveness of platelet-rich plasma treatment. According to the aforementioned authors, this treatment method is particularly effective in the case of tennis elbow enthesopathy and knee osteoarthritis. The researchers moderately recommended PRP injections for patients with patellar tendon and plantar fascia tendinopathy. Le et al., however,

found no convincing evidence for the effectiveness of PRP therapy in the treatment of hip osteoarthritis, rotator cuff and Achilles tendon tendinopathy, bone union disorders, as well as muscle injuries and ankle sprains[2, 20].

In 2022, a retrospective analysis of 400 PRP procedures performed at the Sutherland Medical Center in Warsaw in the period 2017-2020 in 299 people (186 women and 113 men) was performed. Among the study participants, the most common indication for this method of treatment was degenerative disease of the knee joint. Other common indications were: lumbar disc disease, rotator cuff tendon damage, lumbar spinal stenosis, cervical disc disease and degenerative disease of the glenohumeral joint. For the purposes of the investigation, 379 pieces of information about the outcome of the therapy were obtained after 2 months of follow-up and 377 pieces of information about the outcome of the therapy after 6 months of follow-up from the time of the procedure. The authors chose the McNab scale to assess the results of the treatment. The total results of the treatment after 2 months showed 54.25% of satisfactory results, while after 6 months this percentage increased to 59%. The highest percentage of desired results after 6 months of follow-up was noted in the cervical disc disease group – 82.4%. This percentage was also high in the case of the initial phase of knee osteoarthritis – 80%. These results were significantly higher compared to those obtained after 2 months of the procedure. In the subsequent stages of knee osteoarthritis, a significant reduction in the percentage of expected results was observed after 6 months of follow-up (60.5% in the moderate form of the disease and 50% in the advanced form). When examining the group of participants with advanced knee osteoarthritis, it was also noted that among patients over 74 years of age, the frequency of unsatisfactory results was higher than in younger patients. In the case of rotator cuff tendinopathy, regardless of the degree of damage, the percentage of desired results after 6 months was 59.6% and this was a higher result than after the first check-up. In lumbar disc disease, the result six months after the procedure was 63%, which was slightly lower than the result obtained after 2 months. The lowest percentage of satisfactory results after 6 months (regardless of the stage of the disease) was noted in hip osteoarthritis (33-40%). This result was also low in the group of glenohumeral joint osteoarthritis, where it was only 41.7%[2].

In 2017, Cole et al. conducted a retrospective randomized study comparing the effectiveness of PRP and hyaluronic acid in the treatment of knee osteoarthritis (initial and intermediate stage of the disease) based on a 52-week follow-up. The results indicated a slightly higher effectiveness of PRP therapy, after which a reduction of pro-inflammatory factors in synovial fluid was observed[2, 21]. A year later, Cook et al., analyzing numerous publications, found that the use of PRP has a higher efficacy in osteoarthritis of the knee joint not only than hyaluronic acid, but also than steroid injections, rehabilitation, non-steroidal anti-inflammatory drugs and stem cells[2, 22].

The positive effect of PRP on joint function, as well as pain reduction in this disease, was also demonstrated by Dai, who in 2017 analyzed 10 studies conducted on 1069 patients. The efficacy described by Dai referred to a period of 12 months[4, 28]. Similar results were obtained in 2016 in their meta-analyses by Riboh on a sample of 1055 patients and Meheux on a sample of 739 patients [4, 29, 30].

However, there are scientific works that do not confirm the effectiveness of this method of treatment. One such publication comes from 2013. At that time, its authors - Stenhouse et al. examined the effectiveness of using PRP in the treatment of "tennis elbow" in comparison to the therapy consisting in inducing a microhaematoma through serial needle punctures without the use of a drug ("dry needling"). The results did not show significant differences between the mentioned methods[2, 23].

In addition, a significant portion of the studies described in the literature on the effectiveness of PRP use in enthesopathies do not properly document the research process, do not have a randomized control group, and the observations are not long enough. All these factors make it impossible to draw clear conclusions[4].

In 2015, Figueroa et al., observing patients after ACL reconstruction surgery, did not note a beneficial effect of PRP on the recovery process[2, 25].

A year later, Saltzman et al. examined the effect of intraoperative PRP on preventing recurrent rotator cuff tendon rupture. The results obtained by the authors indicated that the use of PRP did not reduce the risk of another injury[2, 24].

The skepticism of opponents of treating patients with PRP intensified after the publication in 2020 by Nauwelaers et al. of a meta-analysis covering as many as 367 scientific papers on Achilles tendons. The authors not only do not recommend PRP therapy as a first-line method, but also did not notice any significant effectiveness of this form of treatment[2, 26].

In 2020, an analysis of various methods of treating cervical radiculopathy was also published, which may develop in athletes as a result of injuries and overloads (contact sports), repetitive movements (e.g. in swimming) and poor training techniques. The authors compared: laser therapy, magnetophoresis with collagen, traction therapy, autologous serum-conditioned therapy, manual therapy and PRP therapy. This time, the results indicated biological therapies (including PRP) as methods with higher effectiveness than mechanical and physical therapies in terms of the parameters used for assessment: neck disability index, pain reduction and hand sensorimotor skills both after the end of treatment and after the observation period, which may suggest their regenerative properties[27].

Researchers are interested in the possible use of PRP therapy in the treatment of acute muscle belly injuries, which are a common cause of training breaks in athletes. The in vivo laboratory researches conducted so far, although they suggested the possibility of accelerating the muscle regeneration process using PRP, did not show clear evidence of similarly satisfactory effects in humans[4, 33, 34].

The results of studies on the effectiveness of PRP in the treatment of bone injuries are also ambiguous. The main problems in their interpretation are small research groups, a significant risk of systematic errors and low statistical quality. This topic requires further studies that would allow for drawing unambiguous conclusions[4, 35, 36]. This is important because in vivo laboratory investigations, a beneficial effect of PRP was noted, especially in combination with bone graft or substitutes[4, 37]. The authors who will soon undertake an analysis of the methods of treating bone nonunions should plan a study that will provide new, reliable information on the possibility of combining PRP therapy with tissue reconstruction techniques[4, 38].

Risks and contraindications

Despite its advantages, PRP therapy is associated with several significant contraindications and risks. Contraindications include current infections, fever, diarrhea, active neoplastic processes, blood clotting disorders, thrombocytopenia, hypofibrinogenemia, as well as pregnancy and breastfeeding[2, 3, 10].

Risks associated with PRP therapy include the possibility of contamination of the preparation with microorganisms during its preparation and the risk of infection and mechanical tissue damage associated with injection.

Furthermore, incorrect administration of PRP into a blood vessel can lead to intravascular coagulation[3].

The presence of leukocytes in PRP is debated, as they may delay healing by releasing catabolic enzymes and reactive oxygen species[3, 43, 44].

Additionally, avoiding skin exposure to sunlight during therapy is recommended due to the unclear effect of UV radiation on TGF-β functions[3, 45].

Patients should be informed about the potential risks before the procedure, especially if they have allergies to anesthetics used during the injection[3, 46].

Conclusions

Studies on the use of platelet-rich plasma (PRP) in the treatment of various conditions have shown that this approach can be effective in selected cases, especially in the treatment of tendinopathy, enthesopathy and osteoarthritis. In particular, the use of PRP led to improved function and reduced pain in the short term, which is confirmed by numerous randomized controlled trials.

However, the results of studies on the effectiveness of PRP are varied, and some studies have shown no significant advantage of this method over standard therapies or placebo. The variability in outcomes may stem from differences in research protocols, including differences in the preparation and administration of PRP, as well as in the characteristics of the studied patient groups. There is also a lack of consensus on the optimal number of injections and the intervals between them, which limits the possibility of formulating clear clinical conclusions.

Despite promising results, further studies with a larger number of participants, a longer observation period, and standardized protocols are necessary to clearly determine the effectiveness and safety of PRP in the treatment of various conditions. It is also necessary to conduct studies comparing PRP with other modern treatments to determine its real clinical advantage.

The use of PRP requires further verification in well-designed clinical trials, which will allow for a better understanding of the mechanisms of action of this therapy and its potential benefits and limitations in various patient groups.

Disclosure:

Authors’contribution:

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Methodology: Aleksandra Mazurek

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