

## **TENDON TRANSFER FOR IRREPARABLE ROTATOR CUFF TEARS**

**Paolo Paladini**

**Giovanni Merolla**

**Giuseppe Porcellini**

**Unit of Shoulder and Elbow Surgery, Cervesi Hospital – Cattolica, Italy**

### **SUMMARY**

#### **Introduction**

Treatment of symptomatic irreparable rotator cuff tears is extremely challenging because, at present, there are no ideal solutions to this problem. Many patients respond favorably to non-surgical treatment. However, when conservative measures fail to improve the patient's pain and disability, surgery should be considered. Different surgical techniques are available and the choice of the most appropriate procedure depends on the presenting symptoms, age of the patient, functional demand, medical comorbidities, joint stability and presence of arthritic changes. The transposition of the surrounding muscles to replace the rotator cuff function represents a viable option in the treatment of younger patients without glenohumeral osteoarthritis and with severe functional limitation.

#### **Aim**

The aim of this study is to give an overview of the currently available evidence regarding tendon transfer procedures for irreparable rotator cuff tears.

#### **Material and methods**

A review of the literature has been made to overview the use of tendon transfer in case of young patients with irreparable cuff tears. The review highlighted the most common

## **PRZENIESIENIE ŚCIĘGIEŃ W PRZYPADKU NIEODWRACALNYCH USZKODZEŃ PIERŚCIENIA ROTATORÓW**

**Paolo Paladini**

**Giovanni Merolla**

**Giuseppe Porcellini**

**Unit of Shoulder and Elbow Surgery, Cervesi Hospital – Cattolica, Włochy**

### **STRESZCZENIE**

#### **Wprowadzenie**

Leczenie objawowych, nieodwracalnych uszkodzeń ścięgien pierścienia rotatorów (RC) jest niezwykle trudne, obecnie nie ma idealnych rozwiązań dla tego problemu. Wielu pacjentów pozytywnie reaguje na leczenie zachowawcze. Jednak, gdy leczenie konserwatywne nie poprawia bólu i niepełnosprawności pacjenta, należy rozważyć leczenie operacyjne. Dostępne są różne techniki chirurgiczne, a wybór najbardziej odpowiedniej procedury zależy od prezentowanych objawów, wieku pacjenta, wymagań pacjenta, co do powrotu funkcji, chorób współistniejących, stabilności stawów i zmian zwyrodnieniowych. Transfer otaczających mięśni stawu ramennego w celu zastąpienia funkcji ścięgien pierścienia rotatorów stanowi realną opcję w leczeniu młodszych pacjentów bez choroby zwyrodnieniowej stawów i ze znaczącym ograniczeniem funkcji barku.

#### **Cel**

Celem niniejszego opracowania jest przedstawienie aktualnie dostępnych dowodów na temat operacji transferu, czyli przeniesienia przyczepu ścięgna w leczeniu nienaprawialnych uszkodzeń RC.

#### **Materiał i metody**

Dokonano przeglądu piśmiennictwa w celu omówienia zastosowania transferu ścięgien u młodych pacjentów z nienaprawialnym uszkodzeniem ścięgien pierścienia rotatorów.

tendon graft procedures using arthroscopic and open approaches.

### Results

The most common tendon transfer used are: latissimus dorsi for posterior-superior cuff tears and pectoral, major and minor, for anterior-superior cuff tears. The outcomes are often good even in presence of limited goals.

### Conclusions

Tendon transfer remains an important weapon in the surgeon hands to treat so demanding lesions, often in young and very active patients. The surgery is difficult and the indications are really strict and precise to achieve good outcomes.

**Keywords:** irreparable cuff tears, tendon transfer, shoulder arthroscopy

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### Introduction

Rotator cuff tears (RCT) represent one of the most common cause of pain and disability of the shoulder. Epidemiological studies have shown that RCT occur more frequently after a certain age, with a prevalence ranging from 30% to 50% in patients older than 50 years (Yamaguchi *et al.*, 2006), and that, in most of cases, they are progressive (Zafra *et al.*, 2009). The treatment of choice in symptomatic RCT is the direct reattachment of the torn tendon to the bone at the original site of insertion through either open or arthroscopic surgery. Irreparable RCT typically present with atrophy and fatty degeneration of the respective muscles that lead

W recenzji wyróżniono najczęściej opisywane techniki operacyjne przeniesienia przyczepu ścięgien z użyciem metod artroskopowych i otwartych.

### Wyniki

Najczęściej stosowane są przeniesienia przyczepu ścięgien: mięśnia najszerzego grzbietu dla uszkodzeń w części tylnego- górnej RC oraz mięśnia piersiowego, większego i mniejszego, dla uszkodzeń w części przednio- górnej RC. Wyniki leczenia są dobre, nawet w przypadku ograniczonych możliwości poprawy.

### Wnioski

Przeniesienie przyczepu ścięgna mięśnia pozostaje ważną bronią w rękach chirurga w leczeniu tak wymagających uszkodzeń, często u młodych i bardzo aktywnych pacjentów. Operacja jest trudna, a wskazania są bardzo rygorystyczne i precyzyjne, aby osiągnąć dobre wyniki.

**Słowa kluczowe:** nieodwracalne uszkodzenie ścięgien pierścienia rotatorów, przeniesienie przyczepu ścięgna, transfer, artroskopia barku

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to impaired muscle quality and thus to defective contraction even if direct repairs are structurally successful (Goutallier *et al.*, 2003). Obviously in presence of an irreparable RCT, also the shoulder biomechanics is altered. Patients with irreparable RCT can present with a variety of clinical manifestations. They may have no symptoms or mild symptoms, or they may be completely disabled and in severe pain (Dines *et al.*, 2006). The management of symptomatic irreparable RCT is still controversial and often the results are less favourable and predictable. Many patients with irreparable RCT respond favourably to nonsurgical treatment

(Merolla *et al.*, 2011). When conservative measures fail to improve the patient's pain and disability, surgery should be considered. Surgical options include arthroscopic debridement with or without partial rotator cuff repair (Gartsman *et al.*, 1997), the use of rotator cuff allografts and synthetic grafts (Wildemann *et al.*, 2012), arthroplasty (De Cupis *et al.*, 2008) and tendon transfer (Paladini *et al.*, 2013, Nelson *et al.*, 2014, Namdari *et al.*, 2014). Among these techniques, the transposition of the surrounding muscles to replace the rotator cuff function represents available option.

### Aim

The aim of this study is to give an overview of the currently available evidence regarding tendon transfer for irreparable RCT, with presentations of results based on the own experience of Authors.

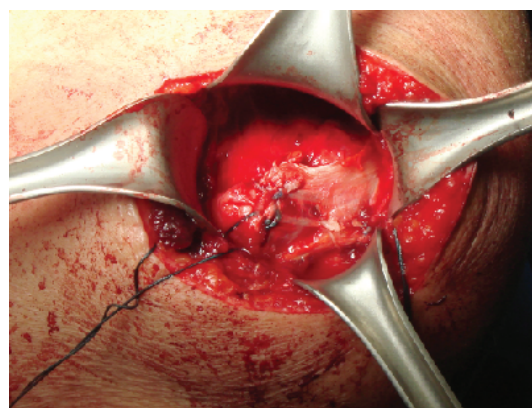
### Material, methods and results

#### TENDON TRANSFER PROCEDURES: TECHNIQUES

##### *Latissimus Dorsi (LD) transfer*

The LD muscle is a large muscle, located along the dorso-lateral side of the trunk. The muscle has four points of origin, the spinous processes of the thoracic vertebrae (T7-T12), the inferior angle of the scapula, the iliac crest and the 9th to 12th ribs, and inserts to the medial edge of the bicipital groove of the humerus (Gerber *et al.*, 1988). LD transfer provides a large, vascularized tendon that closes the cuff defect and exerts an external rotational moment, allowing more effective action of the deltoid muscle (Namdari *et al.*, 2012). In its native location, the LD muscle contributes to internal rotation, retroversion, and abduction of the shoulder joint 33. The procedure is performed on the patient in general anaesthesia in the lateral decubitus position and includes an open superior approach, or arthroscopic, and an axillary approach. The superior approach is performed with a 5-cm supero-lateral skin incision made

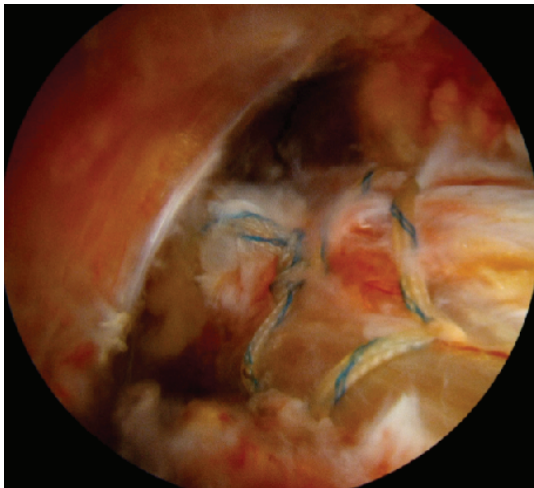
immediately lateral to the acromioclavicular joint going through the space between the anterior and the lateral deltoid without detaching it from the acromion. The rotator cuff is exposed to ascertain that the rupture is irreparable and trying an extensive mobilization of the retracted musculotendinous units to attempt a direct repair of the residual tendon bands. After that, the axillary approach is performed through a 12 to 15-cm posterior skin incision that follow the lateral border of the LD, the muscle is identified and is released from the humeral shaft taking care to identify and separate the LD belly from teres major. After exploration of the neurovascular bundle, the LD is mobilized and is pulled through the plane between the infraspinatus-teres minor (TMi) and the deltoid muscle. The transferred tendon is anchored to the greater tuberosity in the area of supraspinatus tendon insertion with use of 2 double-loaded suture anchors (Threvo FT; ConMed, Largo, FL, USA) or with transosseous sutures/bone trough (Figure 1).



**Figure 1.** Latissimus dorsi transferred to the anterior part of the shoulder by an open approach.

Alternatively, a small osteotomy can be performed in an effort to improve healing of the transfer. The same procedure can be done using arthroscopy (Figure 2). Any remnants of the torn rotator cuff are then sutured to the medial edge of the LD tendon. A post-operative period of 4–6 weeks of immobilization in a rigid orthosis with the arm in slight abduction and externally

rotated is generally required (Gerber *et al.*, 1992). Gentle passive range of motion in abduction and external rotation can begin immediately, but internal rotation and adduction are restricted until 6 weeks after surgery. At 6 weeks the brace may be removed and active range of motion is started. Strengthening exercises can be started in the third month. When the LD tendon is transferred to the greater tuberosity, the muscle's internal rotator torque is removed and the function of the muscle changes into an external rotator. In the majority of patients LD tendon transfer is very effective in reducing pain. However, the functional outcome is more variable. Proper patient selection is critical. Factors associated with poor outcome include muscle dysfunction (subscapularis, deltoid, teres minor) and osteoarthritis of the glenohumeral joint.



**Figure 2.** Latissimus dorsi tendon in the subacromial space: arthroscopic view.

#### *Pectoralis Major (PMA) transfer*

The PMA originates from the anterior surfaces of the medial clavicle, the length of the sternum, the cartilage of ribs 2 through 7, and the aponeurosis of the external oblique muscle and inserts lateral to the bicipital groove. Its insertion consists of two distinct layers. The anterior lamina is the terminal portion of the clavicular head, while the posterior lamina originates from the sternal head. A variable third layer, the abdominal lamina,

is derived from the aponeurosis of the external oblique muscle (Nelson *et al.*, 2014). The procedure is performed with the patient under general anaesthesia in beach-chair position through a standard deltopectoral approach. The deltoid is retracted laterally with the cephalic vein. Subdeltoid, subacromial, and subcoracoid adhesions are bluntly released. A biceps tenodesis or tenotomy is generally undertaken. The lesser tuberosity is exposed and an attempt is made to identify and mobilize the torn subscapularis tendon. If the subscapularis is deemed irreparable, a PMA transfer is performed. The lateral border of the conjoint tendon is identified and the entire conjoint tendon is dissected. The space between the pectoralis minor (PMi) and the conjoint tendon is entered by blunt dissection with the index fingers. The musculocutaneous nerve and its entrance into the muscle are identified. Thus, the space for the transferred muscle between the nerve and the conjoint tendon can be assessed (Gavrilidis *et al.*, 2010). The superior insertion of the PMA on the humerus is identified lateral to the intertubercular sulcus. Three courses can be taken by the transferred tendon. It can be passed in the plane of its normal course but merely in a more superior direction and can then be attached to the lesser tuberosity of the humerus. Conversely, the sternal lamina may be passed deep to the clavicular tendon but superficial to the conjoint tendon. Lastly, the tendon (complete or partial) can be routed deep, through the interval between the conjoint tendon (superficial) and the musculocutaneous nerve. In this way, a transfer is used to rebalance the forces on the humeral head through an inferiorly directed force vector. If rerouted deep to the conjoint tendon, the PMA transfer is thought to also reduce subcoracoid impingement through a soft-tissue interposition effect that aids in pain relief. The tendon is then transferred to the upper lesser tuberosity or the anterior aspect of the greater tuberosity depending on the length



and excursion of the tendon. The site of attachment is burred, providing a surface of punctate bleeding bone. The tendon is then secured to the tuberosity by use of transosseous sutures or bone anchors. Postoperatively, the shoulder is immobilized for 4–6 weeks in a rigid orthosis (Elhassan *et al.*, 2008). Passive range of motion can be started after 4 weeks but it is restricted within a safe range determined intraoperatively in order to protect the transfer. Active range of motion is allowed after 6 weeks and strengthening exercise after 2 months. However, internal rotation against resistance is allowed only 3 months after surgery. If a partial transfer of the PMA is chosen, the two laminae are bluntly separated for selective transfer. This is achieved by retracting the clavicular head proximally and initiating the separation at the level of the musculotendinous junction (Nelson *et al.*, 2014). Despite overlapping insertions, either the anterior or posterior lamina can be elevated while leaving the other one intact on the humerus. Different studies reported outcomes after PMA transfer for irreparable anterosuperior RCT with good outcomes. Same outcomes are not obtainable in case of anterior subluxation of the humeral head (Gavrilidis *et al.*, 2010; Elhassan *et al.*, 2008).

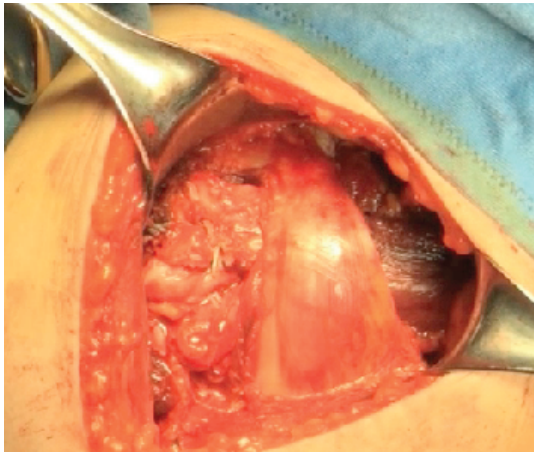
#### *Pectoralis Minor (PMi) transfer*

The PMi is a thin triangular muscle lying deep to the PMA. It originates from the 3rd, 4th and 5th ribs near the costal cartilages. Its fibers ascend laterally and converge in a flat tendon that attaches to the medial border and upper surface of the coracoid process of the scapula. The axillary vessels and brachial plexus lie posterior to the muscle. The PMi pulls the scapula anteriorly and inferiorly toward the ribs (abduction and depression respectively) leading to a dorso-medial movement of the inferior angle of the scapula. This movement is both helpful when retracting the elevated arm and as well as moving the arm posteriorly behind the back. Inclusion criteria for a PMi transfer

are as follow: irreparable RCT involving the upper two-thirds of the subscapularis tendon (Paladini *et al.*, 2013); complete supraspinatus tear; and MRI evidence of fatty degeneration of the supraspinatus and upper subscapularis muscles. All patients are operated under general anaesthesia in a beach-chair position using the same standard deltopectoral approach described for PMA tendon transfer. After careful debridement of the subscapularis footprint and of the interval between the coracoid and the humeral head, the PMi tendon is detached from the coracoid with a bone fragment to foster the healing process and avoid muscle wasting. Two stay sutures placed over the osteotomy are used to drag the PMi tendon, which usually reaches the lesser tuberosity without excessive tension, under the coracoid. The PMi is accurately released, taking care to identify and protect the musculocutaneous nerve, and then sutured to the footprint using 2 double-loaded suture anchors (Threvo FT; ConMed, Largo, FL, USA) (Figure 3). The bellies of the inferior subscapularis and of the PMi can be joined horizontally with 2 free sutures and the biceps tenodesized or tenotomized. After the operation, the shoulder is immobilized in a sling for 6 weeks, active elbow flexion and extension are allowed with the arm at the side; at 6 weeks, the sling is removed and passive mobilizations in forward flexion and passive external rotation are permitted (Paladini *et al.*, 2013). After 8 weeks all range-of-motion (ROM) restrictions were lifted, strengthening is initiated at 3 months.

#### **Discussion and conclusions**

Tendon transfers are complex surgical procedures that require a long period of rehabilitation. They do not restore normal shoulder function and kinematics but can rather be considered as a salvage procedures. The functional outcomes and pain relief that can be achieved after surgery strictly depend on patient. The best candidate for a tendon transfer procedure is a young patient with



**Figure 3.** Pectoralis minor tendon transferred to the lesser tuberosity in open approach.

irreparable RCT, no sign of glenohumeral osteoarthritis and severe functional limitations due to muscle weakness. The choice of donor tendon depends on the location of the RCT. Currently, the two most common tendon transfer procedures involves LD for postero-superior tears and PMa for antero-superior tears.

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*Author responsible for correspondence:  
Paolo Paladini  
Unit of Shoulder and Elbow Surgery, Cervesi  
Hospital – Cattolica  
Ospedale Cervesi  
Via Beethoven  
Cattolica (RN) 47841  
Italy  
palpaolo@tin.it*

*Autor odpowiedzialny za korespondencję:  
Paolo Paladini  
Unit of Shoulder and Elbow Surgery, Cervesi  
Hospital – Cattolica  
Ospedale Cervesi  
Via Beethoven  
Cattolica (RN) 47841  
Włochy  
palpaolo@tin.it*