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Treatment of comminuted calcaneal fracture with platelet-rich plasma: a case report

Tratamiento de una fractura del proceso anterior del calcáneo con plasma rico en plaquetas: caso clínico

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Keywords:

Plasma, platelet, fracture, calcaneous, regeneration.

Abstract

Platelet-rich plasma (PRP) treatment is a technique that gives good results in both soft tissue repair and bone regeneration. The literature describes many applications treating various soft tissue pathologies. However, for bone regeneration, its use has been relegated to surgical procedures in which postoperative acceleration is sought. Based on the scientific evidence that, biologically, PRP promotes healing, a decision was made to consider its use in the resolution of fractures through its promotion of bony callus formation.

A clinical case is described of a 58-year-old woman who presented with anterior process calcaneal fracture. The computed tomography (CT) scan showed multiple fracture lines in the anterior portion of the calcaneus without significant displacement of the fragments. Treatment by local PRP injections was initiated, and symptomatic improvement was observed.

After three sequential local injections of PRP, the patient improved symptomatically and functionally. The CT scan following the treatment showed the fracture to have been resolved.

Platelets' biological regenerating activity accelerates the formation of bony callus, promoting cell regeneration and hence the resolution of the fracture. Clinical relevance, level of evidence V.

The favourable evolution of the anterior process calcaneal fracture raises the possibility of opening new lines of application of PRP injections for bone regeneration.

Palabras clave:

Plasma, plaquetas, fractura, calcáneo, regeneración.

Resumen

El plasma rico en plaquetas (PRP) es una técnica que ofrece buenos resultados tanto en la reparación de tejidos blandos como en la regeneración ósea. La literatura describe múltiples aplicaciones en distintas patologías de los tejidos blandos. Sin embargo, en lo referente a la regeneración ósea su uso queda relegado a procesos quirúrgicos en los que se busca acelerar el postoperatorio. Basándonos en la evidencia científica que afirma que biológicamente una concentración de plaquetas aumentadas favorece la cicatrización, nos planteamos su uso en la resolución de fracturas al favorecer la formación del callo óseo.

Se presenta un caso clínico de una mujer de 58 años de edad que acude a consulta presentando fractura conminuta del calcáneo. La imagen de la tomografía computarizada (TC) presenta múltiples líneas de fractura en la porción anterior del calcáneo sin desplazamientos significativos de los fragmentos. Se inicia tratamiento con infiltraciones locales de plasma rico en plaquetas, se observa mejoría sintomatológica.

Tras tres infiltraciones locales secuenciales de plasma rico en plaquetas se observa mejoría sintomatológica y funcional del paciente. La imagen del TC posterior al tratamiento muestra la resolución de la fractura.

La actividad biológica regeneradora de las plaquetas acelera la formación del callo óseo promoviendo la regeneración celular y en consecuencia la resolución de la fractura.

Nivel de evidencia V. La evolución favorable de la fractura conminuta de calcáneo plantea la apertura de nuevas líneas de aplicación de las infiltraciones de plasma rico en plaquetas para la regeneración ósea.

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INTRODUCTION

In recent years, the use of autologous growth factors has come to be seen as an effective alternative treatment in processes for cell regeneration[1,2]. These growth factors can be easily obtained from the patient's own peripheral circulating blood platelets. The good results reported by scientific studies of this technique have led to the continual expansion of its field of application to different medical disciplines. Its use in the pursuit of cell regeneration has extended from its application in dentistry, maxillofacial surgery, and dental implants[3,4] to the regeneration of tendons[5], ligaments[6,7], and cartilage within the area of orthopædics[5,8-12], and to its application in ulcerous complications of diabetes[13,14].

Platelets arise from the cytoplasmic fragmentation of the bone marrow's megakaryocytes. They enter the bloodstream as anuclear elements, and therefore have a limited lifespan of 7-10 days. Platelet-rich plasma is a volume of plasma extracted from the patient, for whom it is therefore neither toxic nor immunoreactive. Its platelet concentration goes from 2/3 times to some fivefold greater (10^6 plt/µL) than normal blood's (1.5-3.5 × 10^5 plt/µL)[1], being more effective concentrations between 2 to 3 times of normal concentration in blood, because some growing factors are not effective at highest proportion[8].

Platelet-rich plasma can be obtained from an extraction of the patient's own peripheral blood[6]. Its properties are based on the production and release of many growth and differentiation factors when the platelets are activated. Platelets begin to actively secrete these proteins at ten minutes after coagulation. Their action is complex, and each of the factors may have a different effect in different tissues[8]. The interaction between the growth factors and the surface of the target cells activates the induction of the proteins needed for the processes of regeneration. In this way, cell proliferation, matrix formation, osteoid production, and/or collagen synthesis is activated[1,15].

The commonest technique used to obtain the patient's blood is peripheral extraction from the antecubital region. The recommendation is to use an 18-gauge needle so as to reduce irritation and trauma to the platelets, and thus leave them in an inactive state[6]. The blood is collected in a tube with citrate-dextrose-acid-A (ACD-A) anticoagulant, and transferred immediately to the centrifuge[6]. The standard protocol established to prepare autologous blood PRP is based on two centrifugation steps. The first step separates red blood cells from the plasma, which then contains a variable concentration of platelets with or without white blood cells. Subsequently, the top part of the tube (platelets and plasma) is drawn off and subjected to a second centrifugation. In this, the platelets agglutinate, achieving the suspension with the desired concentration of platelets in the appropriate volume of plasma[16]. To activate the platelets for them to release growth factors, calcium chloride must be added to the preparation (10%)[8].

The area of the lesion has to be identified beforehand. The associated tissue damage zone (susceptible to repair with the technique of PRP injections) must be clearly localized by clinical examination and medically indicated diagnostic imaging studies[6]. The application of PRP is by local injection of the preparation directly into the site of the lesion. In most cases, there exists hypersensitivity and/or painful symptomatology in the area. For this reason, sometimes the use of a pre-inoculation local anæsthetic is recommended prior to the injection of PRP[5,7,9,11].

Some authors recommend the use of an ultrasound-guided injection technique, especially in cases in which such visualization of the needle may avoid the PRP preparation being deposited within a tendon[6,12,17].

CASE REPORT

A 58-year-old female patient, with no diabetes or other systemic diseases, presented for pain in the left hindfoot. The patient suffered a severe inversion sprain 9 months ago, witch was treated by his medical doctor with a bandage, analgesics and corticoids. First x-rays dismissed the fracture.

Current clinical examination showed a moderate œdema and localized pain in the sinus tarsi region (which the patient treated with analgesics) that prevented normal ambulation. A CT scan of the left foot without intravenous contrast showed multiple fracture lines in the anterior portion of the calcaneus (Figure 1). So, the patient was diagnosed of anterior process calcaneal fracture, not diagnosed 9 months ago.

Autologous blood PRP treatment was initiated using a closed kit (Ortho Pras®, Proteal, Barcelona, Spain). Into a syringe with 2ml of sodium citrate, 18 ml of blood was drawn from the patient's antecubital region, obtaining a total of 20 ml of anti-coagulated blood. This was immediately subjected to centrifugation (1800 rpm, 8 minutes, with smooth progressive acceleration and deceleration to prevent hæmolysis). The

Figura 1. CT scan prior to treatment with PRP.

Table I. Clinical evolution.

Year	Patient´s condition	Treatment
February 2015	Ankle Sprain. Medical visit, x-rays don´t showed the fracture	Bandage
November 2015	Visit to Podiatrist. Localized pain in the sinus tarsi region. CT revealed the anterior process calcaneal fracture	1st PRP injection
December 2015	Notable improvement in the painful symptoms at rest and a reduction of the œdema in the zone	2nd PRP injection
January 2016	Pain dissapeared and improvement in gait.	3rd PRP injection
February 2016	2nd CT. Resolution of the fracture	

result was about 4 ml of PRP (with no leucocytes), to which 0.20 ml of calcium chloride was added to activate the platelets so that they would release the growth factors. These parameters are stablished by the laboratory to optimally obtains the PRP. This was then administered to the patient by local injection, distributing the preparation (3 ml) over the anterior zone of the calcaneus and the tarsal sinus. After, this treatment the process was repeated twice more, with one month separations. In total, the full treatment consisted of three local infiltrations of autologous PRP and 48 hours of relative rest after the injections.

After the first injection, 48 hours of relative rest was recommended. The patient already referred to a notable improvement in the painful symptoms at rest and a reduction of the œdema in the zone. One month after the second injection, the painful symptoms had disappeared completely, and there was substantial increase in ambulation without limitations. Ten days after the third injection, visible clinical signs were compatible with normality, and the associated painful symptoms and incapacity when walking had completely disappeared. A computed tomography (CT) scan without intravenous contrast one month after the third injection showed complete resolution of the fracture (Figure 2). Clinical evolution of the patient is summarized in Table I.

DISCUSSION

All studies using PRP in therapies involving bone agree in that it is a technique that gives good results in bone regeneration[1,2,8,10,16,18,19]. However, most of the scientific literature limits its use to combinations with different orthopædic surgery techniques in order to accelerate the bone regeneration process[6,8,15,16]. Some authors recommend the technique in cases of unsatisfactory bone fusion, and even combine it with other osteosynthesis materials[20,21]. There have been recent references that deal with the treatment of fractures in diabetic patients, justifying the use of PRP in an attempt to speed up the process of the fracture's resolution[13]. Nonetheless, there has as yet been no scientific reference recommending the treatment of comminuted fractures with PRP as the first treatment option. Due to the good results obtained in the clinical case reported above, we believe that the use of PRP in cases of fractures with avulsion of small bone fragments may be a good therapeutic option. One of the strengths of this technique may be the rapid bone regeneration together with the

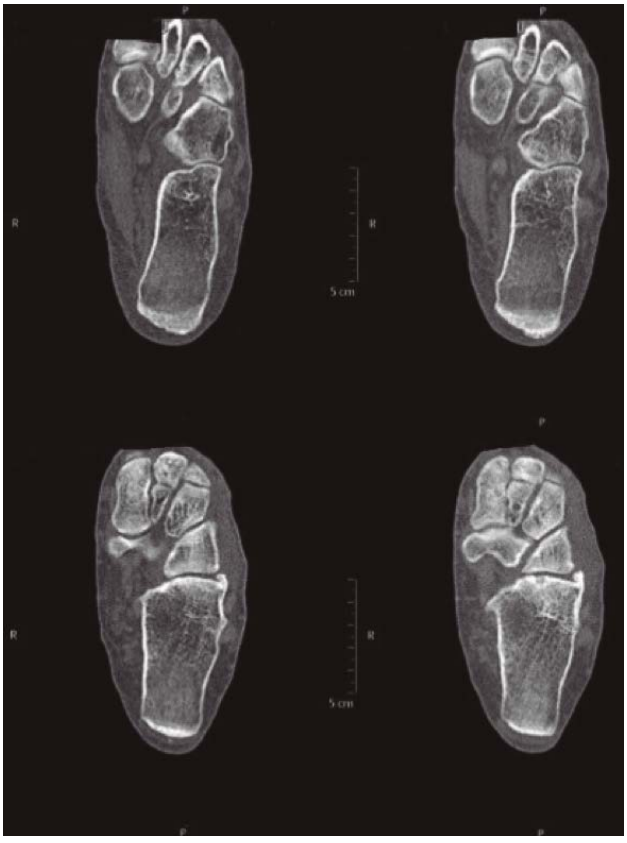

Figura 2. CT scan subsequent to treatment with PRP.

patient's rapid symptomatic improvement without the need for prolonged immobilization or surgery. All this implies an increase in the patient's quality of life since, being able to walk, they do not have to give up their everyday activities. Furthermore, the mobility during the healing process helps prevent the problems of thrombosis and amyotrophy typical of prolonged immobilization.

One must not forget that the use of this technique as a treatment of choice in comminuted fractures must be backed up by scientific studies with larger samples. This is therefore understood as a limitation of the proposed approach, with it instead pointing to new lines of investigation. Nevertheless, given the successful resolution of the comminuted calcaneal fracture with PRP in the present case, we recommend the use of the technique in patients with similar characteristics because, even though the result may vary over time, it is safe in that it poses no toxic or immunoreactive risks for the patient.

REFERENCES

1. Alsousou J, Ali A, Willett K, Harrison P. The role of platelet-rich plasma in tissue regeneration. Platelets. 2013;24(3):173-82. DOI: 10.3109/09537104.2012.684730.
2. Wasterlain AS, Braun HJ, Harris AH, Kim HJ, Dragoo JL. The systemic effects of platelet-rich plasma injection. Am J Sports Med. 2013;41(1):186-93. DOI: 10.1177/0363546512466383.
3. Nathani DB, Sequeira J, Rao BH. Comparison of platelet rich plasma and synthetic graft material for bone regeneration after third molar extraction. Ann Maxillofac Surg. 2015;5(2):213-8. DOI: 10.4103/2231-0746.175762.
4. Pal US, Mohammad S, Singh RK, Das S, Singh N, Singh M. Platelet-rich growth factor in oral and maxillofacial surgery. Natl J Maxillofac Surg. 2012;3(2):118-23. DOI: 10.4103/0975-5950.111340.
5. de Vos RJ, van Veldhoven PL, Moen MH, Weir A, Tol JL, Maffulli N. Autologous growth factor injections in chronic tendinopathy: a systematic review. Br Med Bull. 2010;95:63-77. DOI: 10.1093/bmb/ldq006.
6. Foster TE, Puskas BL, Mandelbaum BR, Gerhardt MB, Rodeo SA. Platelet-rich plasma: from basic science to clinical applications. Am J Sports Med. 2009;37(11):2259-72. DOI: 10.1177/0363546509349921.
7. Mifune Y, Matsumoto T, Takayama K, Ota S, Li H, Meszaros LB, et al. The effect of platelet-rich plasma on the regenerative therapy of muscle derived stem cells for articular cartilage repair. Osteoarthritis Cartilage. 2013;21(1):175-85. DOI: 10.1016/j.joca.2012.09.018.
8. Alsousou J, Thompson M, Hulley P, Noble A, Willett K. The biology of platelet-rich plasma and its application in trauma and orthopaedic surgery: a review of the literature. J Bone Joint Surg Br. 91(8):987-96. DOI: 10.1302/0301-620X.91B8.22546.
9. Creaney L, Hamilton B. Growth factor delivery methods in the management of sports injuries: the state of play. Br J Sports Med. 2008;42(5):314-20.
10. Malhotra R, Kumar V, Garg B, Singh R, Jain V, Coshic P, et al. Role of autologous platelet-rich plasma in treatment of long-bone nonunions: a prospective study. Musculoskelet Surg. 2015;99(3):243-8. DOI: 10.1007/s12306-015-0378-8.
11. Rodriguez-Merchan EC. Regeneration of articular cartilage of the knee. Rheumatol Int. 2013;33(4):837-4. DOI: 10.1007/s00296-012-2601-3.
12. Wiegerinck JI, de Jonge S, de Jonge MC, Kerkhoffs GM, Verhaar J, van Dijk CN. Comparison of postinjection protocols after intratendinous Achilles platelet-rich plasma injections: a cadaveric study. J Foot Ankle Surg.2014;53(6):712-5. DOI: 10.1053/j.jfas.2014.05.015.
13. Gandhi A, Doumas C, O'Connor JP, Parsons JR, Lin SS. The effects of local platelet rich plasma delivery on diabetic fracture healing. Bone. 2006;38(4):540-6.
14. Suresh DH, Suryanarayan S, Sarvajnamurthy S, Puvvadi S. Treatment of a non-healing diabetic foot ulcer with platelet-rich plasma. J Cutan Aesthet Surg. 2014;7(4):229-3. DOI: 10.4103/0974-2077.150786.
15. Kawasumi M, Kitoh H, Siwicka KA, Ishiguro N. The effect of the platelet concentration in platelet-rich plasma gel on the regeneration of bone. J Bone Joint Surg Br. 2008;90(7):966-72. DOI: 10.1302/0301-620X.90B7.20235.
16. Intini G. The use of platelet-rich plasma in bone reconstruction therapy. Biomaterials. 2009;30(28):4956-66. DOI: 10.1016/j.biomaterials.2009.05.055.
17. Finnoff JT, Fowler SP, Lai JK, Santrach PJ, Willis EA, Sayeed YA, et al. Treatment of chronic tendinopathy with ultrasound-guided needle tenotomy and platelet-rich plasma injection. PM R.2011;3(10):900-11. DOI: 10.1016/j.pmrj.2011.05.015.
18. Yin W, Qi X, Zhang Y, Sheng J, Xu Z, Tao S, et al. Advantages of pure platelet-rich plasma compared with leukocyte- and platelet-rich plasma in promoting repair of bone defects. J Transl Med. 2016;14(1):73. DOI: 10.1186/s12967-016-0825-9.
19. Zhang N, Wu YP, Qian SJ, Teng C, Chen S, Li H. Research progress in the mechanism of effect of PRP in bone deficiency healing. ScientificWorldJournal. 2013;2013:134582. DOI: 10.1155/2013/134582.
20. Oryan A, Alidadi S, Moshiri A. Platelet-rich plasma for bone healing and regeneration. Expert Opin Biol Ther. 2016;16(2):213-32. DOI: 10.1517/14712598.2016.1118458.
21. Say F, Türkeli E, Bülbül M. Is platelet-rich plasma injection an effective choice in cases of non-union? Acta Chir Orthop Traumatol Cech. 2014;81(5):340-5.