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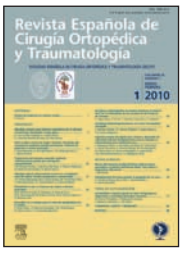

RESEARCH

Functional results after arthroscopic repair of massive rotator cuff tears; influence of the application platelet-rich plasma combined with fibrin

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KEYWORDS
Rotator cuff;
Platelet-rich plasma;
Functional results;
Arthro-MRI;
Constant

Abstract
Objective: The aim of this work is to investigate whether the application of platelet-rich plasma (PRP) with a high fibrin content in the repair area of massive rotator cuff tears treated using arthroscopic techniques improves the functional results and decreases the number of re-tears.
Material and method: This prospective, randomised study included 28 patients (20 females and 8 males) with a mean age of 65 years (range: 53 to 78) and diagnosed with a massive rotator cuff tear (two tendons affected, >5 cm). A complete single row arthroscopic repair of the rotator cuff was performed on all patients. A concentrate of platelet rich plasma with a high fibrin content was applied to the osteotendinous transition area in 14 patients after the operation, whilst in the other 14 patients the repair was performed without any growth factor support. The functional results were evaluated with the Constant scale, as well as an arthro-MRI to check the integrity of the repaired tendon one year after the operation.
Results: There were no complications or repeat operations in any of the two groups. The pre-operative Constant results improved 30 points in the group without PRP and 26 points in the group with PRP, with no significant differences between both groups. In the arthro-MRI study, integrity of the repair was observed in 9 (32%) patients, whilst 4 had a contrast leak and 15 a clear re-tear. No differences were found in the number of re-tears between the group in which the platelet-rich plasma was applied and in the one where it was not applied.
Conclusions: The arthroscopic repair of massive rotator cuff tears gives clinically satisfactory results, despite a high rate of new tears. The application of platelet-rich plasma did not improve the clinic results or decrease the number of re-tears.

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PALABRAS CLAVE
Manguito rotador;
Plasma rico
en plaquetas;
Resultado funcional;
Artro-RM;
Constant

Resultados funcionales tras la reparación artroscópica de roturas masivas del manguito rotador: influencia de la aplicación de plasma rico en plaquetas asociado a fibrina

Resumen
Objetivo: El objetivo de este trabajo es investigar si la aplicación de plasma rico en plaquetas con alto contenido en fibrina a la zona de reparación de roturas masivas del manguito de los rotadores tratadas mediante técnicas artroscópicas mejora los resultados funcionales y disminuye el índice de reroturas.
Material y método: 28 enfermos (20 mujeres y 8 varones) con una edad media de 65 años (rango: 53 a 78) diagnosticados de una rotura masiva del manguito rotador (dos tendones afectados > 5 cm) fueron incluidos en este estudio prospectivo y aleatorizado. En todos los enfermos se realizó una reparación completa artroscópica del manguito rotador con técnica de una hilera. En 14 pacientes una vez finalizada la reparación se aplicó en la zona de transición osteotendinosa un concentrado de plasma rico en plaquetas y alto contenido de fibrina, mientras que en 14 enfermos se realizó la reparación sin ningún aporte de factores de crecimiento. Se evaluaron los resultados funcionales con la escala de Constant al año de la intervención, así como una artro-RM para comprobar la integridad del tendón reparado.
Resultados: No hubo complicaciones ni reoperaciones en ninguno de los dos grupos. El Constant preoperatorio mejoró 30 puntos en el grupo sin PRP y 26 puntos en el grupo con PRP, sin diferencias entre ambos grupos. En el estudio de artro-RM 9 pacientes mostraban integridad de la reparación (32%), 4 presentaban una fuga de contraste y 15 una rerotura franca. No se encontraron diferencias en índice de reroturas entre el grupo en el que se aplicó plasma rico en plaquetas y en el que no.
Conclusiones: La reparación artroscópica de roturas masivas del manguito rotador ofrece unos resultados clínicos satisfactorios a pesar de un elevado índice de nuevas roturas. La aplicación de plasma rico en plaquetas no mejora los resultados clínicos ni disminuye el índice de reroturas.

Introduction

There is a high incidence of degenerative rotator cuff tears in the population. Following arthroscopic repair of a small- or medium-sized tear, functional results are satisfactory in the vast majority of patients, with a low incidence of re-tears regardless of the repair technique used. When it is a so-called massive tear, involving 2 tendons and larger than 5 cm, there is a significantly greater risk of re-tear, with an incidence ranging from 50% to 80%.[1-3] Patients who end with a new tear exhibit satisfactory pain relief, but strength is not recovered, resulting in a variable degree of functional limitation in activities of daily living.[4]

Experience with the use of platelet-rich plasma (PRP) in the healing of tendon tears is limited. PRP has been shown to have beneficial effects on healing in different tissues. There have been conflicting results with applying it to collagenous tissue in tendon and ligament repairs.[5-8] In the best of cases, its beneficial effect on ligament healing is modest.[5]

There is very scant clinical experience with the application of platelet-derived growth factors in rotator cuff tendon repair procedures.[7,8] The available studies have shown contradictory data, and none of them has focused on massive tears–those most at risk for failure to heal.

The objective of this prospective and randomised study was to evaluate whether local application of platelet-rich plasma combined with fibrin during complete arthroscopic repair of a massive rotator cuff tear improves the functional results.

Materials and methods

Between May 2007 and May 2009, 28 patients (20 female and 8 male), with a mean age of 65 years (range: 53-78) and a massive rotator cuff tear (>5 cm, involving the supraspinatus and infraspinatus), were scheduled for arthroscopic surgery and enrolled prospectively in a protocol approved by the Ethics Committee at our hospital. They were placed at random into 1 of 2 groups: those who underwent arthroscopic repair without application of PRP and those who received autologous PRP once the procedure was finished. During this period of time, 150 rotator cuff repairs were performed on our Unit, including tears of all sizes.

All patients signed an informed consent to participate in the study and agreed to the post-operative check-ups scheduled. In all cases, conservative treatment had been implemented for at least 3 months, and none of the patients

had previously undergone surgical treatment on their shoulder. A clinical examination was done, and data was collected on shoulder mobility, severity of pain (using a Visual Analogue Scale), loss of strength, and limitation in activities of daily living. Using the information gathered, a Constant scale was completed for each patient as a standard, validated parameter for functional assessment of the shoulder.[9]

The diagnosis was made through clinical examination and radiological evaluation, including simple x-rays and magnetic resonance imaging (MRI). All patients showed evidence of a massive rotator cuff tear of at least 5 cm and including 2 tendons (supraspinatus and infraspinatus). Smaller tears or those involving the subscapular were excluded, so only posterosuperior cuff tears were included. All patients who presented with associated shoulder rigidity due to capsulitis who had previously undergone surgery on that shoulder and those whose simple x-rays showed degenerative changes were excluded.

Those cases in which there was evidence of chronic infectious disease; patients with haemoglobin levels below 13 g/dL; patients with known haematological or coagulation disorders; and cases where there was a history of difficulty cannulating a peripheral vessel were excluded, the use of platelet-rich plasma being contraindicated.

The 28 patients chosen for the study by closed envelope randomisation were assigned to 1 of the 2 groups the day before surgery. Simple arthroscopic repair was performed on 14 patients (control group), and PRP was added to the repair in the other 14 patients (experimental group).

All patients received 1 gram of cephazolin IV pre-operatively as antibiotic prophylaxis. The surgery was performed in lateral decubitus position under general anaesthesia with interscalene block. The repair was done by arthroscopy using anchors preloaded with 2 polypropylene sutures (Bio-Corkscrew, Arhrex, Naples, FL, USA) and single-layer technique. A complete repair was achieved on all patients, with reanchoring of the tendons to the tubercle. Patients whose repair was incomplete or done via margin convergence with residual defect were excluded from the study. An average of 3 anchors per patient were used (range: 2-5). In 3 patients, an anterior acromial osteophyte was removed, but neither acromioplasty nor resection of the distal end of the clavicle were done routinely on any patient.

In patients assigned to the PRP group, once the complete repair was finished, 7 ml of fibrin-rich PRP (Vivostat PRF, Visostat A/S, Alleroed, Denmark) was applied via endoscopic device directly to the repair area under direct visualisation. Blood in the amount of 120 ml had been taken from the patients beforehand for sterile processing per the mechanised system provided by the manufacturer.

In the immediate post-operative period, an analgesia regimen was administered to the patients per protocol, and their arm was immobilised using a standard sling for 6 weeks. During the first 6 weeks, patients were allowed to do only pendular exercises of the shoulder. After this, they began a rehabilitation program where muscle strengthening exercises were delayed until 12 weeks after the surgery.

The patients had check-ups at 1 week, 1 month, and at 3, 6, and 12 months. At the 12-month visit, sufficient clinical information was collected to complete the Constant scale. Information was also collected on the patient's pain and satisfaction using a VAS. An arthro-MRI was done at 12 months on all patients to check integrity of the tendon.

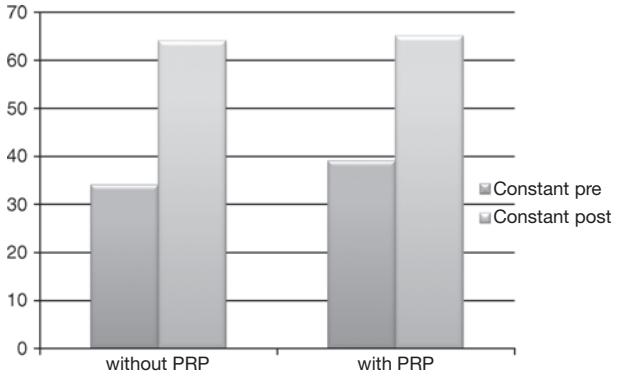

Figure 1 Pre-operative and post-operative Constant values for the control group (without PRP application) and for the experimental group (with PRP application).

The SPSS program (version 15.0, Chicago, IL) was used to do a statistical analysis. For those variables that met the criteria for normality, the Student's t-test was used to compare the mean for each group. When the assumption of normality was not accepted, the non-parametric Mann-Whitney U test was used. The results obtained are presented with the statistical significance values for comparison of the means with their corresponding 95% confidence interval, statistically significant differences being established when $P<.05$.

Results

None of the patients had complications stemming from the surgery in terms of infection or problems related to their surgical wound. None of the patients required another intervention during the follow-up period for this study. All patients came in for the scheduled check-ups. There were no reports of complications from the blood drawing.

The overall mean Constant scale value increased from 36.9±12.7 points pre-operatively to 65±14.1 points ($P<.005$) at 1 year after the surgery. For the group of patients who did not receive PRP at the time of the repair, the Constant value was 34.3±11.7 points pre-operatively and 64.1± 13.6 points at 1 year, while for the group that did receive PRP, it increased from 39.7±10.2 to 65.6±13.1 points. Based on the data available in this study, no significant differences were found between the group with and the group without application of platelet factors ($P=.79$) with regard to either the increase or the final overall Constant score (fig. 1).

When each parametric value included in the Constant scale was analysed, no significant differences between the 2 groups were found. Also, when the incidence of new tears was compared between patients younger and patients older than 65 years, no significant differences were found.

The arthro-MRI evaluation showed that, in 9 patients, the tendon was intact; in 4 patients, there was leakage of

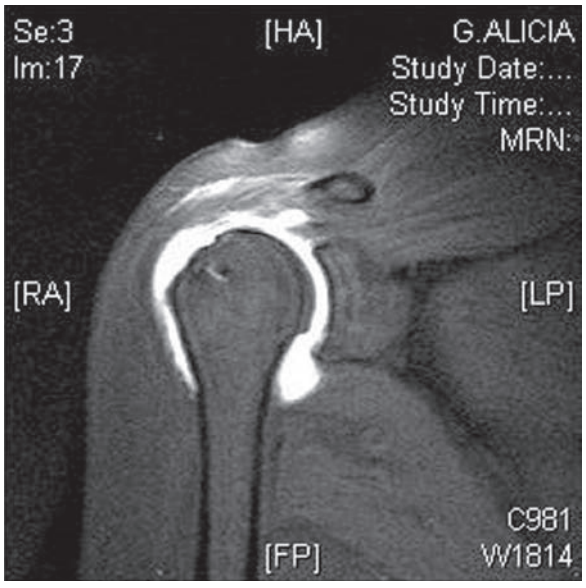

Figure 2 Coronal slice from arthro-MRI of shoulder showing contrast leakage suggestive of a frank rotator cuff re-tear.

contrast into the subacromial space; and in 15 patients, there was a frank re-tearing of the tendon with retraction of the cables (fig. 2). Upon comparing the group with and the group without growth factors for tendon integrity at 1 year after surgery, no significant differences were found. In the group with a re-tear, 9 patients had and 6 patients had not been treated with PRP. In the group with leakage, there was 1 patient with PRP and 3 patients without it. In the group that had tendons intact, there were 4 patients from the group with PRP and 5 patients from the group without PRP (fig. 3).

Discussion

Reconstructive surgery of the rotator cuff achieves improvement in shoulder function and attains a high degree of patient satisfaction, even in patients of advanced age.[3,10] In the case of a massive tendon tear, however, the incidence of re-tear is very high, and some patients suffer a weakness that may become incapacitating.[1,2,4] There are currently several fields of research aimed at fostering a better healing environment for the osteotendinous union that would be applicable to rotator cuff repair.[11]

The mechanism of action of the platelet-derived factors would be related to an increase in the platelet concentration and the alpha granules content. These granules contain numerous growth factors identified above as crucial to normal bone-tendon healing, among which are the following: PDGF (platelet-derived growth factor), TGF-β (transforming growth factor beta), IL-1 (interleukin-1), VEGF (vascular endothelial growth factor), IGF (insulin-like growth factor), osteocalcin, osteonectin, fibrinogen, vitronectin, and fibronectin. As a whole, these proteins belong to the growth factor, cytokine, and chemokine families, and they would be trapped in and function from the three-dimensional structure formed by platelet-rich plasma. Various authors have suggested that the application of platelet-rich plasma combined with fibrin is beneficial to the quality of healing in anterior cruciate ligament repairs and, experimentally, in other tendon lesions. Apparently, other studies have not confirmed these findings, however, and question the effectiveness of these factors in clinical practice.[6,7,11-15]

Information from clinical practice on the applicability of platelet-derived factors in rotator cuff repair is very limited, and only 2 studies have been available to date. Weber et al found no significant differences in the incidence of re-tear, clinical results, or post-operative pain in a group of patients with rotator cuff tears, regardless of size.[7] In contrast, it appears that Randelli et al found some benefit in terms of post-operative pain and final functioning.[8] It is possible that these discrepancies are attributable to differences in methodology because different platelet factor concentrations and different surgical techniques were used in these 2 studies. Tears of various sizes were used for both of these studies, and that decision could have affected the final conclusions.[2,16] Our study included only patients with massive tears involving 2 tendons. The high incidence of re-tearing these patients experience means that biological treatments designed to improve the tendon repair would make more sense.[2,3]

The fundamental limitation of this study is its low number of cases, and it should be looked upon only as an initial exploratory clinical trial. This does not diminish its value,

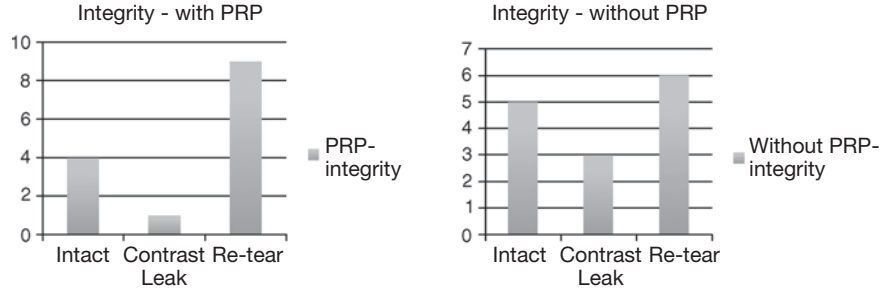

Figure 3 Graphs comparing control group and experimental group in terms of the incidence of repair integrity, contrast leakage (repair partially intact), and frank re-tear.

however, because there is a low incidence of the massive tears that would meet the inclusion criteria, and we would have had to operate on many patients over a great many years, using a technique of uncertain efficacy, to assemble the number of cases that would have given us high statistical power. Our study shows that, in a massive rotator cuff tear, local arthroscopic application of platelet-derived factors combined with fibrin to the complete repair area does not improve functional results and does not reduce the risk of a re-tear. This operation is very effective in improving the patient's painful symptoms, whether or not PRP is applied, but a new tear of the tendon was detected in more than half of the patients. Most likely the quality of the repaired tissue and the biological condition of the myotendinous unit have more to do with the results than the repair technique itself or the concomitant treatments.[1-3,16-18]

In light of these results, it is clear that the surgeon who wishes to improve healing in massive degenerative and chronic tears of the rotator cuff must explore new avenues. The use of surgical techniques aimed at a more solid fixation of the repair, such as the double-layer or bridging techniques, appears to have resulted in a modest improvement in the percentage of healed tendons, though that is not reflected in an improvement in clinical results.[18] Despite these techniques, there is a group of patients who seem destined not to heal. Advanced techniques rooted in molecular biology, such as the use of stem cells and solid scaffolding structures to direct their differentiation and organization, probably hold the key to the future of this surgery.[11]

Evidence level

Evidence level II.

Financing

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Protection of human and animal subjects

The authors will declare that the procedures followed were in accordance with the regulations of the responsible Clinical Research Ethics Committee and in accordance with those of the World Medical Association and the Helsinki Declaration.

Confidentiality of data

The authors will declare that they have followed the protocols of their work centre on the publication of patient data and that all the patients included in the study have received sufficient information and have given their informed consent in writing to participate in that study.

Right to privacy and informed consent

The authors must have obtained the informed consent of the patients and /or subjects mentioned in the article. The author for correspondence must be in possession of this document.

Conflict of interest

The authors have no conflict of interest to declare.

References

1. Boileau P, Brassart N, Watkinson DJ, Carles M, Hatzidakis AM, Krishnan SG. Arthroscopic repair of full-thickness tears of the supraspinatus: Does the tendon really heal? J Bone Joint Surg Am. 2005;87:1229–40.
2. Galtaz LM, Ball CM, Tefey SA, Middleton WD, Yamaguchi K. The outcome and repair integity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am. 2004;86:219–24.
3. Gerber C, Fuchs B, Hodler J. The results of repair of massive tears of the rotator cuff. J Bone Joint Surg Am. 2000;82: 505–15.
4. Jost B, Zumstein M, Pfirrmann CW, Gerber C. Long-term outcome after structural failure of rotator cuff repairs. J Bone Joint Surg Am. 2006;88:472–9.
5. Peerbooms JC, Sluimer J, Bruijn DJ, Gosens T. Positive effect of an autologous concentrate in lateral epicondylitis in a doubleblind randomized controlled trail: platelet-rich plasma versus corticosterod injection with a 1-year follow-up. Am J Sports Med. 2010;38:255–62.
6. De Vos RJ, Weir A, van Schie HTM, Bierma-Zeinstra SMA, Verhaar JAN, Weinans H. Platelet -Rich Plasma Injection for Chronic Achilles Tendinopathy: A Randomized Controlled Trial. JAMA. 2010;303:144–9.
7. Weber SC, Kauffman JI. Platelet-Rich Fibrin Matrix in the Management of Arthroscopic Repair of the Rotator Cuff: A Prospective, Randomized Study. Presented during 2010 meeting of AAOS. New Orleans, EE.UU.
8. Randelli PS, Arrigoni P, Cabitza P, Volpi P, Mafulli N. Autologous platelet Rich plasma for arthroscopic rotator cuff repair. A pilot study. Dissabil Rehabil. 2008;30:1584–9.
9. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res. 1987;214: 160–4.
10. Grondel RJ, Savoie III FH, Field LD. Rotator cuff repairs in patients 62 years of age or older. J Shoulder Elbow Surg. 2001;10:97–9.
11. Kovacevic D, Rodeo SA. Biologic augmentation of the rotator cuff. Clin Ortop Relat Res. 2008;466:622–33.
12. Everts PA, Knape JT, Weibrich G, Schönberger JP, Hoffmann J, Overdevest EP, et al. Platelet-rich plasma and platelet gel: a review. J Extra Corpor Technol. 2006;38:174–87.
13. Hall MP, Band PA, Meislin RJ, Jazrawi LM, Cardone DA. Plateletrich Plasma: Current Concepts and Application in Sports Medicine. J Am Acad Ortho Surg. 2009;17:602–6.
14. Wolfman NM, Hattersley G, Cox K, Celeste AJ, Nelson R, Yamaji N, et al. Ectopic induction of tendon and ligament in rats by growth and differentiation factors 5, 6, and 7, members of the TGF-beta gene family. J Clin Invest. 1997;100:321–30.
15. Rodeo SA, Potter HG, Kawamura S, Turner AS, Kim HJ, Atkinson BL. Biologic augmentation of rotator cuff tendon-healing with

use of a mixture of osteoinductive growth factors. J Bone Joint Surg Am. 2007;89:2485–97.
16. Cole BJ, McCarty LP, Kang RW, Alford W, Lewis PB, Hayden JK. Arthroscopic rotator cuff repair: Prospective functional outcome and repair integrity at minimum 2-year follow-up. J Shoulder Elbow Surg. 2007;16:579–85.
17. Goutallier D, Postel JM, Lavau L, Voisin MC. Fatty muscle degeneration in uff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res. 1994;304:78–83.
18. Dines JS, Bedi A, ElAttrache NS, Dines DM. Sinle-row versus double-row rotator cuff repair: techniques and outcomes. J Am Acad Ortho Surg. 2010;18:83–93.