

# The “Cascade” membrane: a new PRP device for tendon ruptures. Description and case report on rotator cuff tendon

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**Abstract.** Rotator cuff tears are common soft-tissue injuries that often require surgical treatment. Initial efforts to better tendon healing centered on improving the strength of repair. More recent studies have focused on abiologic enhancement of the healing process. Platelet rich plasma (PRP) is a fraction of plasma that has been isolated and used to enhance regeneration in bone and soft tissues. The healing potential of PRP has been attributed to the release of multiple growth factors from the highly concentrated platelets. The “Cascade” membrane is a thin layer of autologous fibrine that is very rich in platelets and is obtained by high speed centrifugation of a small quantity of PRP. The Authors present the case of C.U., a right-handed 53year-old male that came to our attention complaining of severe right shoulder pain and ROM reduction. The MRI showed a thick tear of the sovraspinatus tendon with retraction of the muscle. The patient underwent surgical repair with arthroscopy and mini-open approach with acromionplasty, subacromial decompression, cuff repair by trans-bone suture and application of the “Cascade” membrane (A.T. Grade Milano, Italy) that was sutured side-to-side to close the 10 mm tear. A standard rehabilitation protocol for rotator cuff tears was performed. A MRI 6 months after surgical repair showed the complete integrity of the cuff under the membrane. Currently no widely accepted treatment for massive, irreparable rotator cuff tears is available. Allograft reconstruction to span the remaining defect in massive rotator cuff tears will lead to increase functional results; we believe that further studies are needed to describe and evaluate its potential in tendon healing; multiple MRI studies will demonstrate healing of the tendon with the graft. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** Tendon healing, rotator cuff tear, growth factors

## Introduction

Rotator cuff tears are common soft-tissue injuries that often require surgical treatment. Initial efforts to better tendon healing centered on improving the strength of repair. More recent studies have focused on a biologic enhancement of the healing process. Tissue engineering is a multidisciplinary field that involves the application of scientific principles towards creating living tissue to replace, repair or augment diseased tissue.

It is known that a histologically normal insertion site does not regenerate after rotator cuff ten-

don-to-bone repair. Cytokines play an important role in cell chemotaxis, proliferation, matrix synthesis and cell differentiation and may thus improve rotator tendon-to bone healing. Growth factors are synthesized and secreted by many types of cells involved in tissue repair: platelets are known to contain various cytokines, they can be isolated from autologous blood and may provide an effective method by which to deliver growth factors to a rotator cuff tendon repair site. Growth factors that appear during the wound healing process have been reported to promote tissue regeneration and healing. Among them

the platelet-derived growth factor (PDGF) is noteworthy (1-3).

Platelet rich plasma (PRP) is a fraction of plasma that has been isolated and used to enhance regeneration in bone and soft tissues. The healing potential of PRP has been attributed to the release of multiple growth factors from the highly concentrated platelets. The "Cascade" membrane (A.T. Grade Milano, Italy) is a thin layer of autologous fibrine that is very rich in platelets and obtained by high speed centrifugation of a small quantity of PRP. The kit consists in a system that takes the blood sample from the patient, separates the PRP, and transfers the PRP into the bottle to prepare the membrane. All the operations are sterile, without any contact with air, and last about 25 minutes.

The final product is a membrane of autologous suturable fibrine with a diameter of 35 mm, containing about 50 times the platelet concentration of the initial blood. The mechanical strength for traction is remarkable, allowing good handling, cutting, punching and stitching without additional problems. The overall thickness is variable, depending on the amount of PRP used and on the platelets in the patient's blood.

A significant problem in tendon repair is the lack of suitable graft material for reconstruction; the Cascade is easily suturable and has been successfully used for the therapy of vascular ulcers, but we believe that it could be very useful in all cases of tendon tears where a side-to-side repair is not easy or possible: an improvement in the current repair technique may improve tendon healing leading to improved clinical results.

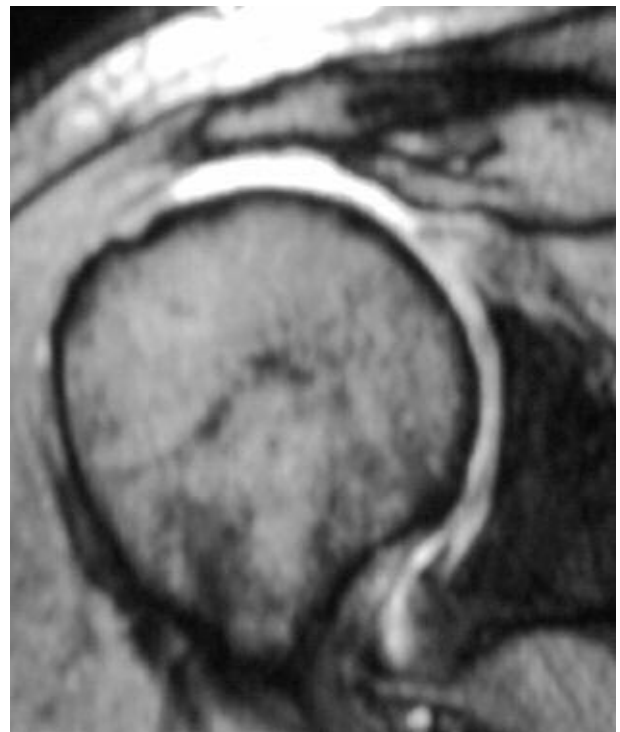
We report the case of a man with a full thickness 10 mm tear of the sovraspinatus tendon of the rotator cuff with considerable retraction of the muscle, that was successfully surgically repaired with a side-by-side suture of the "Cascade" membrane.

### Case report

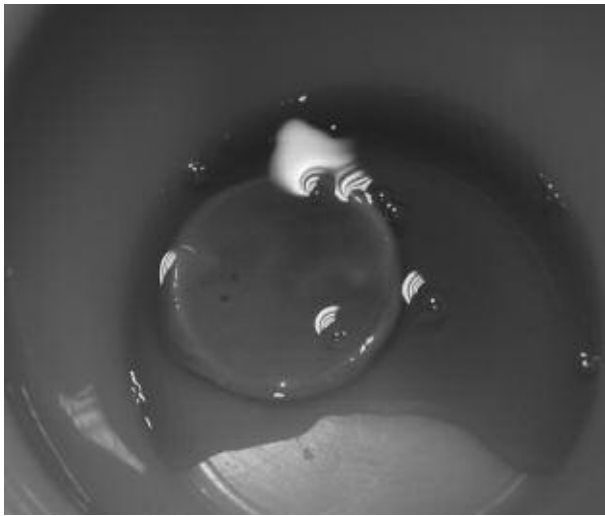
C.U., a right-handed 53year-old male came to our attention complaining of severe right shoulder pain and reduction of ROM. Clinical history was neg-

ative for fractures, trauma or overstrengthening use. Non steroidal drugs and physical therapies failed in controlling pain. Clinical examination showed atrophy of the deltoid muscle, severe ROM reduction of the glenohumeral joint with limitation in shoulder elevation, positivity for Neer, Jobe and palm-up tests (Costant score 56). Plain radiographs were negative. The MRI (November 2006, Fig. 1) showed a thick tear of the sovraspinatus tendon with retraction of the muscle.

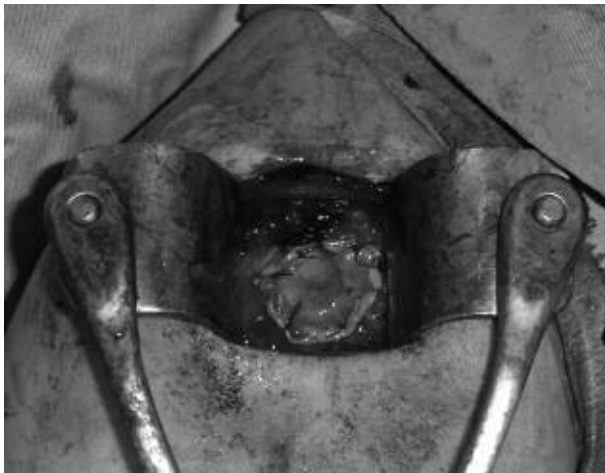
In July 2007 the patient underwent surgical repair with arthroscopy and mini-open approach with acromionplasty, subacromial decompression, trans-bone suture and application on the tear of the "Cascade" membrane (Fig. 2) that was sutured side-to-side to close the 10 mm tear that was 1 cm proximal to the insertion on the greater tuberosity (Fig. 3). No complications followed the operation, the patient was immobilized in an abduction pillow for 4 weeks, and a standard rehabilitation protocol for rotator cuff tears was performed.



**Figure 1.** MRI study of the right shoulder showing a full thickness tear of the sovraspinatus tendon



**Figure 2.** The "Cascade" membrane before its application on tendon

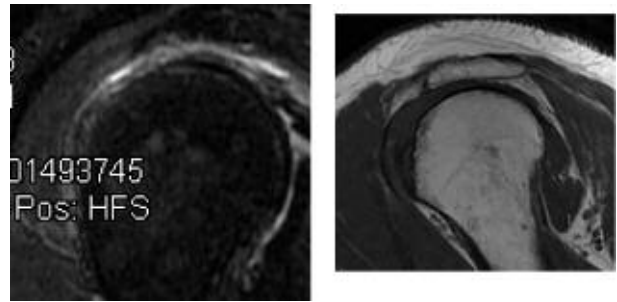


**Figure 3.** The "Cascade" membrane positioned on the tendon to fill the defect. Note the sutures

Clinical examination after 6 months showed good pain relief with significant improvement of ROM. The Constant score rose to 96. A MRI 6 months after surgical repair showed the complete integrity of the cuff under the membrane (Fig. 4).

## Discussion

Rotator cuff tear is one of the most common disorders of the shoulders, whose natural healing seldom



**Figure 4.** MRI study showing complete integration of the membrane and restoration of the tendon integrity

takes place: the repair of a torn rotator cuff tendon may be successfully performed through a variety of techniques, including open approaches, arthroscopically-assisted mini-open surgery and entirely arthroscopic repair. With all of these techniques the repair must be protected from active motion for 6 weeks to allow adequate tendon healing (1, 4, 5).

The poor healing capacity of the torn rotator cuff is well known. Once torn, the rotator cuff tear either remains the same size or expands in size with time. Currently, no therapeutic agents are available that promote the healing of the torn tendon. Thus, surgical repair is the only treatment option when conservative treatment fails. Growth factors are known to appear during wound healing; we hypothesized that any agent that has the ability to promote tendon healing may be beneficial in promoting rapid healing, rapid rehabilitation, and return to complete function of the affected shoulder.

Many authors have reported the use of tendon transfers in order to facilitate the reconstruction of otherwise irreparable rotator cuff tears: all studies compared complex invasive procedures and surgeons had to frequently deal with technically demanding reconstructions. The results of these operations are poor, so that allograft reconstruction for irreparable rotator cuff tears is not recommended in literature (6).

Significant proliferation of reparative tissue around the edges of the chronic torn tendon of the rotator cuff has been observed and is well studied. In addition, cells producing type I collagen have been found at the proximal margin of the supraspinatus tendon. This matrix indicates active new matrix synthesis in the injured tendon consistent with tissue remodelling and wound healing. The platelets contained in the clot

around the injured area produce growth factors like PDGF that are believed to play an important role during initial tendon healing (7-10).

The "Cascade" membrane used in this study is made with autologous blood and platelet rich plasma (PRP). In our experience it is an easy to obtain substratus that contains growth factors that work as stimulators of extrinsic cell migration, regulators of proteinasas, collagen producers, and improve the strength and quality of the repair, allowing shorter surgical and rehabilitation times with less invasive procedures (2, 11, 12). Furthermore, the membrane may help the surgeon in all those difficult cases in which a side-to-side repair is impossible or difficult to obtain.

Most rotator cuff tears require repair of tendon to bone, unlike the tendon-to tendon repair demonstrated in this study: however some rotator cuff tears require partial repair of the torn tendon to a still-intact tendon on the greater tuberosity: a membrane with considerable strength for traction containing growth-factors may be very useful in these cases to help surgeons fill the defect without increasing surgical aggression to tissues.

Currently no widely accepted treatment for massive, irreparable rotator cuff tears is available (7,9). Allograft reconstruction to span the remaining defect in massive rotator cuff tears will lead to increased functional results; we believe that further studies are necessary to describe and evaluate its potential in tendon healing; multiple MRI studies will demonstrate healing of the tendon with the graft.

## References

1. Gelberman RH, et al. The early effects of a sustained platelet-derived growth factor administration on the functional and structural properties of repaired intrasynovial flexor tendons: an in vivo biomechanic study at 3 weeks in canines. *J Hand Surg* 2007; 32 (3): 373-9.
2. Costa MA, et al. Tissue engineering of flexor tendons: optimization of tenocyte proliferation using growth factor supplementation. *Tissue Eng* 2006; 12 (7): 1937-43.
3. Dines, et al. Tissue engineering and rotator cuff tendon healing. *J Shoulder Elbow Surg* 2007; 22.
4. Rodeo SA. Biologic augmentation of rotator cuff tendon repair. *J Shoulder Elbow Surg* 2007; 1.
5. Mollay T, et al. The role of growth factors in tendon and ligament healing. *Sports Med* 2003; 33: 381-94.
6. Woo SL et al.: Tissue engineering of ligament and tendon healing. *Clin Orthop* 1999; 367, S312-23.
7. Moore DR et al.: Allograft reconstruction for massive, irreparable cuff tears. *Am J Sport Med* 2006; 34 (3): 392-6.
8. Kobayashi, et al. Expression of growth factors in the early phase pf supraspinatus tendon healing in rabbits. *J Shoulder Elbow Surg* 2006; 15 (3): 371-7.
9. Murray DH, et al. The effect of cartilage-derived morphogenetic protein 2 on initial healing of a rotator cuff defect in a rat model. *J Surg Elbow Surg* 2007; 16, 2.
10. Burkhart SS: Partial repair of massive rotator cuff tears: the evolution of a concept. *Orthop Clin North Am* 1997; 28: 125-32.
11. Yoshikawa Y, et al. Dose-related cellular effects of platelet-derived growth factor-BB differ in various types of rabbit tendons in vitro. *Acta Orthop Scand* 2001; 72: 287-92.
12. Thomopoulos S. et al. PDGF-BB released in tendon repair using a novel delivery system promotes cell proliferation and collagen remodelling. *J Orthop Res* 2007; 5.

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