# Rehabilitation treatment in subjects with large rotator cuff tears: our experience using Fisiotek HP.

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The rotator cuff is the group of shoulder intra and extra articular rotator tendons with insertion on the tuberosity of the humerus. It is formed of the tendinous attachment of the supraspinatus, infraspinatus, teres minor and subscapularis. The first three (extra articular rotators) insert on the greater tuberosity, the other (intra articular rotator) on the lesser tuberosity. The extra articular rotator tendons fuse to each other at approximately 15 mm from the insertion on the humerus. It is impossible to separate them at this level. The supraspinatus and infraspinatus are formed of five layers[2]. The first (1 mm) is represented by fibrous expansions of the coracohumeral ligament. The one underneath (3-5 mm) by tendinous fiber bands crossed by thin arteriola. The third (3 mm) by bands composed of smaller, and irregularly placed tendinous bundles. The arteriola present in this layer have an even smaller diameter then those located closer to the surface. The underlying layer (fourth) is formed of connective tissue with thick collagen fibers lying on the surface layer of the joint capsule (therefore they are extra articular). Finally the last layer (2 mm) is composed of the joint capsule.

The subscapular tendon is formed of parallel tendon and collagen bands. The bands diverge into a fan near the insertion on the lesser tuberosity. They are adjacent to each other on the surface, underneath (near the joint capsule) they are separated by abundant connective tissue. Subcapsular expansions reach above the greater tuberosity, to the groove transverse ligament, between the first and third layer of the "fibrous plate" of the rotator interval, on the floor of the bicipital groove.

The cuff tendons rotate the humerus in relation to the scapula, they stabilize the humeral head (compression) against the glenoid cavity, and are involved in the "muscle balancing mechanism"[8]. Due to their vast insertion and reciprocal connection the shoulder muscles generate rotational movements. If a movement without rotation is desired, other muscles must be partly neutralized. For example, to make an internal rotation movement, the latissimus dorsi must be neutralized by the rotator cuff and deltoid otherwise it would also generate an adduction movement.

Like other tendons, with age the rotator cuff undergoes progressive narrowing, degeneration and reduction in stretching properties. This results in a predisposition to tearing due to strain and progressively lower loading.

The muscles which comprise the rotator cuff are also dynamic stabilizers of the glenohumeral joint and balancers of the action of other shoulder muscles..

In 1872 Duplay[5] used the term "scapulohumeral periarthritis" to indicate all of the soft tissue pathologies around the glenohumeral joint. After more than half a century, Bonola considered "periarthritis" to be "that group of anatomical-pathological lesions which involve the second shoulder joint" including symptomatic or asymptomatic tendinosis of the shoulder intra-extra rotator cuff tendons, calcified tendinitis, partial and complete rotator cuff tears (observable in operations) and adhesive capsulitis (frozen shoulder).

During anatomical dissection of 60 shoulders De Sèze[4] observed 10 cases where no periarticular pathology was found, 2/3 had lesions of the supraspinal tendon, the rest signs of varying degree of postero-superior rotator cuff degeneration.

Neer[10,11] classified all the degenerative pathologies located under the coracoacromial arch in one painful syndrome and confirmed that 95% of rotator cuff tears are secondary to subacromial disorder. Neer also identified the excessive protrusion of the acromion antero-inferior edge as the principle cause of the disorder with the rotator cuff and classified the main anatomical-pathological tendon alterations into three stages:
-Stage I or tendinitis, characterized by edema and tissue hemorrhage (patients < 25 years of age
-Stage II or tendinosis (patients 25 to 40 years of age);
-Stage III or tendon tear and bone modification (patients 40 years of age).
The same author also described the so-called "Supraspinatus Outlet" as the space delimited on the top by the acromion, acromioclavicular joint and coracoacromial joint and on the bottom by the humeral head, and identified two subgroups of patients:
-Patients with "*Outlet impingement"*: where the space is narrower due to the presence of an anterior acromial spur, a curved or hooked acromion or a prominent acromioclavicular joint.
*-Patients without outlet impingement*: where the "Supraspinatus Outlet" profile is preserved, but the conflict is established: from an excessive prominence of the humeral greater tuberosity following a poorly healed fracture of the greater tuberosity or surgical neck (varus outcome); - loss of function of humeral head depressors (rotator cuff); - calcified tendinitis with thickening of the tendons due to calcium deposits; -chronic dislocations of the acromioclavicular joint. Cuff rotator tears are the most frequent of all subcutaneous tendons. Factors which make individuals predisposed and determine tears have been identified and are still being studied.

| **Predisposing factors** | **Determining factors** |
|---|---|
| Skeleton alterations:<br>- acromial<br>- humeral<br>- glenoid | Repeated microtraumas |
| Capsule and ligament alterations<br>- hyperlaxity | Rotator cuff tendinosis |
| Unbalanced action of intrinsic and extrinsic shoulder dynamic stabilizer muscles | Occasional traumas |
| Dorsal hyperkyphosis | Senile involution of tissues |

Tab. 1 Etiopathogenesis of rotator cuff lesions

Bigliani et al. [1] studied the disposition and form of the acromion on the sagital plane and identified three different types of acromion: Type I with a flat inferior surface; Type II with a curved inferior surface; Type III with a hooked inferior surface (Fig.1). Bigliani and Morrison [1-9] observed that Type III was present in 70% of rotator cuff tears; this observation was confirmed in more recent studies by Tivoinen[16], according to whom the hooked shape causes rotator cuff tears, and removal of it is able to limit the progression of the tear.

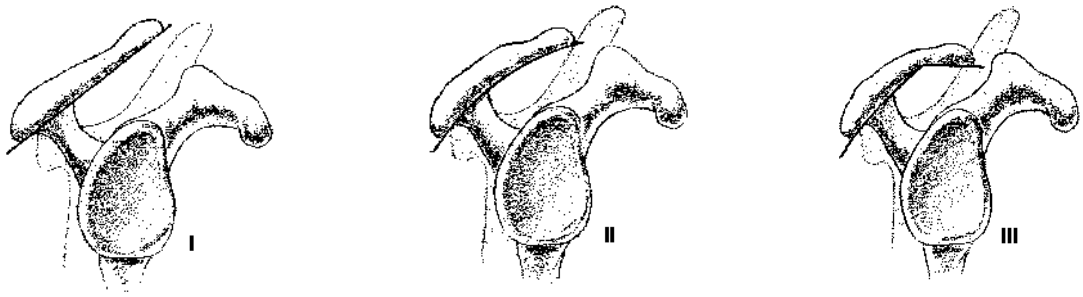


Fig. 1 - Acromion morphology according to Bigliani: I – flat; II – curved; III – hooked

Edelson and Taitz (1992)[6] classified acromions based on the spatial position of the acromioclavicular (AC) joint in relation to the acromial apex and observed three different acromial configurations: square (with articular facet for AC joint located at the acromion apex); cobra head (with articular facet located distally to the apex) and intermediate (with articular facet located in an intermediate position compared to the other two configurations). The shoulders with cobra head acromion had degenerative alterations in approximately a third of the cases. Based on this morphological information Rockwood and Lions[15], recommended surgical removal of the entire anteroinferior edge of the acromion protruding in relation to the AC.

A trauma, even a mild one, can cause tearing of the rotator cuff due to predisposing or determinant causes. This normally occurs in the so-called critical area corresponding to the hypovascularized area of the supraspinatus tendon near the humerus insertion.

Pain and functional limitations are the main causes that make a patient with rotator cuff tearing contact an orthopedic surgeon. The job of the surgeon is to provide a correct diagnosis using clinical tests which are highly sensitive and specific for this pathology and instrument workups which identify it and supply additional information on the dimensions of the tear, amount of inflammation of the bicipital tendon and trophicity of the rotator cuff muscles. Based on this information and the general health conditions of the patient, the surgeon can decide whether to recommend surgical treatment.

Repair techniques depend on the dimensions of the tear[12] and muscle trophicity of the rotator cuff tendons. Patients with a massive tear (> 5 cm) and with lipomatous muscular degeneration are candidates for an arthoscopic debridement (removal of the edges of the tears, acromioplasty and possible tenotomy of the bicipital tendon)[13] or a transposition of the muscle-tendon unit (teres major or latissimus dorsi)[14]. Patients with a small, large or massive tear, but with good muscle

trophicity, are candidates for repair or tendon reinsertion (if it is a disinsertion and not a tear). Tears are divided into partial or full thickness. The latter are further classified based on their shape as well as dimensions[12]. Ellman[7] described tears in the following shapes: half moon, “L”, upside down “L”. trapezoid and massive (Fig.2).

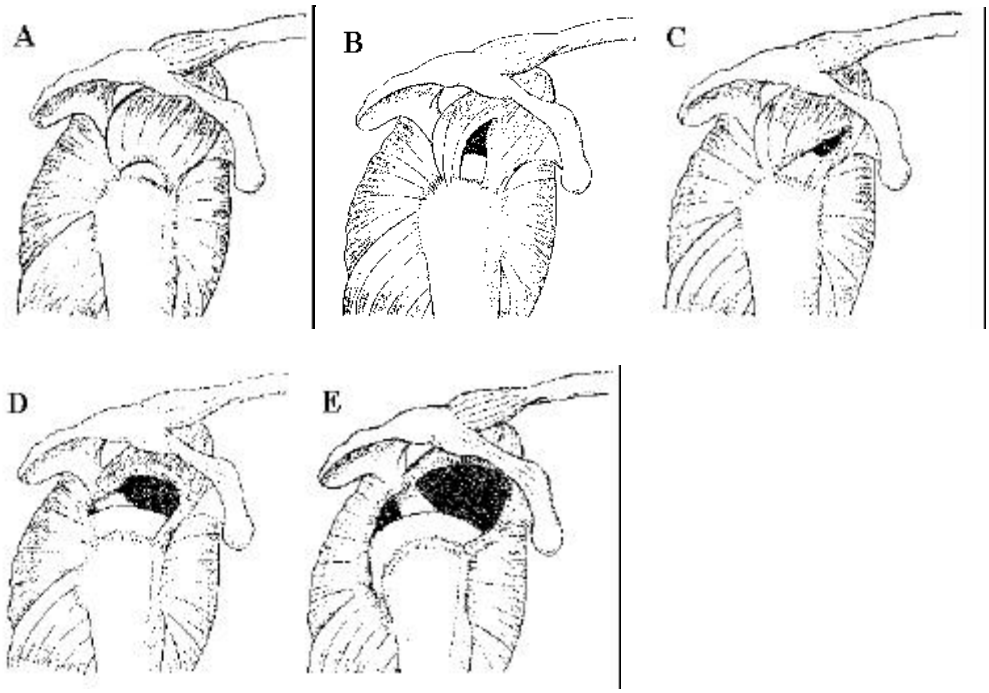


Fig. 2 - Shapes of rotator cuff tears (Ellman, 1993): (A) half moon; (B) “L”; (C) upside down “L”; (D) trapezoid; (E) massive.

The shape and dimensions do not only affect both the surgical technique to use and the post-operative prognosis.

Post-operative rehabilitation treatment lasts an average of three months. Initially, the surgeon, who is aware of the suture tensioning and quality of the sutured tissue, dictates the procedures. A rehabilitation project must take the patient’s lifestyle and expectations into account. It generally has three aims: 1) decrease pain; 2) recover function; 3) stabilization of the humeral head by harmoniously reactivating the proposed muscles. A further goal of resuming previous daily, work and sports activities requires a regression of the pain and recovery of energy, joint function, stamina, proprioception and neuromuscular control. This is obtained with modern rehabilitation techniques which require training, information and the patient’s cooperation with the rehabilitation treatment.

**Patients and methods**

The study was conducted in the Physical and Rehabilitative Medicine Division of the Locomotor System Science Department of "La Sapienza" University of Rome, on a group of 28 patients with surgically treated (suture, suture reinsertion through a bone trough or by using metal anchors) large tears (3-5 cm) of the rotator cuff. All of the patients had a lipomatous degeneration of the rotator cuff muscles of a 0-1 degree according to the Goutallier classification.

The patients started a rehabilitation program in the period from October 2001 and July 2002. The sample was composed of 21 females and 7 males with an average age of 59 (ranging from 50-63). They had all had reduced joint mobility and pain before the operation which had lasted for an average of 2.7 years. The group was composed of homemakers or employees. All had undergone x-ray examinations before the operation and MRI to assess the lifting of the humeral head, extension of the tear, quality of the greater tuberosity and rotator cuff muscles. The patients studied were all in good overall conditions and did not have systemic pathologies which limited daily activity. The right shoulder was operated on in 12 of the cases. All of the patients were right-handed with the exception of 3. Shoulder functional was assessed at the beginning of every treatment cycle with the Constant method (official method of the European Society of shoulder and elbow surgery)[3]. Nevertheless, we made a modification to this method. The 25 points that this method attributes to abduction strength were distributed as follows: 5 to the pain parameter and 20 to mobility. Strength was never tested until four months from the operation. The values obtained from each patient at each cycle, were recorded on a chart (Fig. 2). The total score (Pa) was then multiplied by one hundred and divided by the average factor of shoulder functional (Fm). We calculated the latter on a group of volunteers of various ages, in good health and without shoulder pathologies (Tab. 3).

| Age (years) | 21 -30 | 31 – 35 | 36 - 40 | 41 - 45 | 46 - 50 | 51 - 55 | 56 - 60 | 61 - 65 | 66 - 70 | 71 - 75 | 76 - 80 | 81 - 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fm* Males | 98 | 98 | 97 | 96 | 95 | 93 | 91 | 88 | 86 | 83 | 75 | 67 |
| *Fm* Females | 97 | 95 | 93 | 90 | 88 | 85 | 82 | 78 | 74 | 71 | 68 | 64 |

Tab. 3 - Average shoulder function values in adult subjects of various ages

Arbitrarily, an excellent score was considered 95%-100%, very good 85%-94%, good 75%-84%, fair 65%-74% and poor <65%.

For the pain evaluation, we subjected all the patients to the SDS (simple descriptive scale) self-evaluation test or Huskisson's VAS (visual analog scale) (Fig.4).

Fig.2 – Patient data recording form

Date..... Chart n° ..... **Full name** .....
Sex M F Date of birth ..... Profession .....
Hobbies, Sports and physical activities in spare time
.....
Tel. ..... Receipt n°. .....

- Previous pathological anamnesis ……..
- Medical history and pre-op objectives……..
  - Diagnosis ……..
- Surgical treatment ……
- Objectives beginning rehabilitation treatment (associate: Constant functional evaluation and VAS-SDS) ……
  - VAS: .....… Constant: ……..
- Rehabilitation project ……

Rehabilitation program ……...

**1st Cycle ended (date)** .....
Results(objectives).....
.....
.....
.....…….... Constant: ..... VAS: .....
Changes to rehabilitation program
.....
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**2nd cycle ended (date)** .....
Results(objectives).....
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Changes to rehabilitation program
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**3rd cycle ended (date)** .....
Results(objectives).....
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Changes to rehabilitation program
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Other cycles

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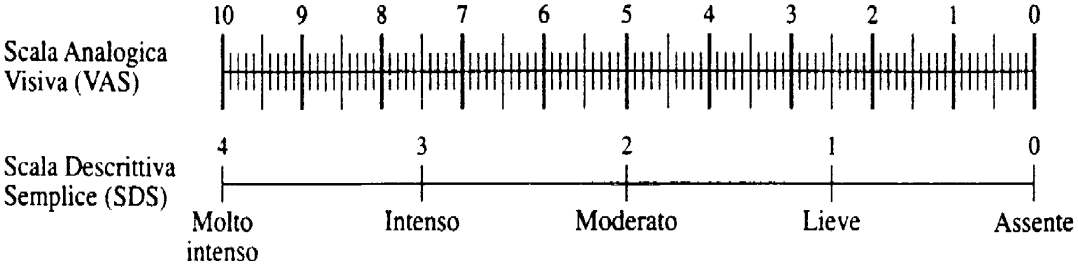



Fig. 4 - Pain self-evaluation scales.

The research group, uniform in age, lesion and treatment, was randomly subdivided into two subgroups: I and II. The first was composed of 13 subjects (10F-3M; average age 60) who underwent a standard physiokinestetic treatment and rehabilitation treatment with Fisiotek HP; subgroup II, composed of 15 patients (11 F and 4 M; average age 57) only underwent standard physiokinestetic treatment.

The rehabilitation treatment lasted an average of four months for both groups and was administered in nine cycles, each composed of ten therapy sessions on a daily basis.

Fisiotek HP (Fig.5), is a device which is used to passively move the shoulder through all movement planes. The machine is equipped with a range regulator on each plane as well as for movement speed and treatment time.

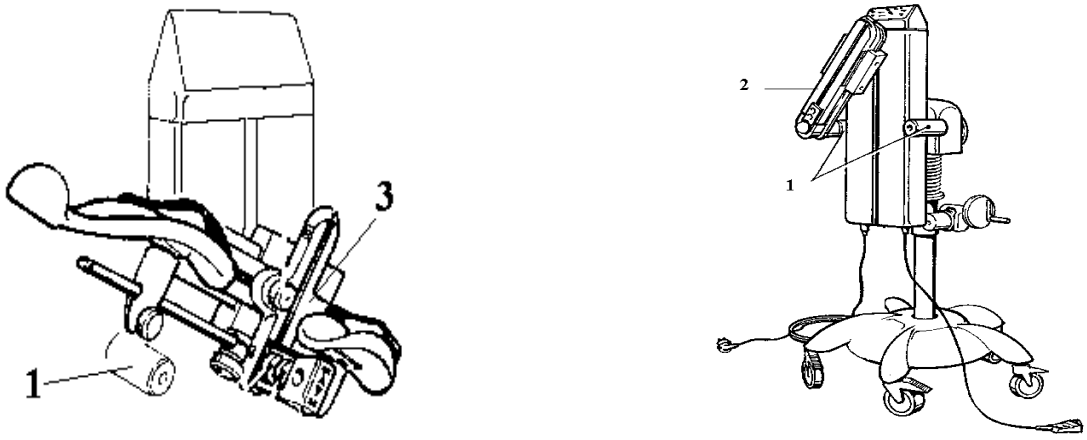



Fig. 5 - Fisiotek HP : 1) Rotation centers and positioning of the mechanical arm. 2) Mechanical arm. 3) Accessory for fitting the arm to the machine, it varies based on the movement to be made.

The patients removed the sling and swathe in adduction and internal rotation, after an average period of 3 weeks. In some cases the patients kept the sling on and off for another 2-5 days if they felt they needed it. The FKT treatment started the day

after the operation, at the patient's bed, with active and passive mobilization exercises for the wrist and fingers.
The protocol involved four phases. Fisiotek HP was only used for subgroup I.
**Phase 1** Post operation; duration from two to six weeks, based on suture tension. The goal is to reduce pain and tissue edema and increase passive mobility.
Treatment:
- Motor reeducation is undertaken in a proximal distal direction, starting with the hand and wrist and integrated with proprioceptive exercises.
- Passive movement with flexed elbow (90°) in a supine position for flexion movements and abduction of the shoulder. No movements are made which increase pain.
- Pendulum exercises for the arm.
- Antalgic electrotherapy for the shoulder.
- Magnetotherapy.
- Laser therapy.

<u>End of second-fourth week</u>
- Passive movement with extended elbow in a supine and sitting positions for flexion and abduction movements. No movements are made which increase pain.
- Self-assisted flexion exercises with pulleys and wand and abduction self-assisted exercises in a supine position.
- Gradual use of Fisiotek HP for flexion in a supine position (0-40°) (Fig.6a).

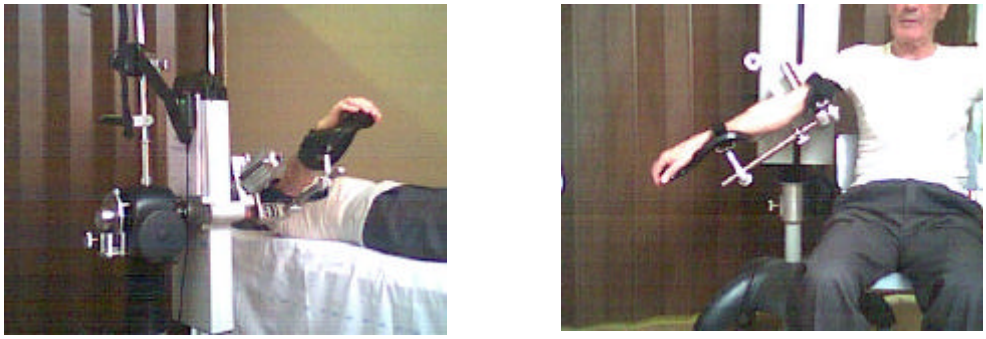
<u>Beginning third-fifth week</u>
- Passive movement for internal rotation, careful external rotation (max 25-30°) with adducted elbow.
- Isometric exercises for abduction and flexion of the arm.
- Gradual use of Fisiotek HP for flexion in a supine and sitting position (0-60°) (Fig.6a) and abduction (0-50°) in a sitting position (Fig.6b).

**Phase 2** Active mobilization; duration due-six weeks. The goal is to increase mobility, reduce pain, to start a cautious increase in shoulder intrinsic muscle strength.
Treatment:
- Mechanical exercises for the shoulder (pulleys), flexion abduction
- Careful isotonic exercises, internal and careful external rotation with elastic tube in supine and sitting position.
- Self-assisted external rotation exercises (max 45-55°) in a supine and sitting position and with adducted arm
- Antalgic electrotherapy .
- Magnetotherapy.
- Laser therapy
- Fisiotek HP for flexion in a sitting position (40~160°) (Fig.7a), abduction (25~145°) (Fig.7b), external rotation in supine position (0~35°) (Fig.7c).

**Phase 3** Muscle strengthening and further joint recovery, duration three-four weeks. The aim is the achieve complete joint functioning and strengthen the extrinsic muscles of the scapula girdle.
Treatment:
- Internal and external rotation exercises with an elastic tube in a sitting position.

- With handlebars strengthening of the adductor, supraspinatus (exercises in deceleration eccentrics with adequate weight) scapulothoracic, bicipital and tricipital muscles .
- Fisiotek HP for flexion in a sitting position (60~180°) (Fig.8a), abduction (60~180°) (Fig.8b), external rotation in a supine and sitting position (Fig.8c).

**Phase 4** Resumption of pre-surgery activities; greater security of shoulder kinetics in a correct posture. Duration two, three weeks.
Treatment:
- Neuromotor work to improve balanced gesture (PNF according to Kabat).
- Assisted and self-assisted ergotherapy exercises.



A B

Fig. 6 - a) Flexion in supine position 0-50° b) Abduction in sitting position 0-50°

A B C

Fig. 7 - a) Flexion in sitting position 40-160° b) Abduction in sitting position 25-145° c) External rotation in supine position 0-45°.

A B C

Fig. 8 - a) Flexion in sitting position 60-170° b) Abduction in sitting position 60-170° c) External rotation in supine position with arm adducted to 50°.

The average scores for VAS-SDS self-evaluation of pain was calculated for each subgroup as well as the weighted constant related to the beginning of treatment and the end of each cycle. We then analyzed if there was a significant statistical difference (t Student test) among the results obtained from the two subgroups [$(Vas_{(in)} - Vas_{(fin)}/Vas_{(in)}$ %]; [$(Pa/Fm_{(fin)} - Pa/Fm_{(in)}/(100 - Pa/Fm_{(in)})$ %].

**Results**

Analysis of the results showed a significant statistical difference (P = 0,022 ± 0,011) between the VAS-SDS average scores obtained from the patients of the two subgroups between the third and seventh treatment cycle. During this period those in subgroup I had a lower intensity of shoulder pain (Fig.9)

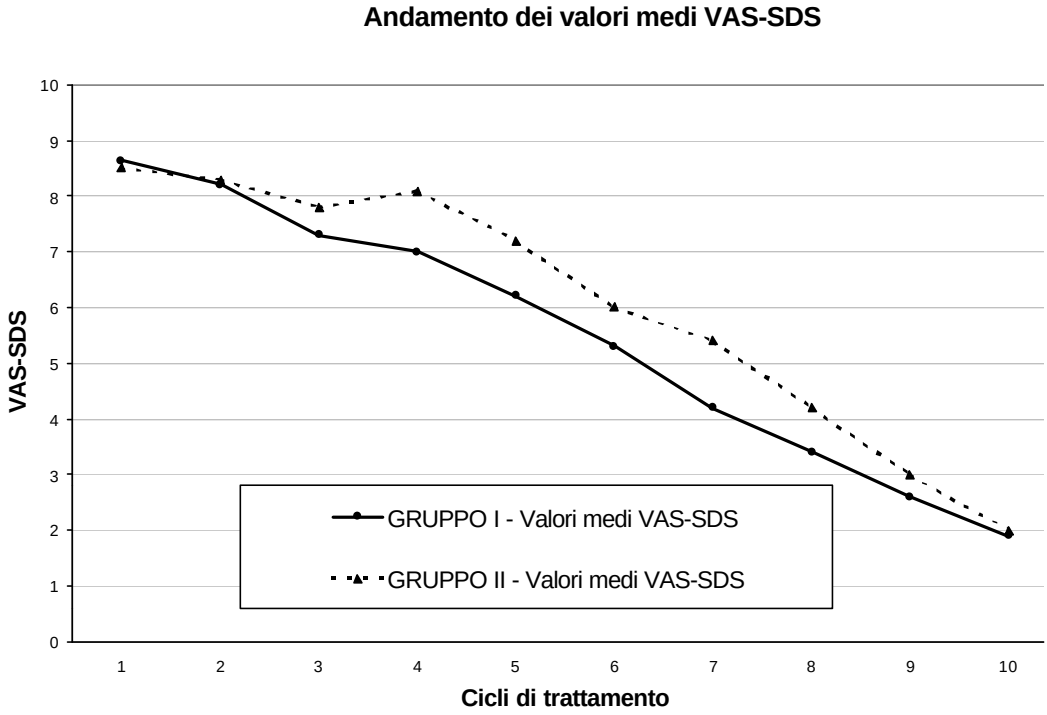



Fig. 9 - Average VAS-SDS values obtained from patients of the two subgroups at the end of each treatment cycle (a cycle is composed of ten sessions).

During the same period the patients of subgroup I had a significantly higher Constant index (P = 0,016 ± 0,010) compared to the patients in the other subgroup (Fig.10). For the first cycles the index increase is due to a progressive reduction in pain obtained with the physiokinetics and analgesic physical therapy, for the intermediate cycles it is due to the progressive increase, primarily in subgroup I patients (P = 0,016), in active mobility and the resumption of daily activities (Fig.10).

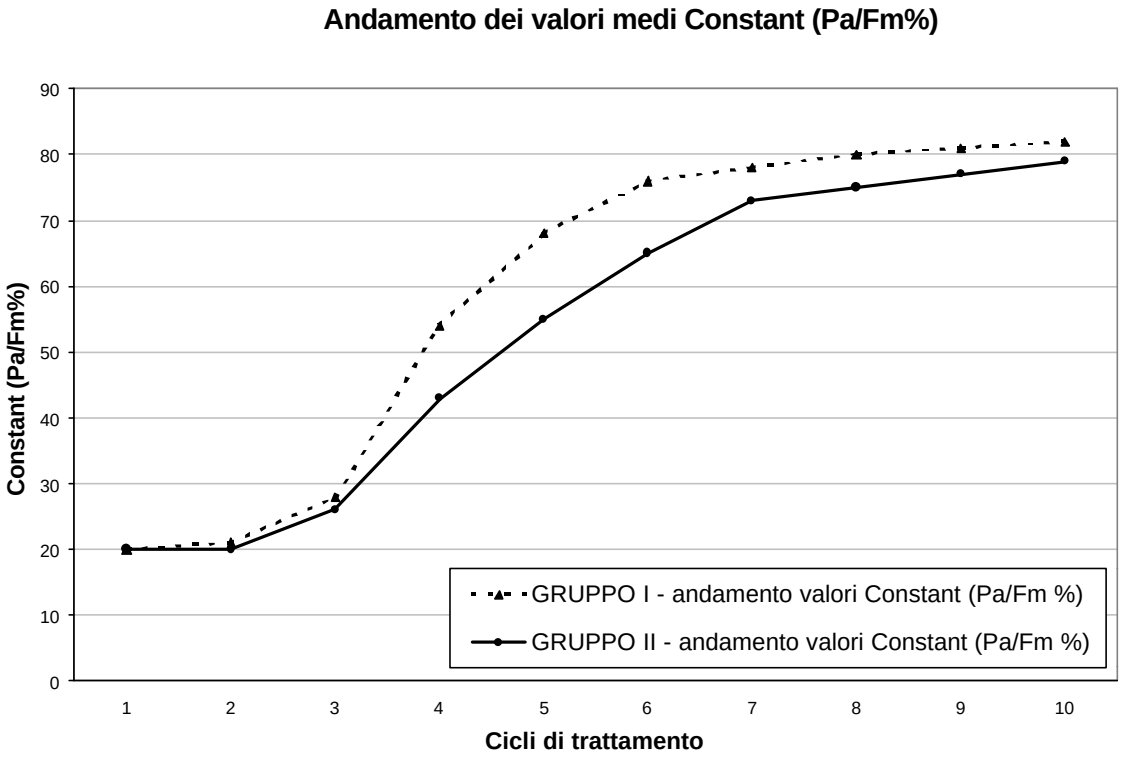



Fig. 10 – Average weighted Constant values (Pa/Fm%) obtained from the patients of the two subgroups at the end of each treatment cycle (a cycle is composed of ten sessions).

**Discussion and conclusions**

The data from our study indicate that patients operated for a full thickness tear of the rotator cuff and treated, after a period of immobilization, with standard physiokinetic therapy protocols and passive shoulder mobilization machine (Fisiotek HP) fared better in the intermediate phases of rehabilitation compared to the patients treated solely with a standard physiokinetic protocol.

The passive mobilization machine was well supported by the patients, it did not cause discomfort, nor increase pain. During the entire period of mobilization with the machine, the patients always reported a sensation of joint stability, and increasing well-being. Subsequent muscle relaxation, made it possible to progressively increase the arc of movement and to be able to harmoniously work on all the shoulder stabilizer muscles.

The differences between the two subgroups involved pain and better shoulder mobility. Probably, continuous passive mobilization contributed to preventing joint contractures and retractions of connective tissue. It is possible that the articular increase of a few degrees at a time and the low execution speed, may gradually tension the plastic elements of the connective tissue, avoiding the excess painful strain which causes contractures..

Passive mobilization, carried out with the protocol we used, may facilitate motor recruitment of active movements. During passive mobilization with the machine, a continual and gradual proprioceptive stimulation is obtained without the interference of pain. This reduces the initial resistance during active movement and prevents scapulothoracic compensation.

Nevertheless, the work of the physical therapist and antalgic physical therapy (magnetotherapy, antalgic electrotherapy and laser therapy) are preparatory results to the action of the mobilization machine. There was no significant statistical difference in the examined parameters (pain, active mobility and resumption of daily activity) in the two studied cohorts and during the immediate post-operative period.

Conclusions. The data which emerged from our study suggest routine use of passive shoulder mobilization machines during functional reeducation of patients who have undergone reconstructive rotator cuff surgery.

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# "REEDUCATION OF ROTATOR CUFF PATHOLOGIES"

*(Parma 28 March 1998 – report by CLAUDIO BERTONCINI - Studio Terapico Kaiser )*

Shoulder rehabilitation has always been governed by numerous different methodologies all with the common thread that when the maximum joint range is obtained, through exclusively passive kinetics, the muscle recovery phase can be started with active exercises.
Our work entails the exclusively passive part of the rehabilitation phase, where an attempt is made to recover maximum joint range (150° / 160° of arm anteposition)
Once this position is achieved, the following is obtained on the scapular plane:
1) complete unrolling of the glenohumeral ligament and coracohumeral ligament and consequent absence of capsule-ligament retraction.
2) passage (painless) of the greater tuberosity under the coracoacromial arch and thus absence of disorder
3) alignment of the muscle cones (belly) and bone levators (cuff vs. deltoid) (humerus vs. spine of the scapula)
4) initial recovery of internal and external rotation using automatic rotation which occurs during elevation from 0° to 150° and return.
To obtain this a wide range of methods can be chosen:
A) joint manipulation according to Mc. Mennel
B) Codman exercises (pendulum)
C) P.N.F. (Kabat maneuver)
D) from Neer protocol to rebalancing according to Sohier
E) hanging equipment (frames with Olive - Guthie – Smith type pulleys)
F) the method of J. P. Liotard - Expert - Mercanton - Padey.

No matter how passive these different methods were, each one maintains a minimum of active movement which may be counterproductive in the rehabilitation phase because it does not permit complete endo-joint relaxation.
This condition is extremely important when treating pathologies like adhesive or retracting capsulitis or in the immediate post-operative phase.
Only more recent experiences, see Liotard-Walch. have led to an increasing interest in swimming pool kinetic therapy, even if probably by chance.

The results have proved extremely encouraging since they have certainly increased the percentage of success even with the most obstinate pathologies which are refractory to other methods, and even more importantly they have made it possible to significantly reduce the time span for complete joint function recovery.
They may occur because kinetics in water, thanks to the specific assistance of the fluid where the work is done, becomes the only truly passive recovery phase tried to date. .

The following positive factors are reported in literature (Liotard - Walch) for hydrokinetic therapy:

Thermal effect :
- release of endorphins
- muscle relaxing
- comfortable feeling on the skin.

Neurophysiological effects :
- Symmetrical healthy – injured arm mobilization as synergic facilitation

-Unloading of muscular tension of the cervicodorsal rachis.
-Capacity of repeating on dry land what was facilitated by water (hydromotor reeducation of alignment).

In this light I would like to highlight some of Dr. Gilles Walch's (1997) thoughts on shoulder reeducation :

- Passive mobility is the most important problem in shoulder rehabilitation.
  Whoever is convinced of this has understood everything on post-operative shoulder reeducation..
- Muscular strengthening must never occur initially, "because it increases pain and the shoulder locks".
- Everything is easier in water because Archimedes is working and not the patient.

Given these stimulating statements and the related practical confirmations, at this point the question is :
can people who do not have a pool benefit from these successes ?

Well, thanks to passive mobilization we think we have found a therapy which is just as valid which can replace a pool if there is not one, and if there is one, provide very interesting work at the same time.
And in some cases even solve the problem of those who are afraid of coming into contact with water while working.
The special features of this work are:
- The work is completely passive.
- The patient works in extremely comfortable positions (sitting or lying down).
- The machine is equipped with an immediate stop and restart (in the opposite direction) button which instills extreme security based on the knowledge that the machine movement can be controlled at any time.
- The possibility of working on different joint positions by adjusting the travel degree completely based on the patient's pain.
- Complete personalization based on the patient's age.

The pathologies, only for the year 1997, where we had the possibility of applying our intervention method using passive mobilization only in the passive recovery phase, were as follows :

**SURGICAL PATHOLOGIES**

- ARTHROSCOPY FOR CALCIFIED TENDINITIS
- ACROMIOPLASTY
- CLB TENOTOMY + ACROMIOPLASTY
- ACROMIOPLASTY + SUPRASPINSATUS TENOTOMY
- ARTHROSCOPY FOR SUPRASPINTATUS
  LESION + ACROMIOPLASTY
- OPEN OPERATION FOR CLB TENODESIS
  AND SUPRASPINATUS REPAIR
- OPEN OPERATION FOR CLB RECONSTRUCTION
  + SUPRASPINATUS
- SYNOVECTOMY, BURSECTOMY, ACROMIOPLASTY ARTHROSCOPY

**NON-SURGICAL PATHOLOGIES**

- BRACHIAL NERVE LESION
- HUMERUS FRACTURE
- ROTATOR CUFF TENDINOPATHY
- GREATER TUBEROSITY FRACTURE
- CALCIFIED TENDINOPATHY
- IMPINGEMENT FROM SUB-ACROMIAL CONFLICT
- ROTATOR CUFF LESION
- ARTHROSIS
- CONTUSION TRAUMAS OF ROTATOR CUFFS
- CAPSULE LIGAMENT HYPERLAXITY
- ADHESIVE CAPSULITIS

The percentage data on the unambiguous methods adopted in the different cases studies, demonstrate the resulting interesting work possibilities. The comparison between the different statistical data that emerged related to the two different intervention phases, before and after passive mobilization is also extremely interesting.

**TREATMENT <u>WITHOUT</u> *FISIOTEK HP***

| SEX | AGE | DX SHOULDER | SX SHOULDER | DOMINANCE | POS. PROGN. |
|---|---|---|---|---|---|
| Male 16 | 23-66 | 70 % | 30 % | 50 % | 62,5 % |
| Female 15 | 24-75 | 80 % | 20 % | 66,6 % | 66,6 % |

**TREATMENT <u>WITH</u> *FISIOTEK HP***

| SEX | AGE | DX SHOULDER | SX SHOULDER | DOMINANCE | POS. PROGN. |
|---|---|---|---|---|---|
| Male 17 | 17-74 | 45 % | 55 % | 50 % | 95 % |
| Female 19 | 40-79 | 73 % | 27 % | 70 % | 87,5 % |

## TREATMENT <u>WITH</u> *FISIOTEK HP*

| Sex | Surgical pathologies | Non-surgical pathologies | Surgical Pos. prognosis | Non-surgical pos. prognosis |
|---|---|---|---|---|
| Males 17 | 15 % | 85 % | 100 % | 90 % |
| Females 19 | 45 % | 55 % | 90 % | 85 % |

## JOINT RECOVERY TIME SPAN

| *PATHOLOGIES* | *RECOVERY AT 150°* | *TOTAL RECOVERY* |
|---|---|---|
| ARTHOSCOPIC SURGERY | 3 - 5 days | 25 days |
| OPEN SURGERY | 3 - 7 days | 25 days |
| TENDINOPATHY | 2 - 8 days | 22 days |
| SUB-ACROMIAL CONFLICT | 3 - 5 days | 23 days |
| FROZEN SHOULDER | 5 - 8 days | 35 days |

**BIBLIOGRAPHY**


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# “REHABILITATION TOWARDS 2000”

(*Rimini, 14-17 September 1999 - Report by Dr. Riccardo Galassi - Ceccarini Riccione Hospital)*

INTRODUCTION

An operated shoulder requires continuous passive mobilization (c.p.m.) right from the immediate post-operative period to progressively and atraumatically reach the physiological joint range. This makes it possible for us to undertake the following rehabilitation phase in the best joint conditions both anatomically and functionally. Generally, the most “uncovered” period in the rehabilitation period of an operated shoulder is represented by the first 15-20 days after the operation. This is the period when the patients are often left to manage the situation by themselves, in an inadequate manner since they have been sent home with printed sheets with some tips and a prepared set of exercises to do. This behavior frequently has a completely negative influence on the following rehabilitation process.

Normal arm use requires consistent fluid movements coordinated by the humerus, scapula and clavicle. In order for these movements to be possible, all the joint and extra-joint components must be integral and there must be a complete range of motion (R.O.M.) in all spatial planes.

Thus complete joint function of the scapula humerus complex is our first important goal in the rehabilitation pathway not only for an operated shoulder, but for all its other pathologies.

Fisiotek HP, based on the c.p.m. design already used for the knee, is an optimal addition to this initial post-operative phase. Obviously, it is not intended to replace a physical therapist’s technical work, but to integrate it at a specific time in the rehabilitation pathway, where the main aim is to obtain the most complete possible recovery of the shoulder joint range.

PASSIVE CONTINUOUS MOBILIZATION (C.P.M.)

Passive joint mobilization is a maneuver made by applying an external force to one or more joint districts to gradually bring them to the limit of their R.O.M. (range of motion) with a fluid, slow and repeated movement, which is more importantly atraumatic and not painful.

The force can be applied manually by trained individuals or by applying motorized mobilizing devices. The mobilization techniques (manual or motorized) can have different aims, for example :

- Mobilization to maintain mechanically healthy joints, but with a temporarily or permanent deficit motor system, this helps maintain tissue trophicity, lubrication of joint surfaces, improves sliding of tissue planes among each other, maintaining a good level of elasticity of the periarticular soft tissues. These mobilizations always require respecting the physiological mobility of each joint hinge.
- Mobilization to recover the physiological joint range in all cases where the joint structure has totally or partly lost its mobility due to a pathological process or prolonged immobilization such as after a trauma or operation. The mobilization technique must scrupulously respect the physiology based on its anatomical characteristics and the type of pathology or operation it has undergone..

Immediate post-operative mobilization, within the limits allowed by the repair process, as often described in literature, has proved to be beneficial to the repair process and recovery of joint function. The list below provides a summary of its principle effects on the healing process:

1. Maintain trophicity of the joint elements.
2. Improve exchange of synovial fluid among the various joint tissue components.
3. Maintain the cartilage surfaces in a state of dynamic pressure and thus improve the exchange of nutrients.
4. Progressively enhance a condition of physiological tension of the capsule ligament system.
5. Maintain muscle fiber elasticity improving muscle trophicity and decreasing hypotrophy from immobility.
6. Improve progressive, atraumatic and painless recovery of joint function, until restoring R.O.M. where possible.
7. Reawaken the proprioceptive system of the mobilized joint complex.
8. Accelerate reabsorption of post-operative hemarthroses and edemas.

9. Prevent the formation of tissue adhesion thus minimizing the reduction of joint range.
10. Decrease the possibility of reflex sympathetic dystrophy.
11. Improve blood flow in tissues and thus aid the repair process.
12. Produce a positive psychological effect on patients who do not find themselves left to their own devices in the first post-operative weeks as often happens.

It is important to start passive mobilization right from the very first post-operative days (2nd-3rd day), because due to the above mentioned effects, it aids the rehabilitation process, preventing the onset of complications which are a hindrance to recovery and difficult to resolve.

**Passive mobilization with Fisiotek HP can be used with many shoulder pathologies, both surgical and non-surgical**

**1. Surgical pathologies**

- Operated recurring dislocations
- Arthroscopy for calcified tendinitis
- Tenotomy of the long head of the biceps tendon
- Acromionplasty with tenotomy of the supraspinatus
- Arthroscopy for supraspinatus lesion with acromioplasty
- Synovectomy, bursectomy, arthroscopic acromioplasty
- Shoulder prosthesis

**2. Non-surgical pathologies**

- Brachial nerve lesion
- Conservatively treated humerus fracture
- Rotator cuff tendinopathies
- Tuberosity fracture
- Calcified tendinopathies
- Sub acromial impingement
- Rotator cuff lesion
- Arthrosis
- Contusion traumas of the rotator cuff
- Adhesive capsulitis

MATERIALS AND METHODS

In the Function Recovery and Reeducation Department of the Riccione Hospital we subjected all patients operated for rotator cuff lesion to passive continual mobilization.

In order to provide a correct and effective rehabilitation intervention, passive mobilization was administered from the first post-operative week for around three weeks. In the first week we started with passive mobilization in Abduction-Adduction and in Flexion on the scapular plane (anterior/posterior flexion of around 20°), which turned out to be better tolerated. External rotation was only introduced in the third-fourth week. The procedure of the gradual recovery of joint range was not rigidly standardized in all patients, but personalized based on the entity of the rotator cuff lesion and arthrotomic or arthroscopic technique used, accelerating the time span for the latter. A faster recovery of joint function in abduction and flexion and earlier introduction of rotation in comparison to the classic models which do not start before the fourth week.

The exercises were administered in a sitting position for Abduction-Adduction and Flexion and in a supine position for the Rotations. Some of the machine characteristics and the goals we had set to reach with it were explained to patients before beginning the first session. The aim was to obtain

patient relaxation and let them become comfortable with the machine in order to achieve the greatest possible collaboration. The duration of each passive session ranged from 45 to 60 minutes, divided into different joint movements (approximately 15-20 minutes for each one). We gave priority to the sitting position, when possible, compared to supine, as this gave us a more complete vision of the should joint, including pitching of the scapula on the thoracic plane.
Each patient was treated on the following joint planes:

**Elevation with patient in sitting position:** this mobilization is administered as early as the first week with progressive increase in R.O.M. of around 20°-40° per week, depending on the type of operation (arthrotomic or arthroscopic) and lesion. The speed varies between 2° and 3.2° per second, always opting for the one the patient deems most comfortable. We always followed the rule of no pain on all spatial planes.

**Abduction-adduction with patient in sitting position:** work time around 15-20 minutes per session, trying to find the speed that was the most comfortable for the patient, with the same values as above. The work range, i.e. joint range, varied between 35° and 150°. Obviously, the R.O.M. recovery was gradually programmed, with an increase between 20°-35° per week. This mobilization was also started early, from the first week.

**Rotation with patient in supine position:** the session was programmed according to the parameters of time, from 15 to 20 minutes, speed between 1.5° and 3.2° per second, modifying it based on the comfort level expressed by the patient; with movement range varying between 30°-0°-85°. This mobilization was introduced later than the others, generally from the third week varying the time based on the shoulder lesion and type of operation (arthrotomic or arthroscopic). The degree recovery was slower compared to the other mobilizations by around 50% (approximately 15°-20° per week).

CONSIDERATIONS

Fisiotek HP device demonstrated a significant degree of versatility in passive mobilization of a shoulder operated on for rotator cuff lesion and in numerous other surgical and non-surgical pathologies, as mentioned above.
The limited number of patients treated at S.R.R.F. at Ceccarini Hospital does not make it possible to extrapolate absolute value figures, but it definitely makes it possible to express a favorable opinion regarding the use of this device in the earliest phases of the rehabilitation process.
There are numerous reason for this favorable impact. These are primarily linked to the significant degree of satisfaction expressed by the patient due to faster treatment by the public health service, as early as the first post-operative week, and because this treatment, with gradual and painless R.O.M. recovery, is viewed as very comfortable and pleasant by the patient..
Its easy use after a short period of training and many adjustment possibilities that can be used to move the should even with different elbow positions are elements which meet the needs of physical therapists. The use of the device carefully following the manual and the rule of painless mobilization proved safe and did not produce problems requiring its suspension.
The greatest advantages to using Fisiotek HP are those linked to an early applied continuous passive mobilization (c.p.m.) which have been described above.
Obviously, Fisiotek HP does not replace the technical and qualified work of the physical therapist, nor could it, just like other devices have not (isokinetic). Its role is to be integrated with the physical therapist's work in the first three to four weeks of the rehabilitation pathway, which are the most "uncovered" and thus very touchy. C.p.m. was seem to have a series of positive effects in the repair processes of tissues which had been operated on, which make it an excellent therapeutic tool suitable

for preventing various complications, which often delay the recovery process, as well as not being fast and easy to solve.
Its use must follow some simple but important rules: treatment must start early, as early as the 2nd-3rd post-operative day, and generally continue for two-three weeks, to be progressively replaced with active reeducation. Its use must comply with the no pain rule. Standardized protocols which are the same for everyone, must not be followed: like all rehabilitation processes, they must be personalized and adapted to the patient's clinical situation, based on the pathological process and repair processes and the rehabilitation goals to be met.
The current opinion on post-operative rehabilitation treatment, has gone from an attitude of waiting and relying on varying lengths of immobilization, towards a more active and dynamic rehabilitation program. The principal to follow is that restoration of joint function must proceed at the same rate as restoration of tissue anatomy and must not be secondary or delayed. For the reason, early passive mobilization, as early as immediately after surgery, has proved to be very beneficial for the entire rehabilitation process, accelerating the timeframe and improving the healing of tissues which have been operated on and preventing various complications. Passive mobilization carried out with an instrument like Fisiotek HP, if started early, completes the rehabilitation pathway of the operated shoulder by profitably integrating the manual work of the physical therapist, who nevertheless remains the focal point of the entire rehabilitation process.

# USE OF THE FISIOTEK HP SHOULDER MOBILIZATION DEVICE

Our experiences and comparison with other methods

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In many clinical situations where the shoulder is the target of traumatic or inflammatory pathologies, one of the pathognomic elements of the overall picture involves joint rigidity with overall R.O.M. limitation, accompanied by pain at times; in all post-acute phase and post-operative rehabilitation treatment protocols, the recovery of joint excursion as close to the physiological values as possible is an essential element of the program.
R.O.M. recovery is obtained with passive rehabilitation methods applied primarily in two ways (passive rehabilitation under general anesthesia with have very limited and specific indications are not discussed here).

a) Manual passive mobilization performed by a physical therapist, has the advantage of being modified based on patient resistance and is extremely adaptable to the subject, however, it has serious defects: it is not consistent as ROM since it is not measurable while being performed, it cannot be applied for long periods of time (due to fatigue of the physical therapists) and the performance speed is never consistent.
b) Continuous passive mobilization using a mechanical mobilization device; this method is applied with a ROM previously established before each session based on the clinical situation, it has the advantage of being reproducible and can be applied for a potentially unlimited amount of time; it requires devices which have two characteristics, sufficient mechanical power to mobilize a joint of significant resistance like the shoulder and the possibility of applying the device to patients who must remain in bed; unfortunately, my experience to date with shoulder mobilizing devices that we used and still use, is that they all have limited power and use is restricted to a few cases of rotator cuff inflammatory periarthritis, often only one side can be used and requires that the patient be sitting (which is impossible with large multiple fractures or multiple traumas), for this reason we have practically stopped using mechanical mobilization devices and have entrusted the passive mobilization phase of our protocols exclusively to our physical therapists.

In 2001 the company UBER ROS kindly provided us with a FISIOTEK HP mechanical mobilization device manufactured by RIMEC, this device has features which makes it use irreplaceable:

- Laser pointer for correct positioning of the rotation center.
- Work ROM in Rotation, Abduction-adduction and Anterior/posterior shoulder movements.
- The possibility to be used with the patient supine in bed, sitting or standing for both the right and left arm.
- Significant power which allows real joint recovery.
- Modifiable operating speed.
- Use of the device for the elbow and wrist in cases (not rare) of multiple fractures.
- The device is easy to use for physical therapists and the learning phase is fast and simple.
- The device can be stopped by the patient at any time.

Therefore we have standardized the use of Fisiotek HP in all rehabilitation protocols which we apply to patients with particularly difficult and complex shoulder pathologies with excellent results.

I wanted to consider the results of a first group of patients which we treated during 2001; since we have used this device by comparing the results obtained both in terms of recovery time and ROM with similar groups treated with traditional manual protocols (I did not take into account cases treated with other types of mechanical mobilization devices because their results in the pathologies I mention were so poor that they are not worth using).
Since the period was used the device was limited we formed 4 groups of patients in order to assess data that could be objectively compared and statistically significant.

1. Head of humerus fractures: 10 cases
2. Rotator cuff lesions (with or without tuberosity detachment): 8 cases
3. Surgical reconstruction of the rotator cuff: 6 cases
4. Frozen shoulder from adhesive capsulitis: 14 cases

These groups were taken from a total of around 60 patients treated to date with Fisiotek: we preferred only using these patients for the time being, because the remaining ones are composed of a mixture of not well-classified cases and because we wanted to compare them with uniform control groups and because to assess the real qualities of the device, we wanted to examine the cases which were actually more complex and difficult to treat.

For each of the four groups we applied a therapy protocol which involved the use of Fisiotek and we compared the group of patients with a similar group treated with a traditional protocol, we them effected comparative evaluations at identical deadlines.

The obtained results were as follows:

**1st group:** HEAD OF HUMERUS FRACTURES 10 cases **(group A)** composed of 6 women, 4 men, average age 54 all surgically treated
compared with a similar group of 8 cases **(group B)**
it is important to note that 4 cases in the group refer to multiple fractures (in 3 cases pelvis fractures) where the patient had to stay in bed during the first phase of treatment.

The protocol called for constriction of the operated arm in adduction for 7 days, rehabilitation treatment was started an average of 9 days after surgery.
Average ROM at the beginning of treatment in adduction 0 -15°; anterior flexion 20°; posterior flexion 10°; rotation 0°.
Rehabilitation protocol:

GROUP A: 9-15 days: passive mobilization with FISIOTEK 40 min., 2 times per day: 20min. Abduction with ROM 0° ⇒ 40°
20 min. Anterior/posterior flexions ROM +30°⇒ -10°
Fisiotek at minimum speed.

15-25 days: 10° in ROM every 4 days increase in application time of Fisiotek 60 min. 2 times per day, increase in mobilization speed to maximum; start assisted active mobilization program and start passive rotation movements by physical therapist .

25-45 days: start FISIOTEK treatment for internal rotation 0°⇒30° and external rotation 0°⇒40° continued increase of 10° in ROM every 5 days.

From 45th day: phase 2 of the protocol start with active exercises, counter resistance and stretching.

The Fisiotek device was preferably applied to patients sitting on their beds first and then on chairs, in the cases of pelvis fracture for the first 20 days the device was applied to patients in bed due to the impossibility of putting weight on the pelvis.

GROUP B: the protocol was the same with passive mobilization sessions of approximately 15 min. applied by a physical therapist 2-3 times per day with the same ROM potential.

Treatment phase B no longer entailed (generally) the use of FISIOTEK, nevertheless, it was used in 2 cases for an additional 10 days.

Periodic evaluations were made at the 15th-25th-45th days with the following results:

| ***Abduction*** | ***15th day*** | ***25th day*** | ***45th day*** |
|---|---|---|---|
| GROUP A | 80° | 110° | 140° |
| GROUP B | 50° | 70° | 90° |

| ***Anterior/posterior flexion*** | ***15th day*** | ***25th day*** | ***45th day*** |
|---|---|---|---|
| GROUP A | 30° 20° | 90° 30° | 110° 40° |
| GROUP B | 20° 10° | 60° 20° | 80° 30° |

| *Internal/external rotation* | *15th day* | *25th day* | *45th day* |
|---|---|---|---|
| GROUP A | 15° 20° | 30° 40° | 45° 55° |
| GROUP B | 10° 15° | 20° 30° | 40° 35° |

**2nd group:** ROTATOR CUFF LESIONS 8 cases **(group A)** (3 with tuberosity detachment) all cases were studied with shoulder MRI which did not reveal complete detachment of the rotator cuff muscle groups; no one had undergone surgery (6 men, 2 women, average age 45)
The group was compared with an identical control group composed of 10 uniform cases **(group B).**

Treatment protocol: joint mechanical rest with shoulder tutor in adduction for 15 days; start rehabilitation program from that date.

GROUP A: 15-25 days: FISIOTEK 2 40 min sessions per day:
Abduction ROM 0°⇒40°
Anterior/posterior flexions 20°⇒20°
Increase of 10° every 4 days.

25-40 days: add to FISIOTEK rotation movements with ROM +30°⇒-30°
Increase of 10° every 5 days, start active kinesitherapy+isometric exercise+stretching

from 40th day: if clinical result is good, stop FISIOTEK and move to only active kinesitherapy and counter resistance.

GROUP B: Similar treatment protocol, passive mobilization is replaced with pendulum exercises and passive kinetics with a physical therapist.

Periodic evaluations were made at the 15th-25th-40th days with the following results:

| *Abduction* | *15th day* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 40° | 90° | 135° |
| GROUP B | 40° | 70° | 100° |

| *Anterior/posterior flexion* | *15th day* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 60° 20° | 90° 30° | 130° 35° |
| GROUP B | 65° 25° | 80° 30° | 120° 30° |

| *Internal/external rotation* | *15th day* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 20° 20° | 30° 45° | 45° 65° |
| GROUP B | 15° 20° | 35° 40° | 40° 60° |

**3rd group:** SURGICAL RECONSTRUCTION OF ROTATOR CUFFS
**(group A)** 6 cases; 4 men, 2 women; average age 38
**(group B)** 5 cases;

Rehabilitation protocol:

GROUP A: 0-20 days: permanently maintained tutor in abduction at 30-40° on operated arm

20-30 days: passive mobilization with FISIOTEK 30 min., 1 time per day:
Abduction ROM 0°⇒ 45°
Anterior flexion ROM 0°⇒ 60°
External rotation ROM 0°⇒ 15°

30-60 days: passive mobilization with FISIOTEK 45 min., 2 times per day, with 10° increase in ROM every 5 days.
from 60th day: progressive complete joint function, recovery of strength, normalization of joint kinematics.

GROUP B: Similar protocol with replacement of FISIOTEK with pendulum exercises and passive kinetics with a physical therapist with the same ROM.

Periodic evaluations were made at the 20th-30th-60th days with the following results:

| *Abduction* | *20th day* | *30th day* | *60th day* |
|---|---|---|---|
| GROUP A | 30° | 60° | 100° |
| GROUP B | 30° | 45° | 70° |

| *Anterior/posterior flexion* | *20th day* | *30th day* | *60th day* |
|---|---|---|---|
| GROUP A | 20° 10° | 50° 20° | 90° 35° |
| GROUP B | 20° 10° | 40° 15° | 80° 30° |

| *Internal/external rotation* | *20th day* | *30th day* | *60th day* |
|---|---|---|---|
| GROUP A | 0° | 20° 30° | 30° 40° |
| GROUP B | 0° | 10° 10° | 20° 30° |

**4th group:** FROZEN SHOULDER FROM ADHESIVE CAPSULITIS
**(group A)** 14 cases; 2 men, 12 women; average age 58
**(group B)** 7 cases with uniform characteristics

Rehabilitation protocol:

GROUP A: 1-10 days: antalgic electrotherapy + subsequent passive mobilization with FISIOTEK 45min. 2 times per day
Abduction + Anterior/posterior flexions starting from the maximum ROM values of each patient obtainable without pain.

10-25 days: passive mobilization with FISIOTEK 45min., 2 times per day increasing ROM by 10° every 5 days + internal/external rotation from minimum obtainable levels with 10° increase every 7 days.

25-40 days: continue FISIOTEK + active kinetics and stretching

GROUP B: Identical program with passive mobilization performed by a physical therapist based on the resistance presented by the patient.

Periodic evaluations were made at the 25th and 40th days :

| *Abduction* | *start* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 30° | 65° | 80° |
| GROUP B | 25° | 50° | 70° |

| *Anterior/posterior flexion* | *start* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 20° | 50° | 70° |
| GROUP B | 25° | 40° | 60° |

| *Internal/external rotation* | *start* | *25th day* | *40th day* |
|---|---|---|---|
| GROUP A | 0° | 10° 20° | 20° 40° |
| GROUP B | 0° | 10° 10° | 20° 30° |

CONCLUSIONS

The limited number of cases and time the device was used do not make it possible to obtain absolute value data, nevertheless, significant data emerged from the comparison among cases with similar characteristics.

a) A clearly faster recovery of shoulder joint excursion and better ROM results in all cases where the FISIOTEK mobilization device was used, this result permits a better functional recovery and, in all cases where the protocol entails an active phase and muscular strengthening, it can be used to accelerate this phase thus lowering costs.
b) Greater patient treatment compliance since the device can be applied in a more gentle and calm manner, without provoking the fear that these cases of physical therapy often cause; we observed that the patient-machine relationship was generally well-tolerated by patients and much less worrying than the physical therapist-patient relationship.
c) A significant saving in time and effort for physical therapists, since the entire passive phase is delegated to the machine with clear economic benefits.
d) The possibility of applying Fisiotek to patients while lying down and thus using it also in the initial phases in multiple fracture or multiple trauma cases and for all patients who cannot be lifted from their bed.

Finally, comparing Fisiotek with similar mobilizing devices, its significant mechanical power is important to note, it allows a true therapeutic phase and not just maintenance of what has been obtained with manual methods. The fact that it is easy to adjust with its centering system and very easy to handle means that it can be used wherever passive mobilization of the shoulder is needed, above all in rehabilitation facilities which manage problematic and difficult patients such as a hospital on a national level like the one we work in.