DOI: 10.5114/areh.2023.126467
Original article
Advances in Rehabilitation, 2023, 37(1), 49–60

# An early, intensive and complementary aquatic rehabilitation protocol after arthroscopy rotator cuff repair: consensus through a Delphi study

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A – Research concept and design
B – Collection and/or assembly of data
C – Data analysis and interpretation
D – Writing the article
E – Critical revision of the article
F – Final approval of article

Received: 2022-11-16
Accepted: 2023-03-22
Published: 2023-04-04

## Abstract

**Introduction:** Ruptures of the rotator cuff tendon are one of the most common causes of pain and dysfunction in adults, and total rupture affects approximately 20% of the population, with this number increasing significantly after the age of 50. When conservative treatment fails, surgical repair is necessary. Studies show that aquatic rehabilitation improves joint balance early in the initial stages after rotator cuff surgery and that the aquatic environment is a safe and protective environment for the integrity of the sutures. The aim of this study is to present an early, intensive and complementary aquatic rehabilitation protocol for arthroscopy of the rotator cuff.

**Materials and methods:** Consensus was reached by the Delphi method. Twelve experts in aquatic rehabilitation were recruited to evaluate the proposed protocol. They were selected considering their experience in aquatic rehabilitation as well as their knowledge of the subject based on the expert competence coefficient. The questionnaires were completed online through a website created for this study. The questions were rated on a 5-point Likert scale, and a minimum threshold of 80% favourable responses was regarded as consensus.

**Results:** Three sessions of 30 minutes of active functional exercises in the water for three weeks will achieve the proposed goals.

**Conclusions:** The experts agreed on the early, intensive and complementary aquatic rehabilitation protocol following arthroscopic repair of the rotator cuff.

**Keywords: aquatic therapy, arthroscopy, Delphi technique, rehabilitation, rotator cuff**

## Introduction

Rotator cuff problems such as tendinosis and rupture result in a decrease in shoulder function and are common in elderly people [1]. Their incidence ranges from 33% to 81% [2], while that of rotator cuff tears ranges from 5% to 39% in the general population, increasing significantly with age [3]. Such tears are the most common non-traumatic upper limb cause of disability in people over 50 years [4]. The main causes of rotator cuff ruptures are direct injury or trauma and degeneration due to repetitive stress [5]. Rupture of the rotator cuff tendons can cause pain, weakness, alteration in glenohumeral movements and sometimes instability [6]; in addition, after five years, asymptomatic partial or total ruptures usually trigger pain [7].

Nonoperative treatments can be used to manage most rotator cuff tears, especially in patients with lower demands. Rotator cuff tendons do not heal spontaneously, however, and surgical treatment is often required in patients who have persistent symptoms and functional impairment after conservative treatment [8]. One adverse effect of rotator cuff surgery is stiffness, whose incidence is estimated to be between 4.9% and 32.7% [9–12]. Stiffness is more likely if rehabilitation is too conservative [11–13], and it tends to decrease if an arthroscopic operation has been performed [10]. Early rehabilitation protocols achieve significant improvements in range of motion (ROM) in the short and medium term compared to more conservative protocols that begin rehabilitation later [13–19]. The early introduction of aquatic therapy will allow fast improvement of glenohumeral ROM [20–23]; in addition, an aquatic environment appears safe for the integrity of the sutures [20,22,24,25] and thus helps reduce secondary post-operative complications such as the appearance of sub-acromial adhesions and glenohumeral capsule contracture [20] and stiffness [9–12].

Few studies have examined the suitability of an aquatic rehabilitation programme in combination with standard treatment after rotator cuff surgical repair [20,23,26,27]. Previous studies demonstrate that an aquatic environment offers favourable conditions for the recovery of these injuries. The fact that water acts to compensate the force of gravity means that it is the ideal environment to reduce joint impact and can be very beneficial in rehabilitation and recovery processes [28], and slow arm elevations (<30°/s) are advantageous for improving joint mobility with low mechanical solicitation [29]. Electromyography studies indicate the aqueous environment requires less muscle activity than activities on land for exercise [30,31], making rehabilitation exercises within an aquatic environment safe for the integrity of the sutures [30,32]. In addition, it is better and safer to start early rehabilitation exercises in water, since the buoyancy of the water decreases workloads and may help to decrease tensile stress and protect repaired tendons [33].

This study describes the design of an early, intensive and complementary aquatic rehabilitation protocol after arthroscopic rotator cuff repair based on the Delphi method.

## Materials and methods

### Study design

The Delphi method is an interactive, structured and repetitive process that is used to collect and distil the judgements of experts through a series of questionnaires interspersed with feedback [34,35]. It is a widely-used and accepted technique for collecting data from participants who are experts in the subject [36], and it is very suitable as a research instrument when there is incomplete knowledge about a problem or phenomenon [34], or when the existing information about the problem is limited [37,38].

### Rehabilitation protocol

An early, intensive and complementary aquatic rehabilitation protocol after arthroscopy rotator cuff repair was proposed.

This protocol was early because aquatic rehabilitation will begin in the second or third week after the operation, it was intensive because there will be 12 45-minute sessions in the water for three weeks, and it was complementary because the aquatic session will be complemented by two land sessions that will be held in the rehabilitation facilities of a hospital or medical centre during the protocol. The protocol has been designed based on existing evidence [20,25,27,39,40], and the author's experience in aquatic shoulder recoveries [41]. To assess the improvement in joint balance, a simple passive anterior flexion, abduction and external rotation goniometry of the glenohumeral joint will be performed at the beginning and at the end of the protocol.

During the proposed aquatic exercise routine, the patient is placed in a bipedal position with their back against the wall and with the water at neck level. The patient performs active movements in all directions with the maximum possible amplitude, always at low speed and respecting the rule of no pain. During the exercises, the shoulder is kept down while various active movements are made. Forced external rotations in abduction and anterior flexion of the glenohumeral joint must be monitored [42].

The structure of this protocol (supplementary 1) its objectives, and the exercises in each of its stages are described in the protocol section of the website created for the project (https://sites.google.com/hubfub.cat/aquarehabilitation). The procedure is also accompanied by audiovisual support.

### Determination of the sample

The target size for an expert panel will vary depending on the expertise required, but the selected qualified participants should have knowledge of the issues and viewpoints related to the topic being studied [43]. For this study, it was considered that there should be a minimum of 10 participants for it to be deemed valid.

### Participants

A panel of experts in rehabilitation in aquatic environments was created to agree on the proposed protocol.

The participants were selected for their expertise in the field of aquatic rehabilitation.

Recruitment for the panel took place through a notable Spanish expert in aquatic rehabilitation, who provided the contact details of other experts who might be interested in participating. In addition, international experts were sought though an announcement in a forum specialized in aquatic recovery (Aquatic Therapist hub). All the experts that showed interest in this study were contacted by email and asked if they would like to participate voluntarily in the proposed Delphi study. They were sent all the information about the process by email, as well as a link to the website designed for the study, where all the information and access to the different questionnaires were found.

To ensure the suitability of the participants, their expert competence coefficient (K), knowledge coefficient (Kc) and the argumentation coefficient (Ka), was assessed. This index is obtained from the self-perception of the experts about their level of knowledge regarding the analysed topic, as well as about the sources that allow them to argue their decision [44]. The expert competence coefficient provides a more appropriate framework through which to select experts [45]

To assess the knowledge coefficient (Kc), the experts were asked to assess their own knowledge regarding aquatic rehabilitation in rotator cuff injuries on a scale from 1 to 10. To assess the argumentation coefficient (Ka), the participants had to rate six aspects that influence their *level of argumentation* or foundation regarding aquatic rehabilitation (low, medium or high). This comprised the following: 1. Theoretical analyses performed by the respondent. 2. Experience obtained by the respondent from practical activity. 3. Research on the topic by national experts. 4. Research on the topic by international experts. 5. The knowledge held by the respondent regarding the state of the problem in other countries. 6. The knowledge of the respondent regarding the topic [46]

The value of the expert competence coefficient was derived from the formula K = 0.5 (Kc + Ka). The questions to determine the expert coefficient were included in the sociodemographic questionnaire.

**Survey process**

To facilitate and ensure the proper development of the Delphi study, a web page was created that contained all the necessary information for the participants, as well as access to all the procedures and questionnaires (https://sites.google.com/hubfub.cat/aquarehabilitation/). To avoid possible bias, a third person was placed in charge of conducting the study. The third person sent a unique and non-transferable code to each of the participants in order to maintain their anonymity, ensure honest responses and avoid any possible coercion or influence on the answers. The anonymity of the participants was maintained throughout the process [47,48]. Although the consensus in these studies is defined by 75% of the responses [49–51], given the innovation of this programme, this study defined a consensus as equal or superior to 80%. The questions were answered with a 5-point Likert scale. The questionnaire was designed to reach an agreement on the proposed protocol.

The questions were formulated based on both the existing scientific evidence and on the author's own professional experience in the field of aquatic rehabilitation in shoulder pathologies. As noted by Oliver et al., rehabilitation protocols are often based on the clinical experience and opinion of the experts rather than on scientific rationality [41].

The questions were chosen to answer the three main ideas on which the protocol is based. The temporal structure of the aquatic sessions, the early improvement of the articular balance of the glenohumeral joint after surgical intervention of the rotator cuff and the safety of sutures during the functional work in the water. In the temporal structure of the protocol, both the duration of the aquatic sessions and number of aquatic sessions to be carried out per week had to be defined within the three weeks established by the protocol.

The first round of the questionnaire consisted of 27 statements (supplementary 2) divided into six main areas: length of time working in the water, joint balance, security of sutures, movements in the three planes of space, improvement of ROM, and the advantages that the aquatic environment offers. The second round consisted of 12 statements (supplementary 3) that were formulated based on the answers obtained in the first round.

The areas that did not achieve the necessary consensus in the first round were the temporal structure, muscular activation and the spatial position of the body in the water. Therefore, in the second round, these statements were modified. The statement regarding temporal structure was reformulated to achieve a clear definition of the duration of the aquatic sessions and the number of aquatic sessions per week. With regards to muscle activation, extra information was provided on the results of the main electromyographic studies carried out in water. Finally, regarding the position of the patient in the water, the phrasing of the statement was modified to avoid any doubts in its interpretation.

**Ethical considerations**

Participation in this Delphi study was completely free and voluntary on the part of the participants. Even so, when answering the sociodemographic questionnaire, the participants signed an agreement regarding

data protection and confidentiality of the study results. This study meets the criteria set out in the Declaration of Helsinki as well as the Spanish organic law 3/28 (5 December) that protects personal data and guarantees digital rights. It was approved by the clinical research ethics committee of the Osona Foundation for Health Research and Education (FORES) on 29/10/2019 with code CEIC 2019054/ Own code AC275.

**Statistical analysis**

The data obtained in each round were analysed in order to establish consensus. The percentage, mean, median (Me), standard deviation (SD), first quartile (Q1), third quartile (Q3), interquartile range (IQR = Q3-Q1), relative interquartile range (RIR = (IQRx100)/Me), and Fleiss Kappa coefficient (g) were calculated using Microsoft Excel.

A consensus was assumed if the IQR tended to 0 or if the RIR was less than 15% [52,53]. The Fleiss Kappa coefficient (g) was calculated in order to assess the degree of agreement between the expert's responses. The interpretation of this coefficient was based on the following criteria [54]: $g \leq 0,4$ (Weak or poor reliability); $0.4 < g \leq 0.6$ (moderate reliability); $0.6 < g \leq$ (good reliability) and $g > 0.8$ (excellent reliability).

**Tab. 1.** Calculation of the expert competence coefficient (K)

| Participants | Kc* | Ka** | K*** |
|---|---|---|---|
| E1 | 0.9 | 1 | 0.95 |
| E2 | 0.8 | 1 | 0.9 |
| E3 | 0.9 | 1 | 0.95 |
| E4 | 1 | 1 | 1 |
| E5 | 1 | 1 | 1 |
| E6 | 0.9 | 0.9 | 0.9 |
| E7 | 0.9 | 0.9 | 0.9 |
| E8 | 0.9 | 1 | 0.95 |
| E9 | 0.7 | 0.9 | 0.8 |
| E10 | 0.7 | 0.8 | 0.75 |
| E11 | 0.8 | 0.8 | 0.8 |
| E12 | 0.9 | 1 | 0.95 |

* − knowledge coefficient, **− argumentation coefficient, ***– expert competence coefficient

## Results

**Panel of experts**

The mean expert competence coefficient (K) of the participants was 0.9 (SD 0.08), the mean knowledge coefficient (Kc) was 0.86 (SD 0.1), and the mean argumentation coefficient (Ka) was 0.94 (SD 0.08). Of the 12 participants, 11 achieved high competence and one was placed in the highest range of intermediate competence (Tab. 1).

As a result, all the initially assessed experts were included in the study [46]. Of the 12 participants, 10 were female and two were male. The mean number of years spent in aquatic rehabilitation was 20.27 (SD 9.80). The areas of expertise were Physiotherapy, Rehabilitation and teaching. Five of the participants had PhDs and another was completing her doctorate at the time of the study (Tab. 2).

**Consensus**

*First round results*

Twelve experts answered the questions formulated in the first wave. Of the 27 questions asked (supplementary 2), seven achieved 100% total consensus, 11 achieved 91.66% consensus, and one achieved 83.3% consensus. Eight questions failed to reach the 80% consensus established by this study (Tab. 3).

The following statements achieved 100% consensus:

- The aquatic environment is a safe environment for the integrity of the sutures following the rule of no pain; the aquatic environment causes less tension in the rotator cuff than the same exercises performed outside water.
- The buoyancy of the water enables active mobility with moves in slow motion in the early stages, avoiding excessive tension in the sutures.
- The movements made in the three planes of space in the water in early rehabilitation allow better neuromuscular integration and more functional work than work performed outside the water and in movements in a single plane.
- If patients keep the shoulder down during the water sessions, they will be able to gain greater glenohumeral ROM than without keeping it down.
- The patient will be more involved and more collaborative in the early work in the water due to the feeling of lightness of their arm when performing active movements in the water.
- The aquatic environment offers a significant difference in the perception of the ease of carrying out the movements inside the water than outside it.

**Tab. 2.** Summary of the answers to the socio-demographic questionnaire of the participants in the Delphi study

| Participants | Socio-Demographical Questions | | | | | |
|---|---|---|---|---|---|---|
| | Age | Gender | Education – main studies | Current professional job | Years dedication water rehabilitation/ investigation Average: 20.27/ SD: 9.80 | Specialized course in water rehabilitation |
| P1 | 65 | Male | Degree | CEO Aquatic therapy company | 42 | Bath hydrotherapy and Valens aquatic therapy course |
| P2 | 53 | Fem | Master | Physical therapist | 16 | Aquatic Therapy University Aquaticist |
| P3 | 41 | Fem | PhD | Physiotherapist rehabilitator and university teacher | 20 | Therapeutic swimming, Specific water therapy, Halliwick, Watsu TCSA, Water therapy in ASD |
| P4 | 34 | Fem | Master | Injury rehabilitator and physical trainer at the pool and gym | 10 | Teaching specialized courses in the recovery of injuries in the aquatic environment |
| P5 | 62 | Fem | PhD Candidate | Director of hydrotherapy department | 40 | Several: Advanced Hydrotherapy, Watsu, halliwick, Bad Ragaz, neurology, Pediatrics… |
| P6 | 57 | Fem | PhD | Physiotherapist in hospital | 20 | Several in: IATF and GIFA-APFISIO |
| P7 | 40 | Fem | PhD | Physiotherapist | 21 | Halliwick |
| P8 | 48 | Fem | Degree | PTA | 6 | Certification from Aquatic Therapy University |
| P9 | 63 | Male | PhD | Teacher | 35 | No. I´ve created a method of a aquatics therapy |
| P10 | 40 | Fem | Degree | Physiotherapist | 15 | Several (Bad ragaz, halliwick, ai-chi, therapeutic swimming, watsu, expert technician in aquatic therapy |
| P11 | 41 | Fem | Degree | Physiotherapy | 20 | No |
| P12 | 57 | Fem | PhD | Invited teacher, physioterapist on hospital | 20 | Several: in switzerland and Portugal. I'm IATF member |

AFFisio − Portuguese Association of Physiotherapists, ASD − Autism Spectrum Disorder, GIFA − Interest Group in Aquatic Physiotherapy, IATF − International Aquatic Therapy Faculty, TCSA − Cranio Sacral Aquatic Therapy.

The following statements obtained 91.63% consensus:

♦ The proposed protocol will make it possible to gain more glenohumeral ROM than the conventional protocol of two land sessions per week.

♦ 45 minutes of work in the water will gain more glenohumeral ROM than 10 minutes of work; the aquatic environment allows more glenohumeral ROM to be gained in early stages than conventional land work.

♦ The buoyancy of the water enables active movement in early stages avoiding excessive tension in the sutures.

♦ In the water, low-speed movements cause less tension in the rotator cuff than high-speed movements.

**Tab. 3.** Summary table of responses to the 1st wave of the Delphi study

| 1st wave | Participant response / (Percentage answers) | | | | | |
|---|---|---|---|---|---|---|
| Question | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Consensus reached |
| 1 | 7 (58.31%) | 4 (33.32%) | 1 (8.33%) | | | 91.63% |
| 2 | 5 (41.65%) | 6 (49.98%) | | 1 (8.33%) | | 91.63% |
| 3 | 6 (49.98%) | 3 (24.99%) | 2 (16.66) | 1 (8.33%) | | 74.97% |
| 4 | 3 (24.99%) | 5 (41.65%) | 3 (24.99%) | 1 (8.33%) | | 66.64% |
| 5 | 4 (33.32%) | 5 (41.65%) | 3 (24.99%) | | | 74.97% |
| 6 | 2 (16.66%) | 7 (58.31%) | 2 (16.66%) | 1 (8.33%) | | 74.97% |
| 7 | 10 (83.33%) | 1 (8.33%) | 1 (8.33%) | | | 91.63% |
| 8 | 3 (24.99%) | 3 (24.99%) | 3 (24.99%) | 2 (16.66%) | 1 (8.33%) | 49.98% |
| 9 | 10 (83.33%) | 2 (16.66%) | | | | 100% |
| 10 | 10 (83.33%) | 2 (16.66%) | | | | 100% |
| 11 | 6 (49.98%) | 2 (16.66%) | 2 (16.66%) | 2 (16.66%) | | 66.64% |
| 12 | 3 (24.99%) | 2 (16.66%) | 2 (16.66%) | 5 (41.65%) | | 41.65% |
| 13 | 6 (49.98%) | 5 (41.65%) | 1 (8.33%) | | | 91.63% |
| 14 | 6 (49.98%) | 5 (41.65%) | 1 (8.33%) | | | 91.63% |
| 15 | 9 (74.97%) | 3 (24.99%) | | | | 100% |
| 16 | 9 (74.97%) | 2 (16.66%) | 1 (8.33%) | | | 91.63% |
| 17 | 10 (83.33%) | 2 (16.66%) | | | | 100% |
| 18 | 5 (41.65%) | 6 (49.98%) | 1 (8.33%) | | | 91.63% |
| 19 | 9 (74.97%) | 2 (16.66%) | 1 (8.33%) | | | 91.63% |
| 20 | 5 (41.65%) | 4 (33.32%) | 2 (16.66%) | 1 (8.33%) | | 74.97% |
| 21 | 9 (74.97%) | 2 (16.66%) | 1 (8.33%) | | | 91.63% |
| 22 | 9 (74.97%) | 3 (24.99%) | | | | 100% |
| 23 | 5 (41.65%) | 6 (49.98%) | 1 (8.33%) | | | 91.63% |
| 24 | 10 (83.33%) | 1 (8.33%) | 1 (8.33%) | | | 91.63% |
| 25 | 7 (58.31%) | 5 (41.65%) | | | | 100% |
| 26 | 12 (100%) | | | | | 100% |
| 27 | 2 (16.66%) | 8 (66.64%) | 2 (16.66%) | | | 83.30% |

♦ Aquatic programmes that perform movements in a single plane do not allow the same level of neuromuscular integration as those combined in all planes.

♦ The aquatic environment in early stages of rehabilitation after rotator cuff repair enables patients to work in combined movements in the three planes of space sooner than in land work; it is important to insist that the patients keep their shoulder down to achieve the goals set for the early improvement of the glenohumeral ROM.

♦ It is important to keep the shoulder down when working in the water to achieve a more functional work and a higher level of neuromuscular integration of the glenohumeral joint.

♦ Adherence to aquatic treatment is greater due to the feeling of freedom of movement in the early stages of rehabilitation; improvement in the glenohumeral ROM in early rehabilitations in water will be equal or almost equal between the two sexes.

Eight statements failed to reach the 80% consensus marked by this study. The areas in which no agreement was reached were as follows:

♦ The time of the sessions in the water.

♦ The number of sessions to be held per week.

**Tab. 4.** Summary table of responses to the second round of the Delphi study

| 2nd round | Participant response/(Percentage answers) | | | | | |
|---|---|---|---|---|---|---|
| Question | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Consensus reached |
| 1 | 5 (45.45%) | 3 (27.27%) | 3 (27.27%) | | | 72.72% |
| 2 | 8 (72.72%) | 3 (27.27%) | | | | 100% |
| 3 | 4 (36.36%) | 3 (27.27%) | 4 (36.36%) | | | 63.63% |
| 4 | 3 (27.27%) | 2 (18.18%) | 2 (18.18%) | 3 (27.27%) | 1 (9.09%) | 45.45% |
| 5 | 2 (18.18%) | | 1 (9.09%) | 4 (36.36%) | 4 (36.36%) | 18.18% |
| 6 | 3 (27.27%) | 3 (27.27%) | 3 (27.27%) | 2 (18.18%) | | 54.54% |
| 7 | 5 (45.45%) | 3 (27.27%) | 1 (9.09%) | 2 (18.18%) | | 72.72% |
| 8 | 6 (54.54%) | 4 (36.36%) | | | 1 (8.33%) | 90.90% |
| 9 | 5 (45.45%) | 5 (45.45%) | | | 1 (8.33%) | 90.90% |
| 10 | 8 (72.72%) | 3 (27.27%) | | | | 100% |
| 11 | 3 27.27%) | 4 (36.36%) | 1 (9.09%) | 3 (27.27%) | | 63.63% |
| 12 | 8 (72.72%) | 1 (9.09%) | | 1 (9.09%) | 1 (9.09%) | 81.81% |

- ♦ Muscle activation in the aquatic environment.
- ♦ The adverse effects of working in water.
- ♦ The spatial position of the patient in the water.

In the first round, in 13 of the questions, the RIR was less than 15%. Also, poor concordance was found between experts, indicated by a Fleiss Kappa coefficient from multiple observers of 0.09.

*Second wave results*

Eleven participants answered the 12 questions (supplementary 3) formulated in the second wave (Tab. 4).

One participant failed to respond to the statements given in the second round. After analysing the responses (Tab. 4), the experts agreed on the early, intensive and complementary aquatic rehabilitation protocol after arthroscopy rotator cuff repair (Tab. 5).

In the second round, a consensus was reached on the temporal structure of the protocol: three aquatic sessions of 30-minute of exercises for each session for three weeks). In addition, it was agreed that changing the patient's position in the water will help to improve joint balance and that exercises in the water in the early stages after rotator cuff repair have fewer side effects than exercises on land. The results obtained indicate that there is no consensus on muscle activation in water.

In the second round, in three of the questions, the RIR was less than 15% and the Fleiss Kappa coefficient from multiple observers showed was 0.04, i.e. poor concordance (Tab. 4).

## Discussion

The design of the protocol was based on three main ideas: the temporal structure of the aquatic sessions, the early improvement of the articular balance of the glenohumeral joint after surgical repair of the rotator cuff, and the safety of sutures during the active functional work in the water.

**Temporal structure of the aquatic sessions.** The main consideration when designing the protocol was that the improvement of the articular balance of the glenohumeral joint was directly proportional to the duration of the aquatic rehabilitation sessions and the number of sessions per week. Therefore, the proposed protocol for this study was four aquatic rehabilitation sessions of 45 minutes, one per week; this assumed that, being complementary, two rehabilitation sessions per week were carried out in the hospital. However, the experts did not agree on this proposal. The statement 4 (supplementary 2) achieved 67.3% consensus. Furthermore, the statement 8 (supplementary 2) achieved only a 45.5% consensus. Therefore, neither of the two statements reached the 80% consensus established by this protocol, thus invalidating them.

To determine the duration of the aquatic sessions, it was necessary to analyse the responses to the statements in the second round. The experts reached 100% consensus on the statement 2 (supplementary 3). In contrast, the statement 1 (supplementary 3) only received a 72.72% consensus, thus failing to reach the minimum

**Tab. 5.** Summary table of the protocol agreed upon by the experts through a Delphi study. An early, intensive, and complementary aquatic rehabilitation protocol after arthroscopy rotator cuff repair

| | | | |
|---|---|---|---|
| Initial valuation | _ ROM (passive) | Valuation at the beginning of the first session | |
| Beginning of the protocol | _Start on the 2nd or 3rd week * after surgery | * According to the decision of the surgeon and healing of the incisions. Possibility to start earlier with waterproof dressings to prevent contact with water with surgical incisions prior to complete healing | |
| Duration of the protocol | _Three weeks | | |
| Sessions | Aquatic sessions:<br>_three sessions per week –<br>_30-minute work per session | Land-based sessions:<br>_2 rehabilitation sessions a week at the hospital / medical center following his working protocol | |
| Targets | First week of aquatic therapy | _Contact with the aquatic environment.<br>_Take confidence with the aquatic environment.<br>_Increase security in performing the exercises.<br>_Do the exercises suggested correctly.<br>_Understand work safety slogans for integrity of tendon repair and follow them appropriately. To promote the mobility of the glenohumeral joint in the different planes of the space within the rule of non-pain. | Remind the patient to perform the exercises and guidelines given by the hospital / medical center rehabilitation service at home |
| | 2nd and 3rd week of aquatic therapy | _Favor the mobility of the glenohumeral joint in the different spatial planes.<br>_Increasing the amplitude of movements always within the rule of non-pain.<br>_Promote the elasticization of the tissues that make up the joint capsule through different movements in different spatial planes. | |
| Work instructions | PATIENT ACTIVITIES: _Perform active movements in all spatial directions<br>CONSIGNES:<br>_Active movements in all directions of space with the maximum possible amplitude, at low speed and within the rule of no pain.<br>_ Control the position of the GH avoiding his rise.<br>_Mainly monitor the movement in ADD + Flexion and forced external rotation.<br>PHYSIOTHERAPEUTIC WORK:<br>_Control the patient's adaptation to the aquatic environment.<br>_Check the correct execution of the exercises.<br>_Give clear and understandable instructions | _Start the sessions with the patient's body leaning forward and with the shoulder covered by the water and performing active pendulum movements.<br>_Continue the session in standing position (shoulders covered by the water) with flexion-extension active movements in a neutral position of the GH joint. _Continue with flexion-extension movements gradually increasing GH ABD by 0 to 60 degrees.<br>_Continue with movements describing circles of medium and small amplitude depending on each patient in a neutral position, between 30 and 45 degrees of flexion. Bilateral direction of the circles. Gradually increase the diameter of the circles.<br>_Add motions by describing an infinite or continuous „8" motion.<br>_Add exercises by drawing figures or writing words. | |
| Final valuation | _ ROM (passive) | Valuation at the end of the last session (session 9) | |

ABD − Abduction, ADD −Adduction, GH – Glenohumeral, ROM − Range of Motion.

80% consensus. On analysing the responses, it was determined that the optimal duration of the aquatic sessions in this protocol is 30 minutes.

In the second round, the experts were also asked about the ideal duration of the aquatic sessions to reach the goals of early improvement of the articular balance of the glenohumeral joint proposed in this protocol. Neither of the two statements presented managed to reach the required 80% consensus. The statement 3 (supplementary 3) only achieved 63.63%. In addition, the statement 4 (supplementary 3) only achieved 45.45%.

These responses are difficult to interpret: 100% consensus was reached when the statements were asked with working time intervals: statements 1 and 2 (supplementary 3) a; however, no consensus was reached regarding the 'ideal' length of the aquatic sessions, even though the agreed upon 30 minutes was one of the proposed time slots. It is possible that the word *ideal* may have generated controversy, since it can also mean *optimal* or *excellent* [55], and for each expert their ideal length of the sessions will depend on their clinical experience [41] and the method of aquatic therapy they use.

To determine the number of aquatic sessions to be carried out each week, the responses from the second round were also analysed. Statement 7 (Supplementary 3), achieved a consensus of 72.72%. Statement 8 (Supplementary 3), achieved a consensus of 90.90%, and statement 9 (Supplementary 3), achieved a consensus of 90.90%. From the analysis of the responses, it was determined that the optimal number of sessions needed to achieve early joint balance is three sessions a week.

The proposed protocol was designed to last three weeks: This assumed it was intensive and complementary with two rehabilitation sessions per week at the hospital, and was aimed at gaining joint balance early after surgery.

Reaching consensus on the length of the aquatic sessions was not easy, as can be seen in the statistical results. The Kappa Fleiss coefficient in both the first and the second round was 0.09, which is interpreted as poor agreement between multiple observers [54]. This result could be due to different factors. The first is the few studies currently exist on water recoveries after surgical repair of the rotator cuff [20,23,26,27]. The second is the variety of therapeutic approaches that exist in the aquatic environment: Water Specific Therapy (WST), Halliwick, Bad Ragaz Ring Method (BRRM), Clinical Ai Chi, Aquatic motor-cognitive therapy (AMCT) and, Aquatic Passive Manual Handling (APMH). The third is that each therapist approaches their patients according to their clinical experience and the method they think is most appropriate [41].

The consensus reached in this study modified the time structure that had initially been proposed: from 45 minutes of exercises per session and four sessions per week for three weeks (Supplementary 1) to 30 minutes of work per session and three sessions per week for three weeks (Tab. 5). The experts agreed that this organisation is the most appropriate for achieving early improvement in ROM of the glenohumeral joint after arthroscopic repair of the rotator cuff.

**Early improvement of joint balance.** Another key principle in the design of the protocol was that early rehabilitations enable short and medium term improvements in joint balance [13–19], especially in aquatic rehabilitations [20–23]. This idea was supported by the experts since the statement 7 (supplementary 2) achieved a 90.9% consensus.

**Active functional work**. The other main idea in the design of the protocol was that active functional work should be performed from the first session of aquatic rehabilitation (in the second and third week after rotator cuff surgery) to allow an early recovery of normal movement patterns [20]. This active functional work can be performed in the early stages since water is a protective environment for the sutures [20,24,25,56]. The protocols of the studies carried out so far in aquatic rehabilitation after rotator cuff surgery focus on gaining joint balance by performing movements in a single plane of space, starting with passive movements on the first phase of rehabilitation and with active range of motion (AROM) exercises in the second phase of rehabilitation [20,23,26,27]. In contrast to the studies carried out so far, the protocol designed for this study proposes a new aquatic work approach. It proposes active functional work based on combining movements in the three planes, always at low speed and according to the rule of no pain. The patient performs the exercises actively from the first work session in the water, which starts in the second or third week after the rotator cuff surgery and after the approval of the surgeon to start the rehabilitation protocol.

This idea was agreed upon by the experts. All the questions in the first round of the Delphi that referred to active functional work and water as a protective environment for sutures received more than the minimum 80% consensus.

It would be necessary, however, to analyse why the experts did not agree on the statement that the muscle electromyographic activity is reduced when exercises are performed in the water. In the second wave of the Delphi, the experts were provided with various electromyographic articles indicating that muscle activation is lower in water [24,30–32,57]. Even so, no agreement was reached, since the statement statement 11 (supplementary 3) only achieved a 72.72% consensus. Perhaps

the statement should specify "exercises performed at low speeds" in order to obtain a clearer response.

The study has some limitations. Being an innovative study, it was decided that the group of experts would be made up only of physiotherapists who are experts in aquatic rehabilitation and that the consensus for statements would be set at 80%. In addition, the sample is limited. In future studies intended to validate aquatic rehabilitation protocols, the possibility of having a larger sample should be considered, and these should include participants from other specialities, such as surgeons and rehabilitation doctors, who are experts in rotator cuff surgery and rehabilitation.

Our findings, both regarding the evaluation of the expert competence coefficient (K) and the responses to the two rounds of statements in the Delphi study, were based on the opinions, knowledge and experience in aquatic rehabilitation of the experts who participated. One of the main limitations of the Delphi method is that the survey only captures the expert's view of the problem. There can be no doubt that such data can be highly imprecise depending on the perspective of the interviewee regarding the issue in question [58]

Therefore, our findings should be regarded with some caution, and further control cases, pilot tests and clinical trials with larger samples will be necessary. To assess the effectiveness of the agreed protocol, a pilot test will be carried out**,** and if the results are successful, a clinical trial with a control group will be conducted.

## Conclusions

The experts agreed that early, intensive and complementary aquatic rehabilitation protocol is recommended after arthroscopy rotator cuff repair. This study could be a new step forward in trying to unify action criteria and serve as a basis for planning future studies.

**Funding**
This research received no external funding.

**Conflicts of Interest**
The authors have no conflict of interest to declare.

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