

The Effect of Platelet Rich Plasma Dosage on the Tendon Healing in Rabbits

Min-Wook Kim, On Lim,
So-Min Hwang, Min-Kyu Hwang,
Jong-Seo Lee

*Aesthetic, Plastic and Reconstructive Surgery
Center, Good Moonhwa Hospital, Busan, Korea*

Received: April 12, 2016

Revised: [1] June 23, 2016

[2] September 4, 2016

[3] October 12, 2016

Accepted: October 14, 2016

Correspondence to: So-Min Hwang
Aesthetic, Plastic and Reconstructive Surgery
Center, Good Moonhwa Hospital,
119 Beomil-ro, Dong-gu, Busan 48735, Korea
TEL: +82-51-630-0199
FAX: +82-51-630-0145
E-mail: Limon0910@gmail.com

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/bync/3.0/>) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Purpose: Autologous platelet rich plasma (PRP) has been known to enhance tendon healing and improve tensile strength after tendon injury. This study investigated the dosage of PRP to increase the tensile strength.

Methods: PRP was harvested from peripheral bloods of the rabbits. Direct injury model was adopted using 60 achilles tendons in 30 rabbits. The autologous PRP was infiltrated into the Achilles tendon repair site of four groups (control, 0.1, 0.2, 0.4 mL) with different dosages. Tendons were harvested at 2, 4 and 8 weeks and subjected to measuring mechanical tensile strength and dosage of collagen content.

Results: At 2, 4, and 8 weeks, PRP administration following experimental achilles tendon repair resulted in an overall higher average tensile strength and collagen content compared to these of the control. Also, the lengthen the time, tensile strength and collagen content was increased.

Conclusion: Autologous PRP enhanced tendon healing in rabbits. Within the PRP dosage set by the author, more dosage of the infiltrated PRP increases the strength of the tendon and the dosage of collagen content. Further studies will be essential to determine the optimal dosage of PRP in clinical practice.

Keywords: Platelet rich plasma, Tensile strength, Collagen, Tendon

INTRODUCTION

Despite modern advances in tendon repair techniques, primary suture repair has been the principal treatment for lacerated tendons. There is still a critical need for new methods of enhancing the healing process to achieve optimal outcomes. Recent advances in surgical technique and suture material, were able to reduce gap formation, allowing for earlier motion¹. However, early motion before healing can induce gap formation, and this will lead

to a decline in tensile strength. Thus, for earlier motion to reduce the development of adhesion formation, a new method to accelerate overall healing in tendon repair is required.

The introduction of growth factors has already been shown to enhance the normal healing process²⁻⁵. Platelets contain large stores of cytokines and growth factors that normally are released during clot formation at wound site. Platelet rich plasma (PRP) is used for a wide variety of surgical applications⁶⁻¹⁰. PRP is a volume fraction of

the plasma, having a platelet concentration above whole blood.

PRP contains a set of platelet derived growth factors, including platelet derived growth factor (PDGF)-BB, transforming growth factor (TGF)- β 1, insulin-like growth factor (IGF), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), and fibroblast growth factor (FGF)^{11,12}. In addition, the fibrin matrix that is generated on activation may potentially aid in tissue repair by providing a scaffold for tissue ingrowth. But, the use of PRP has not been placed under as much scrutiny as other techniques, especially those utilizing exogenous growth factors¹³.

PRP has been used as the source of platelet derived growth factor and transforming growth factor, and it has been reported that PRP has the positive effect on cell proliferation and collagen production, and it induces the production of matrix-degrading enzymes and endogenous growth factors by tenocytes^{12,13}. In the healing process of tendon, it has been demonstrated the PRP promotes collagen production and cell proliferation¹⁴. Therefore, the quantitative changes of productive collagen can represent velocity of tendon healing.

Up to date, the precise PRP dosages that would bring optimal results are not yet to be determined. Thus, the purpose of this study was to investigate the extent to which PRP accelerate tendon healing. The present study was designed to measure the tensile strength and mechanical properties of tissue healing, with different dosages of PRP administered, in surgically created Achilles tendon injuries in a rabbit model; and evaluate the effect of PRP.

MATERIAL AND METHODS

This study has been approved by Institutional Review Board of our hospital and followed its Code of Ethics for Scientific Research.

1. Animals

Male New Zealand white rabbits were used (30 rabbits, 3 months, 2.5–3.5 kg). They were housed in cages and fed

on rabbit feed available in the market. Both right and left hind legs were used (n=60). National Institute of Health (NIH) guidelines for the care and use of laboratory animals published by NIH (NIH publication no. 85-23, revised 1985) were observed in this study.

2. PRP preparation

The rabbits were anesthetized with intramuscular injection of 200 mg ketamine hydrochloride. Whole blood samples (13 mL) was collected from the ear arteries of each rabbit, using 20 mL syringes coated anticoagulant (1.5 mL, heparin). The samples were transferred into YCELLBIO-Kit (YCBM, Seoul, Korea) and centrifugated at 4,000 rpm for 10 minutes. Separated PRP was transferred in 1 mL syringes (Fig. 1). The average platelet counts in PRP was $2.48 \times 10^8/\text{mL}$ ¹⁵.

3. Tendon injury model

Under standard aseptic conditions, a longitudinal skin incision was made over the posterior aspect of the each right and left hind leg near the heel. The Achilles tendon was exposed, the tendon was cut completely by scissors at the midportion between its insertion and the tendon-muscle junction. The tendon was repaired using nonabsorbable 4-0 prolene suture (Ethicon, Johnson & Johnson

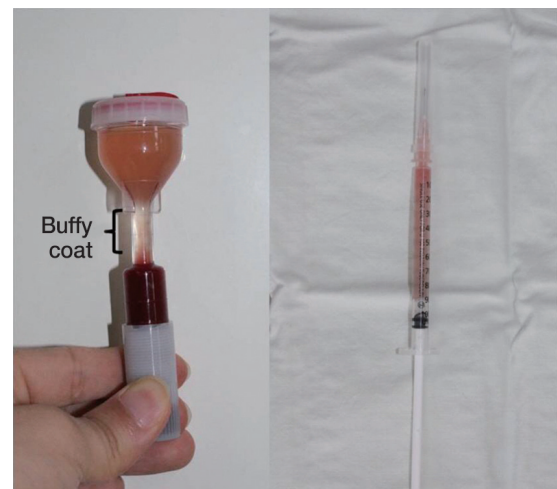


Fig. 1. Preparation of platelet rich plasma (PRP). The blood was centrifuged at 4,000 rpm for 10 minutes using a YCELLBIO-Kit. The buffy coat including PRP was separated and transferred in 1 mL syringe.

International, Somerville, NJ, USA) by 4-strand core suture technique (modified Kessler's method) and the knot was taken out to be removed later (Fig. 2). 0, 0.1, 0.2, and 0.4 mL PRP was respectively infiltrated at 0.5 cm intervals from the repair site.

In the previous literature, 1 mL or 1.5 mL PRP was used^{16,17}. But during several our preliminary testing, when amounts of 1 mL or 1.5 mL PRP were injected, there was a significant amount of PRP that leaked out of the tendon. We were determined to be stable in the amount of about 0.4 mL PRP the maximum value is maintained within the tendon.

The rabbits were divided into 4 groups: the control group (n=15), after repairing the tendon, none infiltrated PRP; the autologus 0.1 mL PRP group (n=15) (the platelet

counts was 2.48×10^8) was infiltrated to the tendon repair site; the autologus 0.2 mL PRP group (n=15) (the platelet counts was $2.48 \times 10^8 \times 2$) was infiltrated; the autologus 0.4 mL PRP group (n=15) (the platelet counts was $2.48 \times 10^8 \times 4$) was infiltrated. Skin wound was closed and the legs were immobilized using a short leg cast in the position of ankle-plantar flexion for tension free at the tendon repair site. 5 tendons per group were harvested at 2, 4 and 8 weeks after repair for evaluation.

4. Mechanical tensile strength testing

Rabbits were anesthetized with an intramuscular injection of 200 mg ketamine hydrochloride. Previous wound were opened and Achilles tendon was harvested from the insertion site to the tendon-muscle junction. The 1 cm range marking was made on the each tendon repair site using Gentian Violet (Fig. 3). Then the harvested tendon was stored in formalin solution.

The tensile strength of all tendons were tested onto an Instron mechanical tester (Instron 5567, Instron, Canton, MA, USA) operated at 20 mm/min velocity traction speed. Maximum load was recorded on a personal computer.

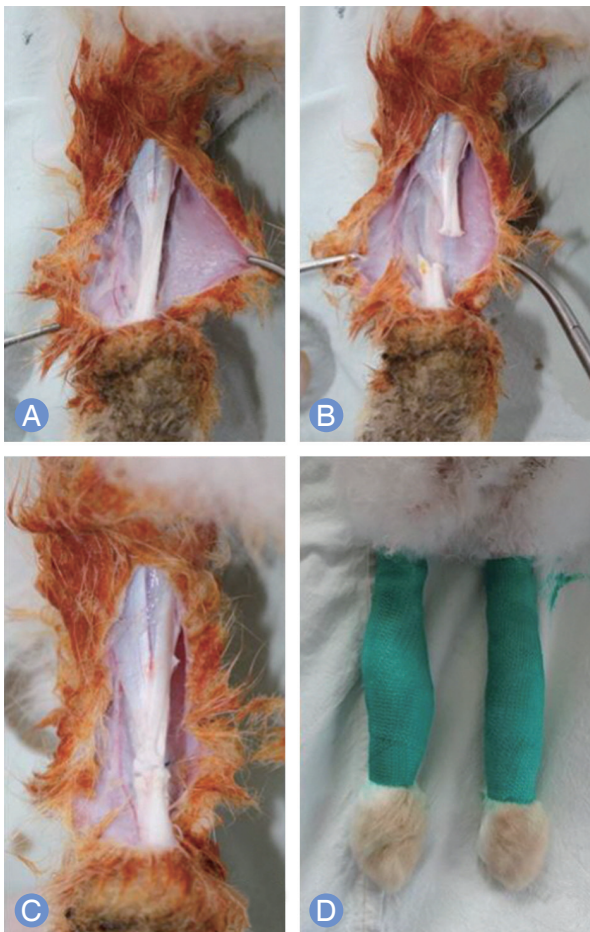


Fig. 2. Traumatic tendon injury model of rabbit. (A) Achilles tendon of a rabbit was exposed. (B) The tendon was cut at the midportion. (C) The tendon was repaired while the suture knot was out. (D) The legs were immobilized using a short leg cast.

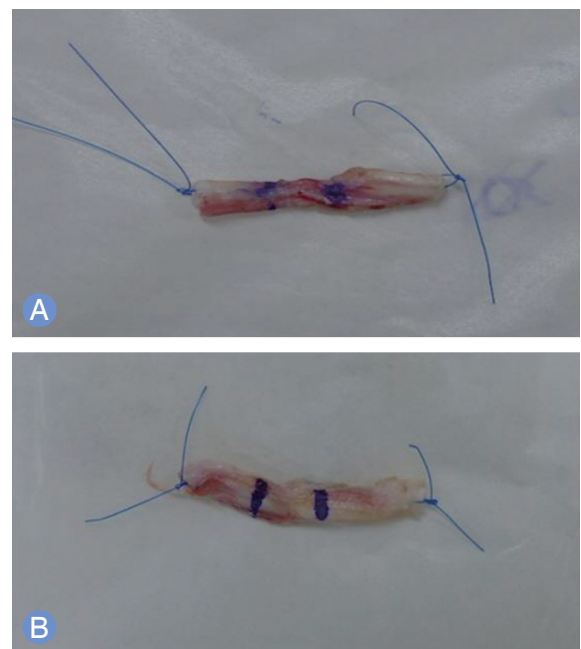


Fig. 3. (A, B) The harvested tendon on the repair site of which the 1 cm range marking was made, was sutured by tagging at both ends.

By basing the preliminary testing on the references, the velocity traction speed was initially adjusted to 10 mm/min¹⁶, but the actual speed was too slow, and due to stretching that occurred in the tendon grasping area, the final speed was adjusted to 20 mm/min.

5. Biochemical analysis for determining collagen content

After mechanical tensile strength testing, harvested tendons weighed directly to determine the wet weight, snap frozen in LN₂, and stored at -70°C prior to biochemical analysis. Tendons were hydrolyzed (110°C, 20 hours) in 6M HCl for mass spectrometric (MS) determination of hydroxyproline (Hyp) content. The hydrolyzed tendon samples were vacuum-dried and dissolved in an internal standard solution (2.4 mM homo-arginine). After centrifugation at 13,000 g for 10 minutes, the supernatants were subjected to MS, using a 4,000 Q-TRAP mass spectrometer (Applied Biosystems/MDS Sciex, Foster City, CA, USA) at a source temperature of 300°C, and a spray voltage of 45 kV. Amino acids were separated on a Synergi MAX-RP 80A (250×3 mm, 4 mm) column (Phenomenex Inc., Torrance, California, USA) at a flow rate of 400 mL/min, using a gradient from MilliQ1 water (Millipore, Billerica, MA, USA) to acetonitrile, both containing 1.2 mM of tridecafluoroheptanoic acid and 2.5 mM ammonium acetate. Amino acids were identified by MS in multiple reaction mode using the mass transition 131.8/67.8. Data were related to the recovery of internal standard. Collagen content was calculated as follows: $\mu\text{g collagen} = (\text{pmol Hyp}/300) \times 0.3$ (300 is the number of Hyp residues in one collagen triple helix, 0.3 is deduced from the molecular weight of collagen, 300,000 Da). Results were expressed as μg per mg of wet weight.

6. Histologic analysis

The specimens for light microscopy were fixed in 10% phosphate-buffered formalin (pH 7.4) for 1 day. Each specimen was cut longitudinally and embedded into paraffin. Five micrometers in a plane parallel to the longitudinal axis of the tendon was taken, and the sections were stained with hematoxylin eosin for general evaluation and stained with picrosirius red (Sigma-Aldrich) for

collagen detection.

7. Statistical analysis

All statistical analyses were performed using MedCalc for Windows, ver. 15.10.0. (MedCalc Software, Mariakerke, Belgium). Analysis of variance test for statistical analysis of all the results in the current study ($p < 0.05$). To assess differences between control group and another group, Tukey's method ($p\text{-value} < 0.05$) was considered significant.

RESULTS

1. Gross finding

For all specimens from each group, there were no observable macroscopic differences between the groups at 2, 4, and 8 weeks after surgery. Achilles tendons were adhered to surrounding soft tissues.

2. Biomechanical tensile strength testing

At 2, 4, and 8 weeks, PRP administration following experimental achilles tendon repair resulted in a higher average tensile strength as compared to the control.

At 2 weeks after surgery, the tensile strength of tendon repair site in the control group ranged from 25 to 44 N, as the average was 34.6 N. In the 0.1 mL PRP group, the tensile strength range was 21–68 N, as the average was 49.8 N. In the 0.2 mL PRP group, the tensile strength range was 50–84 N, as the average was 68.6 N. In the 0.4 mL PRP group, the tensile strength range was 66–88 N, as the average was 74.8 N ($p < 0.05$) (Fig. 4).

At 4 weeks after surgery, the tensile strength of tendon repair site in the control group ranged from 29 to 72 N, as the average was 48.0 N. In the 0.1 mL PRP group, the tensile strength range was 29–74 N, as the average was 54.6 N. In the 0.2 mL PRP group, the tensile strength range was 51–93 N, as the average was 73.2 N. In the 0.4 mL PRP group, the tensile strength range was 62–130 N, as the average was 93.8 N ($p < 0.05$) (Fig. 5).

At 8 weeks after surgery, the tensile strength of tendon repair site in the control group ranged from 42 to 77 N, as the average was 66.2 N. In the 0.1 mL PRP group, the tensile

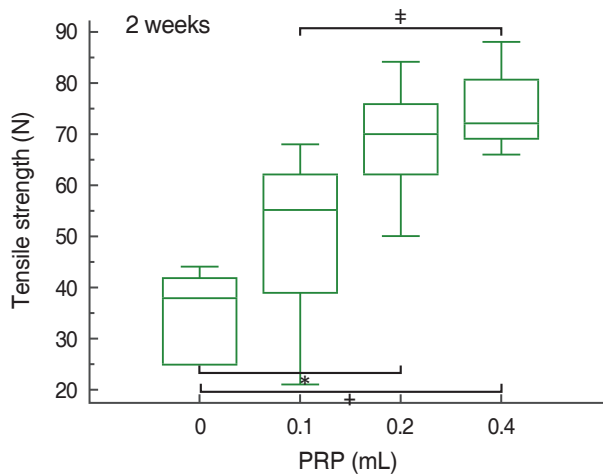


Fig. 4. This graph shows value of the tensile strength according to the platelet rich plasma (PRP) dosage at 2 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.001$). Significant value between one group and another group was evaluated by Tukey's method. Control vs. 0.2 mL ($*p=0.003$), control vs. 0.4 mL ($*p=0.001$), and 0.1 mL vs. 0.4 mL ($*p=0.029$) were significant.

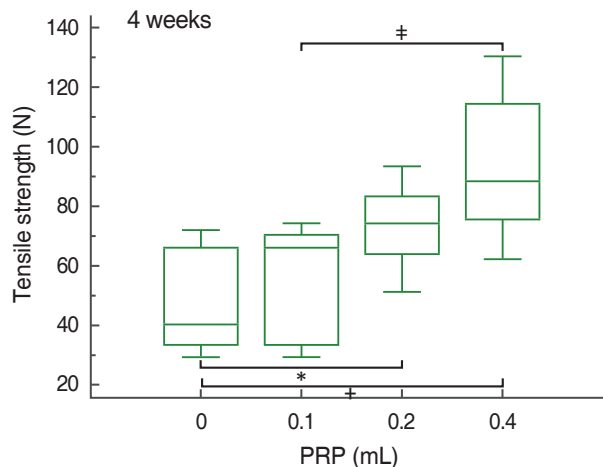


Fig. 5. This graph shows value of the tensile strength according to the platelet rich plasma (PRP) dosage at 4 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.013$). Significant value between one group and another group was evaluated by Tukey's method. Control vs. 0.2 mL ($*p=0.021$), control vs. 0.4 mL ($*p=0.015$), and 0.1 mL vs. 0.4 mL ($*p=0.040$) were significant.

strength range was 47–111 N, as the average was 77.6 N. In the 0.2 mL PRP group, the tensile strength range was 65–102 N, as the average was 89.2 N. In the 0.4 mL PRP group, the tensile strength range was 80–112 N, as the average was 98.8 N ($p<0.05$) (Fig. 6).

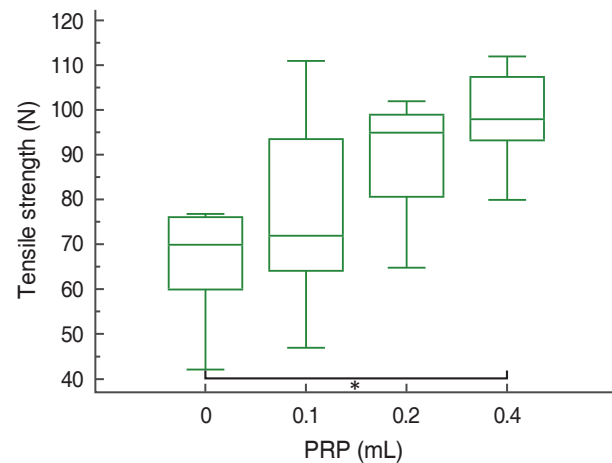


Fig. 6. This graph shows value of the tensile strength according to the platelet rich plasma (PRP) dosage at 8 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.039$). Significant value between one group and another group was evaluated by Tukey's method. Only control vs. 0.4 mL ($*p=0.033$) was significant.

Mean maximum tensile strength of Achilles tendon repair site in rabbits was 93.8 N, the value was obtained in 0.4 mL PRP administration group at 4 weeks after surgery. In the 0.4 mL PRP administration group at 8 weeks after surgery, mean maximum tensile strength was 98.8 N. The tensile strength between those two groups was not significant difference ($p>0.05$).

3. Determining collagen content

At 2, 4, and 8 weeks, PRP administration following experimental achilles tendon repair resulted in an overall higher average collagen content as compared to the control.

At 2 weeks, the dosage of collagen content ranged from 0.765 to 0.925 μg , as the average was 0.833 μg in the control group; 0.690–0.870 μg , as the average was 0.763 μg in the 0.1 mL PRP group; 0.815–0.910 μg , as the average was 0.863 μg in the 0.2 mL PRP group; and 0.815–0.935 μg , as the average was 0.878 μg in the 0.4 mL PRP group ($p>0.05$) (Fig. 7).

At 4 weeks, the dosage of collagen content ranged from 1.190 to 1.345 μg , as the average was 1.241 μg in the control group; 1.285–1.445 μg , as the average was 1.339 μg in the 0.1 mL PRP group; 1.370–1.575 μg , as the average was

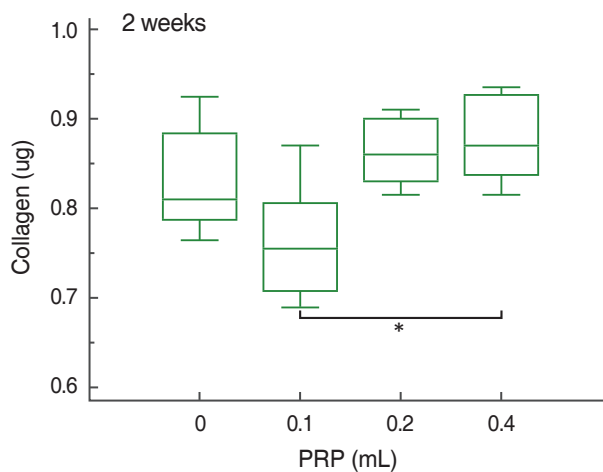


Fig. 7. This graph shows value of the collagen content according to the platelet rich plasma (PRP) dosage at 2 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.028$). Significant value between one group and another group was evaluated by Tukey's method. Only 0.1 mL vs. 0.4 mL ($*p=0.028$) was significant.

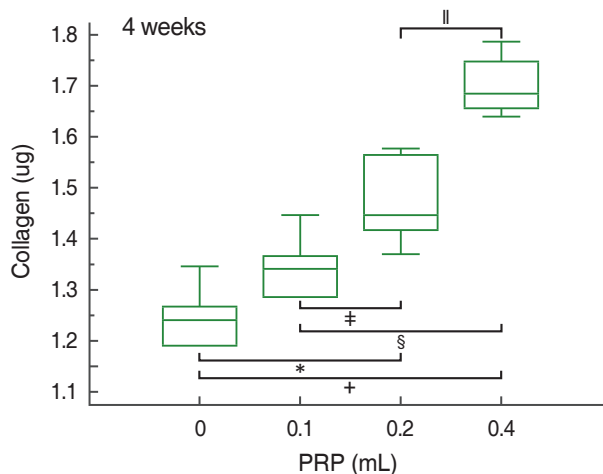


Fig. 8. This graph shows value of the collagen content according to the platelet rich plasma (PRP) dosage at 4 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.001$). Significant value between one group and another group was evaluated by Tukey's method. Control vs. 0.2 mL ($*p=0.001$), control vs. 0.4 mL ($*p=0.001$), 0.1 mL vs. 0.2 mL ($*p=0.030$), 0.1 mL vs. 0.4 mL (§ $p=0.001$), 0.2 mL vs. 0.4 mL (§ $p=0.001$) were significant.

1.477 μ g in the 0.2 mL PRP group; and 1.640–1.785 μ g, as the average was 1.701 μ g in the 0.4 mL PRP group ($p<0.05$) (Fig. 8).

At 8 weeks, the dosage of collagen content ranged from

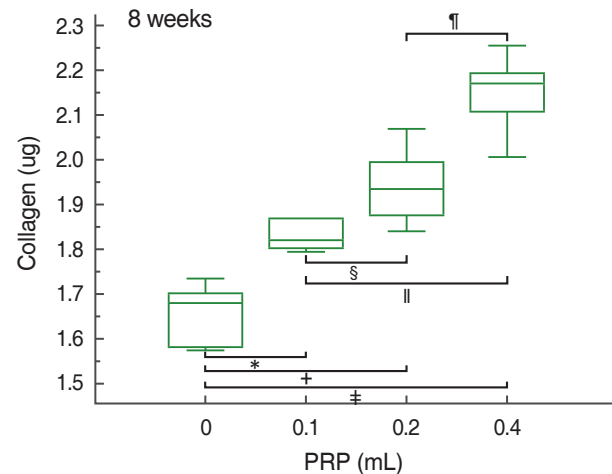


Fig. 9. This graph shows value of the collagen content according to the platelet rich plasma (PRP) dosage at 8 weeks. The graph shows mean±standard deviation, that was evaluated by analysis of variance test ($p=0.001$). Significant value between one group and another group was evaluated by Tukey's method. All comparison between the groups was significant (*). Control vs. 0.1 mL ($*p=0.004$), control vs. 0.2 mL ($*p=0.001$), control vs. 0.4 mL ($*p=0.001$), 0.1 mL vs. 0.2 mL (§ $p=0.025$), 0.1 mL vs. 0.4 mL (§ $p=0.001$), 0.2 mL vs. 0.4 mL (§ $p=0.002$).

1.585 to 1.735 μ g, as the average was 1.653 μ g in the control group; 1.795–1.870 μ g, as the average was 1.832 μ g in the 0.1 mL PRP group; 1.840–2.070 μ g, as the average was 1.941 μ g in the 0.2 mL PRP group; and 2.005–2.255 μ g, as the average was 2.149 μ g in the 0.4 mL PRP group ($p<0.05$) (Fig. 9).

4. Histologic analysis

At 2 weeks, the structural maturation and density of the repaired tendon site generally increased with more PRP dosage on hematoxylin eosin stain. And on picrosirius red stain, also the quantity of stained collagen was increased, as more PRP (Fig. 10).

DISCUSSION

This study that PRP administration improves the enhancing on the healing process of a treated Achilles tendon using a rabbit model was supported by the results. This experimental data demonstrated that the autologous PRP accelerates overall healing time in

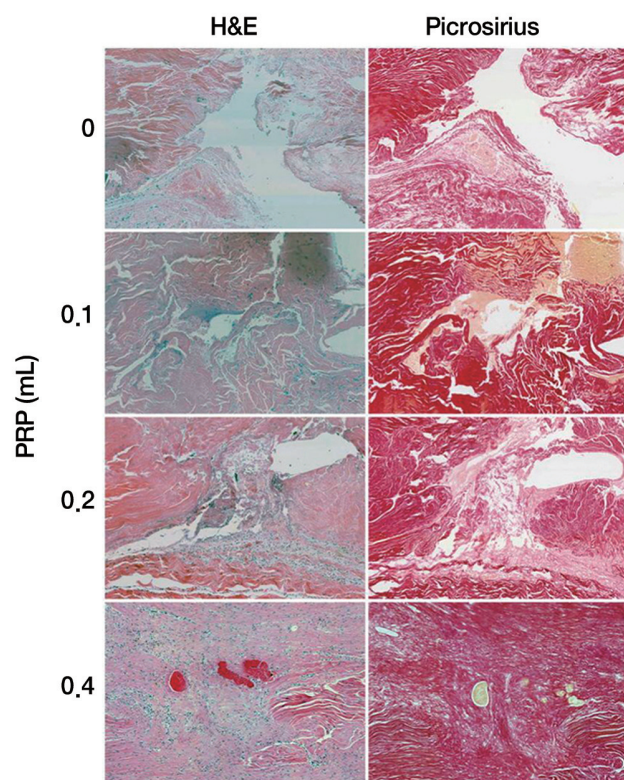


Fig. 10. Histological photographs at 2 weeks (H&E and picrosirius red, $\times 100$). Representative images of structural maturation and quantitative changes of stained collagen with different platelet rich plasma (PRP) dosages.

tendon repair.

Tendon healing occurs in inflammatory phase, remodeling phase, and maturation stage. In the initial inflammatory phase, erythrocytes and inflammatory cells, particularly neutrophils, enter the site of injury. Vasoactive and chemotactic factors are released with increased vascular permeability, initiation of angiogenesis, stimulation of tenocyte proliferation, and recruitment of more inflammatory cells. Tenocyte gradually migrate to the wound, and type III collagen synthesis is initiated¹⁴. PRP has been used as source of platelet derived growth factor and transforming growth factor, and it has been reported that PRP has a positive effect on cell proliferation and collagen production, and that it induces the production of matrix-degrading enzymes and endogenous growth factors by tenocytes^{11,12}. Therefore, PRP can be a remarkable environment that accelerates overall healing time in tendon repair.

Several studies have been reported that attempted to use growth factors to repair injured tendon *in vivo*. In the 1999, study by Kurtz et al.², Achilles tendon in rats was treated by IGF-1. They identified that injected insulin-like growth factor I (LR3-IGF01) increased the healing rate by reducing inflammation. In the 2000 study by Chan et al.³, the effects of basic fibroblast growth factor (bFGF) on early stages of tendon healing. They identified that injected bFGF with increasing dosage increased the expression of collagen type III, but there was no significant difference on ultimate stress and the pyridinoline content between the control group and the others. In 2010, Suwalski et al.⁴ identified that PDGF-BB increased the healing process on Achilles tendon in rats. PRP including growth factors also was expected to achieve similar results. In this study, at 2, 4, and 8 weeks after surgery, all PRP injection to Achilles tendon repair resulted in a higher average tensile strength as compared to the control.

Although the effect of PRP on increasing tensile strength was dosage dependent, increasing PRP dosage did not result in increasing the last maximum tensile strength. At 2 and 4 weeks after surgery, the tensile strength was significant difference between control and 0.2 mL PRP group. But, at 8 weeks after surgery, the tensile strength was not significant difference between control and 0.2 mL PRP group. The effect of PRP on increasing tensile strength was mainly manifested at early stages of tendon healing. Therefore, to exert a long term PRP effects on tendon healing, it may need more PRP dosage.

With more PRP, in this study, the dosage of produced collagen seems to increase. However, the increase in the synthesis of collagen and tensile strength did not indicate a significant correlation. This shows that the tensile strength is affected not only by the dosage of collagen. Because, as was confirmed in the histological result, in tendon healing, density and structural maturation of the collagen matrix and tendon fiber also affect the tensile strength. Though produced collagen may increase tendon healing rate, there is not enough direct correlation of collagen dosage and tendon strength.

There were some limitations to this study. Until now differences among PRP commercial presentations have

not been clarified, regarding the optimal concentration of growth factors delivery. PRP infiltration method might be inappropriate, because PRP was not evenly distributed and some flowed out of the tendon. Standardization in the centrifugation, platelet concentration, and injection methods is necessary. Another limitation was the evaluation time, 2, 4, 8 weeks after surgery. The effect of PRP injection on the tendon healing over 8 weeks after surgery was not known. Finally a sample size was too small to detect significant differences of tensile strength test and collagen with different dosages of PRP infiltrated.

CONCLUSION

In a rabbit Achilles tendon injury model, infiltration of autologous PRP was proven to enhance tendon healing process. The more dosage of the PRP brought a longer term for increasing the strength of the tendon. But, Further research needed to find the maximum effect on tendon healing. Likewise, future studies will be essential to determine the dosage of PRP on tendon healing in clinical practice.

REFERENCES

1. Yao J, Woon CY, Behn A, et al. The effect of suture coated with mesenchymal stem cells and bioactive substrate on tendon repair strength in a rat model. *J Hand Surg Am.* 2012;37:1639-45.
2. Kurtz CA, Loebig TG, Anderson DD, DeMeo PJ, Campbell PG. Insulin-like growth factor I accelerates functional recovery from Achilles tendon injury in a rat model. *Am J Sports Med.* 1999;27:363-9.
3. Chan BP, Fu S, Qin L, Lee K, Rolf CG, Chan K. Effects of basic fibroblast growth factor (bFGF) on early stages of tendon healing: a rat patellar tendon model. *Acta Orthop Scand.* 2000;71:513-8.
4. Suwalski A, Dabboue H, Delalande A, et al. Accelerated Achilles tendon healing by PDGF gene delivery with mesoporous silica nanoparticles. *Biomaterials.* 2010;31:5237-45.
5. Liu CF, Aschbacher-Smith L, Barthelery NJ, Dymment N, Butler D, Wylie C. What we should know before using tissue engineering techniques to repair injured tendons: a developmental biology perspective. *Tissue Eng Part B Rev.* 2011;17:165-76.
6. Blanton MW, Hadad I, Johnstone BH, et al. Adipose stromal cells and platelet-rich plasma therapies synergistically increase revascularization during wound healing. *Plast Reconstr Surg.* 2009;123:56s-64s.
7. Kim HY, Park JH, Han YS, Kim H. The effect of platelet-rich plasma on flap survival in random extension of an axial pattern flap in rabbits. *Plast Reconstr Surg.* 2013;132:85-92.
8. Kim HJ, Nam HW, Hur CY, et al. The effect of platelet rich plasma from bone marrow aspirate with added bone morphogenetic protein-2 on the Achilles tendon-bone junction in rabbits. *Clin Orthop Surg.* 2011;3:325-31.
9. Beck J, Evans D, Tonino PM, Yong S, Callaci JJ. The biomechanical and histologic effects of platelet-rich plasma on rat rotator cuff repairs. *Am J Sports Med.* 2012;40:2037-44.
10. Dolkart O, Chechik O, Zarfati Y, Brosh T, Alhajajra F, Maman E. A single dose of platelet-rich plasma improves the organization and strength of a surgically repaired rotator cuff tendon in rats. *Arch Orthop Trauma Surg.* 2014;134:1271-7.
11. Guevara-Alvarez A, Schmitt A, Russell RP, Imhoff AB, Buchmann S. Growth factor delivery vehicles for tendon injuries: Mesenchymal stem cells and Platelet Rich Plasma. *Muscles Ligaments Tendons J.* 2014;4:378-85.
12. de Mos M, van der Windt AE, Jahr H, et al. Can platelet-rich plasma enhance tendon repair? A cell culture study. *Am J Sports Med.* 2008;36:1171-8.
13. Graziani F, Ivanovski S, Cei S, Ducci F, Tonetti M, Gabrielle M. The in vitro effect of different PRP concentrations on osteoblasts and fibroblasts. *Clin Oral Implants Res.* 2006;17:212-9.
14. Sharma P, Maffulli N. Biology of tendon injury: healing, modeling and remodeling. *J Musculoskelet Neuronal Interact.* 2006;6:181-90.
15. Shin KH, Lee H, Kang S, et al. Effect of leukocyte-rich and platelet-rich plasma on healing of a horizontal medial meniscus tear in a rabbit model. *Biomed Res Int.* 2015;2015:179756.
16. Sen B, Guler S, Cecen B, et al. The effect of autologous platelet rich plasma in the treatment of achilles tendon ruptures: an experimental study on rabbits. *Balkan Med J.* 2016;33:94-101.
17. Fukawa T, Yamaguchi S, Watanabe A, et al. quantitative

assessment of tendon healing by using MR T2 mapping
in a rabbit achilles tendon transection model treated with

platelet-rich plasma. Radiology. 2015;276:748-55.

토끼 힘줄 치유에 있어 혈소판 풍부 혈장의 용량에 따른 효과에 관한 연구

김민욱 · 임온 · 황소민 · 황민규 · 이종서

좋은문화병원 미용성형재건센터

목적: 힘줄 손상 후 회복에서 자가 혈소판 풍부 혈장의 주입으로 회복을 증진시킬 수 있다는 사실이 알려지고 있다. 저자들은 혈소판 풍부 혈장의 양에 따른 힘줄 회복양상의 변화를 알아보고자 하였다.

방법: 혈소판 풍부 혈장은 실험 토끼 귀에서 자가 채취한 혈액에서 준비하였다. 30마리의 토끼에서 60개의 아킬레스건을 대상으로 실험을 진행하였다. 절단된 아킬레스건을 재봉합하여 0 mL, 0.1 mL, 0.2 mL, 0.4 mL 혈소판 풍부 혈장 주입군으로 나누어 실험을 진행하였다. 각 그룹별 2, 4, 8주에 채취하여 인장 강도와 콜라겐의 양을 측정하였다.

결과: 2, 4, 8주에 채취한 아킬레스건의 인장 강도와 콜라겐의 양은 혈소판 풍부 혈장을 주입하지 않은 대조군에 비해 혈소판 풍부 혈장을 주입한 실험군에서 높게 측정되었다. 또한 2, 4, 8주로 주수가 늘어날수록 인장강도와 콜라겐의 양은 점점 높게 측정되었다.

결론: 토끼에서 자가 혈소판 풍부 혈장을 이용하여 힘줄의 회복을 증진시킬 수 있었다. 저자들이 정한 혈소판 풍부 혈장의 용량 내에서는 힘줄의 회복 시 인장 강도와 콜라겐의 양은 혈소판 풍부 혈장의 양을 증가시킬수록 높아진다는 사실을 알아냈다. 임상에서 적용하기 적합한 혈소판 풍부 혈장의 용량을 결정하기 위해서 추가적인 연구가 필요할 것으로 생각된다.

핵심단어: 혈소판 풍부 혈장, 인장 강도, 콜라겐, 힘줄

접수일 2016년 4월 12일 **수정일** 1차: 2016년 6월 23일, 2차: 2016년 9월 4일, 3차: 2016년 10월 12일

게재확정일 2016년 10월 14일

교신저자 황소민

부산시 동구 범일로 119

좋은문화병원 미용성형재건센터

TEL 051-630-0199 **FAX** 051-630-0145

E-mail Limon0910@gmail.com