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PREVENTATIVE REHABILITATION FOR RUGBY INJURIES TO THE SHOULDER COMPLEX – EVIDENCE-BASED LITERATURE REVIEW

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Providing coaches, referees, players, and administrators with the knowledge, skills, and leadership abilities to ensure that safety and best practice principles are incorporated into all aspects of contact rugby.

There are a number of epidemiological studies which have established the incidence of shoulder injuries in professional and amateur rugby players [2,8,9,10,27,31,47]. There is also evidence which attributes a large number of the injuries to the contact nature of rugby [3,9,27]. However, information regarding players' intrinsic risk factors is lacking. However, the available data does fulfill, in part, the first 2 stages of van Mechelen's 'sequence of prevention' [55]. The next stage (stage 3), aims to introduce a preventative measure prior to re-assessing the incidence to establish the effectiveness of stage 3. This document aims to contribute to stage 3, introducing preventative measures aimed at reducing the incidence and severity of shoulder injuries in rugby players.

THE MOST COMMON SHOULDER JOINT INJURIES

The lower limb is the most common site for injury in rugby [2,4,8,54]. However, the severity of the shoulder injuries sustained in rugby is disproportionately severe [2,7,27].

Shoulder injuries result in the second greatest loss in time (days) of rugby players, after the knee. [8,9] (Table 1). The number of shoulder injuries sustained by rugby players relative to all other joints is between 6.3 and 19.1% [2,3,31]. The lower limb is more frequently injured during both matches and training [3,8,9,10,31]. However, injury to the shoulder joint was found to be more severe, with a greater number of player hours missed due to injury [2,8,9,10]. In a study investigating elite Australian rugby players, 56% of all shoulder injuries were found to be severe [2]. In this study, 80% of these severe injuries were dislocations and all of the players required surgery, resulting in a large number of days missed. A further study found that dislocations accounted for 123 days' absence for every 1000 playing hours. Acromioclavicular joint injury and shoulder impingement accounted for 55/1000 and 54/1000 days missed respectively [9].

TABLE 1: MOST SEVERE INJURIES SUSTAINED BY ELITE RUGBY PLAYERS [8]

INJURY	NUMBER	AVERAGE SEVERITY (DAYS)
Anterior cruciate ligament	1	235
Knee cartilage/degenerative injury	1	155
Rotator cuff/shoulder impingement	3	71
Cervical disc	1	45
Thoracic facet joint	3	35

The most frequently described shoulder injuries include acromioclavicular injury, shoulder or rotator cuff impingement syndrome and shoulder dislocation/instability [2,8,9,27]. Damage to the acromioclavicular joint (32%) and rotator cuff injury or shoulder impingement (23%) accounted for the greatest number of shoulder injuries [27]. However, dislocation or shoulder instability, which accounted for 14% of shoulder injuries in rugby players, accounted for 42% of days missed due to injury. As a result, dislocation is the

most severe shoulder injury experienced by rugby players [27]. In a single study evaluating the frequency and severity of injuries in elite rugby players it was found that a shoulder joint sprain was the most common shoulder injury (Table 2) while a rotator cuff impingement injury was the most severe [8] (Table 1).

Acromioclavicular joint injury is a common injury amongst rugby players [8] (Table 2). A survey identified that 45% of a cohort of 105 players had suffered an acromioclavicular joint sprain [57]. The mechanism of injury in all cases was contact, either falling on the tip of the acromion or injury during a tackle. All players returned to play approximately 4 weeks after the injury.

TABLE2: MOST FREQUENT INJURIES SUSTAINED BY ELITE RUGBY PLAYERS [8]

INJURY	NUMBER	AVERAGE SEVERITY (DAYS)
Hamstring muscle injury	14	11
Calf muscle injury	12	11
Thigh haematoma	10	3
Shoulder joint sprain	8	6
Ankle lateral ligament	8	9
Calf shin/haematoma	6	4
Knee joint sprain/jar	6	20
Cervical facet joint	5	3
Rib fracture/contusion	5	6
Adductor muscle injury	5	8

Rotator cuff tears with concomitant instability have been described in a small series of rugby union and league players [24]. These players all describe a single event which caused a large tear within the rotator cuff. Of the 6 players in the case series study, 5 had pre-existing symptoms of instability prior to the main injury event, therefore it is likely that these tears occurred as a result of a macrotrauma event on an already damaged tendon. All these players required surgery and all had successful outcomes. This case series highlights the importance of identifying shoulder instability as this appears to be associated with a rotator cuff tear. Whether exercise rehabilitation would be sufficient in preventing the injury event has not been determined.

A single case study has described a “bench presser’s shoulder” which presented with pain during a bench press exercise [5]. On examination the injury was found to be an overuse tendinopathy of the Pectoralis minor. As weight lifting and in particular the bench press is a cornerstone of strength training in the upper body of rugby players, this previously undescribed injury should not be ignored.

A large number (27%) of the shoulder injuries were recurrent [27]. These injuries accounted for just under half of the days lost to training and matches. The author suggested that this finding indicated that the management and rehabilitation of shoulder injuries may have been sub-optimal [27]. Dislocation and

instability injuries in the shoulder may recur despite adequate rehabilitation, as a result of physical demands of rugby (i.e. contact involving forceful collisions).

The injury profile for shoulder injuries is much the same for schoolboy rugby as it is for senior players but the incidence of shoulder injuries in schoolboys is greater [31,47]. This may be explained, in part, by a lack of experience and skill, especially with regards to contact activities in schoolboy rugby players.

Front-row forwards and midfield backs sustained the highest number of shoulder injuries (not significant) [27]. Both backs and forwards experienced shoulder injuries but when the injury profile was assessed the most common injuries to forwards were upper body injuries while for the most part backs experienced lower limb injuries [4,9].

MECHANISM OF INJURY

The most common mechanism of injury is contact activities, with the tackle accounting for the greater proportion of shoulder injuries sustained [2,3,9,27]. In a single study investigating the epidemiology of shoulder injuries 97% of injuries in this region were attributed to contact [27]. Although there are more shoulder injuries sustained during a match situation, the injuries sustained during training, most especially the skills training component of a training session, were more severe [27].

Physical contact does, for the most part, explain the aetiology of shoulder dislocations, large rotator cuff tears, acromioclavicular joint sprains, shoulder fractures and haematoma [27] but does not explain the intrinsic risk factors of individuals presenting with rotator cuff impingement. Further, it does not explain the potential intrinsic risk factors of individuals sustaining contact injuries to the shoulder. Brooks & Kemp [7] highlighted the lack of studies investigating training methods, biomechanics, musculoskeletal parameters and nutrition. Future studies should investigate these factors as possible contributing factors towards shoulder injuries in rugby players.

Despite the high number of contact injuries there are a number of studies which have identified rotator cuff impingement or injury as both a frequent or severe injury [8,9,10]. Rotator cuff impingement is used to describe a number of pathological conditions in the shoulder. These include rotator cuff pathology [6,33], scapular dyskinesis [12,13], shoulder instability [44,58], biceps pathology and slap lesions [11]. A functional instability of the shoulder, often difficult to detect during clinical assessment, has been identified as a factor which may lead to secondary impingement and chronic shoulder pain [53]. A large number of factors have been identified as possible causes of impingement syndrome and the resultant loss of functional stability of the shoulder. These can be divided into 2 categories:

a. Excessive humeral translations which may threaten glenohumeral stability [25] and,

b. Scapula dyskinesis, decreasing scapula stability which compromises the glenohumeral joint during overhead activities [46].

For the most part these problems with stability are muscular, relating to the specific function of the muscle (stability versus mobility), and the strength and endurance of those muscles.

Further risk factors for shoulder injury, although not significant include, increasing age (31-34 years), increasing body mass index and decreasing height [27]. The aetiology behind these findings is not clear.

PREVENTION

The role of preventative rehabilitation can be divided into two areas: Prehabilitative (exercise therapy to reduce the risk of injury) and Rehabilitative (rehabilitation to prevent the recurrence of injury). Rehabilitation following injury to the shoulder is a strategy commonly implemented by both sporting and general populations ([13,22,23,36,38,51]. Prehabilitation or preventative rehabilitation would be implemented to reduce the risk of injury by addressing a number of musculoskeletal variables which are associated with shoulder injuries. The vast majority of shoulder injuries in rugby players are sustained during contact activities. For this reason Headey et al. [27] suggested that training or prehabilitation be implemented to prepare players for different contact situations. The merit of this argument is largely accepted but the point must be made that although adequate strengthening of the shoulder girdle may reduce the number or severity of shoulder injuries, the nature of the game of rugby, the contact and collisions are associated with a naturally higher risk of injury [7].

Fundamental to the reduction of shoulder injuries is skill training, most particularly during the tackle situation. However, the high recurrence rate of shoulder injuries would support both rehabilitation and prehabilitation programmes to reduce the number of shoulder injuries in rugby [27].

Prevention of common shoulder injuries in rugby will be discussed under a number of headings: **(a) shoulder pads, (b) gym training, (c) skill training and (d) exercise therapy**. The focus of this document is exercise therapy but it is important that other factors aimed at reducing the number of shoulder injuries in rugby players are also discussed so that exercise therapy is put into context.

(a) Shoulder pads

The mechanism by which physical contact causes injury at the shoulder joint has been postulated [37,42]. In accordance with this proposed mechanism shoulder padding has been promoted as a way by which forces can be absorbed by the tissues and so decrease injury [21]. However, according to the rules, padding during matches cannot exceed 1 cm in thickness or a density of 45 kg per cubic metre [30]. A single study did not find shoulder pads with these dimensions to be effective in reducing the incidence of shoulder injuries in professional players [27]. As such, their effectiveness in reducing injury has not been

clearly established. The American Academy of Orthopaedic Surgeons' Committee on Sports Medicine concluded that shoulder pads may be useful, but that proper technique training such as falling technique, the use of weight training to build up protective shoulder musculature, and the inclusion of conditioning programmes to reduce the effects of fatigue were all equally important in attempting to reduce the number of shoulder injuries [1]. Although this statement was made in 1974 there has not been any substantive data since then to refine these recommendations.

(b) Gym training technique

Gym training is an essential component of a rugby player's conditioning programme. Although injuries while training in the gym are not described within the epidemiology papers for rugby players, it is recognised that technique faults, including poor technique, rapid increase in training load, frequency and duration, have been identified as risk factors in the aetiology of tendinopathies [40]. The use of resistance training is central to strengthening of the upper body in rugby. The safety of resistance training is greatly enhanced if the training program is designed and supervised by qualified instructors [26]. The National Strength and Conditioning Association (NSCA) have issued a position statement on resistance training during prepubescent and adolescent years [20]. Their position was that a properly designed and supervised resistance training program was safe for children. Included in this document are a few common technique faults adopted by individuals during weight training (Table 3).

However, a detailed description of the resistance training exercises and Olympic lifts is not included in this document as these exercises need to be taught to players on a one-to-one basis by a qualified professional to ensure safety for the player, to prevent overloading and further, to prevent overuse shoulder injuries associated with poor technique during resistance training.

TABLE 3. STRENGTH TRAINING TECHNICAL FAULTS THAT LEAD TO INJURY

INCORRECT TECHNIQUE	CORRECT TECHNIQUE
 **Problem:** Elevated shoulder when lowering the weight. **Cause:** Weak shoulder, weight too heavy	 **Correction:** Keep both shoulders at the same level. **Solution:** Slow progression of weight, correct spotting
 **Problem:** Letting the weight down too high (close to the face) **Cause:** Incorrect technique	 **Correction:** Lower the bar to the level of the nipple line. **Solution:** Movement of the bar is in an arc, from the eyes at full extension to the nipples, when the bar is on the chest
  **Problem:** Swaying forward and back when doing a bicep curl **Cause:** Weight too heavy	 **Correction:** There should be no movement in the upper body when lifting the weight. **Solution:** Slow progression of weight, stand with your back to the wall.


Problem:
Lifting arms above the head in different planes.

Cause:
Shoulder not stable, weight too heavy

Correction:
Arms must be elevated in the same plane

Solution:
Improve shoulder stability. OR only do this exercise if the individual has sufficient stability to perform the lift. Lighten the load


Problem:
Elevated shoulder during the lift

Cause:
Weakness, lack of stability

Problem:
Bringing your wrists together and not your elbows

Cause:
Inflexibility of the posterior shoulder (posterior capsule), weight too heavy


Correction
Shoulders must work together and be `down' during the lift phase

Solution:
Work on correct form and slow progression from lighter weights. Improve shoulder stability

Correction:
Ensure sufficient flexibility prior to attempting the press. Stretch prior to the press. Elbows and wrists to touch at the same time

Solution:
increase flexibility, lighten weight lifted

  **Problem:** Bringing the weight up in an arc, and not directly in front of the body **Cause:** Incorrect technique, weak scapular depressors (shoulder stabilisers)	 **Correction:** Bring arms up close to the body, keeping shoulders down **Solution:** Train correct technique. Progression of programme and weight lifted
  **Problem:** Lifting one shoulder when pulling up in the movement **Cause:** Lack of flexibility, lack of shoulder stability, exercise too advanced	 **Correction:** Keep both shoulders depressed and level with each other **Solution:** Improve flexibility, appropriate training progression and programme design.

(c) Skill training

Headey et al. [27] called for 'prehabilitation' to prepare players specifically for the varying contact-related demands of the game. This may be done in part with appropriate exercise therapy as described below. However, it also includes specific training with regards to the technique of tackling, being tackled, scrumming, and the ability to fall to name but a few. Although this usually falls within the domain of the coach, these areas can be included in rehabilitation programmes which include exercises such as forward rolls (Specific exercise examples: Phase 3). Similarly boxing (Specific exercise examples: Phase 3) may be used to assist with on-field agility during the tackle situation.

(d) Exercise therapy

Exercise therapy for shoulder pain is largely directed at an impairment-based model. As such rehabilitation or prevention is aimed at dysfunctions of the neuromuscular system. To understand this, it is necessary to understand how the stability of the shoulder is achieved by the musculoskeletal system. As indicated earlier (mechanisms of shoulder injury) stability of the glenohumeral joint and scapula is essential [25,46]. It is for this reason that both rehabilitation and prehabilitation focuses on the stability of both the scapula and the glenohumeral joint as the first phase of rehabilitation.

Glenohumeral stability is provided by the rotator cuff muscles of the shoulder to provide joint stiffness prior to movement [16]. The Subscapularis muscle is part of the rotator cuff and plays a pivotal role in this function [16]. Individuals presenting with glenohumeral instability demonstrate a delayed activation of the rotator cuff. This dysfunction and the appropriate rehabilitation of the rotator cuff function is therefore central to the first phase of rehabilitation.

Scapula stability is provided by the scapula stabilisers. These muscles include Lower Trapezius and Serratus anterior [15,16,34]. Scapula dyskinesis is the term given to the observed motor dysfunction of the scapula when these muscles do not function appropriately [39,56]. Scapula dyskinesis is observed in 100% of individuals presenting with rotator cuff impingement signs and 64% glenohumeral instability. Dysfunction in the scapula stabilisers themselves has been observed using electromyography (EMG) [14,52]. Shoulder injuries in rugby players include both aspects of instability and impingement and as such preventative exercise therapy aimed at the glenohumeral and scapula stability muscles is critical.

IMPORTANT: There is strong evidence that pain alters the timing and function of stabilising muscles [16,28,29]. As such the function of the stabilising muscles will be altered following an acute, traumatic contact injury such as a shoulder dislocation, acromioclavicular joint sprain or muscle tear. For this reason it is imperative that ALL shoulder injuries be appropriately rehabilitated to reduce the risk of recurrence or a secondary shoulder overuse injury developing.

Shoulder rehabilitation is divided into 3 stages of rehabilitation, following basic principles of stabilisation outlined in other rehabilitation programmes [48,50]. The 3 phases are outlined in Table 4.

TABLE 4. THE PHASES OF REHABILITATION IN THE SHOULDER

	PHASE 1 COGNITIVE STAGE	***PHASE 2 ASSOCIATIVE STAGE***	***PHASE 3 AUTONOMOUS STAGE***
Aims of the phase	To activate and isolate the stabilisers of the glenohumeral joint and scapulothoracic joint	To retrain movement patterns and isolated muscles	The aim is dynamic stabilisation with emphasis on skill training and functional rehabilitation

Phase 1

During phase one the aim of the treatment would be to activate the stabiliser muscles of both the glenohumeral joint and scapulothoracic joint. This must be achieved with the shoulder in a neutral position and with good upper body posture [41,45]. The main muscles targeted in this phase are the Subscapularis (glenohumeral joint stabiliser) and Serratus anterior and Lower Trapezius (scapulothoracic joint stabilisers) [15,16]. This aim of this first goal is to gain awareness of, and activate the deep stabiliser muscles of the shoulder [41]. This phase is done for the most part under the guidance of a physiotherapist or biokineticist, and the value of this in preventative programmes is limited due to the individual training required for this step. For the requirements of this document the scapula setting position has been highlighted to isolate Serratus anterior and Lower Trapezius [45]. Subscapularis setting requires highly skilled feedback and for this reason has been excluded from this document [41].

Phase 2

The aim of this phase is to retrain movement patterns and improve strength and endurance of the stabiliser muscles [41,48]). The focus is to restore muscular balance, endurance, neuromuscular control and proprioception [32,58]. This phase emphasises low load, high repetitions [48]. The exercises are done using therabands or bodyweight, and do not include gym-based exercises. If this phase is part of rehabilitation of a specific injury it should be done instead of strength training/conditioning shoulder exercises until such time as stability is obtained and strengthening of the large torque producing muscles can be initiated. However, when these exercises are being used as an adjunct to a conditioning programme to reduce the risk of injuries, they can be used in conjunction with the shoulder conditioning programme.

There is literature to support the use of selected exercises to recruit and retrain the Subscapularis and Serratus anterior muscles [17,18]. The push-up, the dynamic hug and the Serratus anterior punch were three exercises which recruited the Serratus anterior the most [17]. The push-up, the diagonals, internal rotation and dynamic hug were found to recruit the Subscapularis greater than 20% MVC [18]. Detailed instructions and pictures of these exercises are included in the section on specific exercise examples.

In athletes participating in sports which require activities above their heads (i.e. tennis) the ratio of external rotation to internal rotation is often reduced and inclusion of external rotator strengthening exercises is important to normalise this ratio [19]. Closed kinetic chain exercises are used in this phase with the aim of causing the joint surfaces to approximate and to obtain a co-contraction in the muscles of the rotator cuff and more superficial torque producing muscles [35].

Phase 3

This phase of rehabilitation is functional and concentrates on more skilled activities while still achieving dynamic stability. As the name of this phase suggests, the stability of the shoulder should be automatic

and care should be taken not to load the shoulder too quickly to threaten this balance. Strengthening exercises are continued and plyometric exercises can be added in functional positions [49]. This phase of rehabilitation, or preventative exercise therapy, would see the inclusion of specific gym training techniques and exercises to include the whole of the kinetic chain [43]. Examples of the latter include boxing and 4-point Swiss ball exercises (included in the section below).

SPECIFIC EXERCISE EXAMPLES

The following section outlines the phases a player must successfully negotiate to minimise the risk of shoulder injury. Each individual must pass through the phase before proceeding to the next. The phases are designed to improve shoulder stability in a progressive and structured way. The level of rugby played does not influence the phase at which the player starts. Each player should start at phase 1.

Progression through the phases should be limited to the player's ability to complete the exercise set and repetitions without compromising their technique or form.

Phase 1:

The aim of this stage is to set the shoulder blades onto the rib cage

	*Scapula setting:* Draw the tip of the shoulder away from the fingers, which lie in the line of the pec muscle. Sustain a hold for 10 s and repeat 10 times

Phase 2:

The aim of this phase is to retrain movement patterns and improve the strength and endurance of the stabilising muscles.

	*Scapular protraction and retraction (push up plus):* Keeping the elbows extended, drop your chest toward the ground. Push up through the chest. Take 3 s to go down, and 2 s to come up again.

	*Dynamic hug:* Place a piece of theraband across your shoulder blades as shown. Extend your elbows and push your shoulders forward, bringing your hands together. Take 2 s to extend, and 3 s to go back to the resting position.
	*Scapular retraction with weights:* Place a heavy dumbbell in your hand. Draw the shoulder blade toward the spine, moving the inferior angle more than the upper portion. Do not activate the muscles in your neck. Take 2 s up, and 3 s down.
	*Serratus punch:* Place the theraband as shown. Jab the leading arm forward while rotating the arm inwards. Concentrate on moving the arm and the shoulder blade forward. And slowly return to the starting position.
 	*Scapular retraction and protraction:* Lying over a ball, with your upper body suspended. Keeping your elbows locked in extension, allow your chest to move toward the ground (shoulder blades to move together), push your chest up into the starting position.

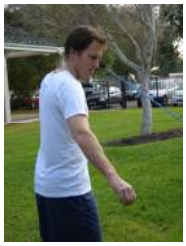
 	*Theraband internal rotation:* Tie the theraband to an immovable object. Bend your elbow to 90°, and keep it slightly away from your side, rotate the band toward your stomach.
  	*Step walking:* Place your hands on either side of a step (as shown). Move one arm and then the other onto the step. Return to the starting position. Keep your shoulder blades in the protracted (forward) position.
  	*Bent over row:* Place a weight in your hand. Retract your shoulder blade (move inferior border closer to the spine). Once that movement has been achieved, lift the weight up, bending your elbow. The weight must reach your waist.

 	*Cable rows:* As you pull the rope towards you, make sure that you pull your shoulder blades back at the same time. Be careful not to elevate the shoulders.

Phase 3:

The aim of the third stage is to provide for functional training and movement. The movements aim at including cross body movements in multi-directions, not in a single plane

 	*Windmill:* Start in a push up position, move onto one shoulder, by rotating your body to one side. Maintain neutral alignment, and do not allow your shoulder to collapse.
	*Four point kneeling on a ball, with leg elevation:* Place both hands and legs on the ball. Once you have achieved balance, extend one leg behind you, Maintain balance by using your shoulder blades as stabilisers

  	*Reverse throws:* Tie the theraband to an immovable object. Facing the band, draw the band back and up, into the throwing position, using your shoulder blade and arm. Return your arm to the starting position slowly, releasing both your arm and shoulder blade. Be careful not to elevate your shoulder as you pull back.
 	*Medicine ball push up:* Place either hand on a medicine ball. Complete a push up. Do not allow the balls the touch together.
  	*Forward roll:* Roll over on either shoulder. Ensure that you have the ability to fall and roll over each shoulder.

	*Plyometric heave* Place medicine ball in front of your foot. With your opposite hand lift the medicine ball diagonally across your body until you arm is vertical. Return the medicine ball to the original starting position in a slow controlled manner.

SAMPLE PROGRAMMES

Phase 1:

All players should be able to achieve scapula setting. This exercise must be performed 5 – 6 times a day, 7 days a week or until the player is able to set their shoulder blade with ease.

For those players who are involved with a strength training programme the following guidelines should be adhered to.

1. Scapular setting should be completed every day of the week, including gym days
2. Scapular setting must be completed just prior to and after gym training
3. During this phase of rehab, the players must limit their upper body routines to those exercises that are below shoulder height
4. Players should concentrate on correct form and technique, and should not attempt to make any weight gains on any of their exercises
5. The trainer/coach should re-evaluate their training programme and identify possible areas to concentrate on during this phase
6. Coaches should work on other aspects of the player's physical profile

Phase 2:

This phase requires players to integrate the phase 2 preventative exercises into their current training programme. Player should be able to choose 4/5 exercises that are given and include those into their routines. These exercises should rotate with every training session they complete until they have mastered all the exercises. The guidelines for training are as follows:

1. Frequency – x3 a week
2. Intensity – Follow the remainder of the programme in terms of sets and repetitions.
3. Progression – Increase the number of exercises completed per session, increase the number of sets and repetitions, while maintaining correct form.
4. Load – The initial load should allow 3 sets of 10 repetitions performed without altering technique. Weight can be increased gradually still allowing players to perform 3 sets of 10 repetitions without losing form.

A sample programme would look as follows:

Exercise	***Description***	***Sets***	***Reps***
Bench press	Superset (Combining a set of one exercise and alternating it with another set of a different exercise).	1,1,1,1	15,12,12,10
Scapular protraction and retraction		1,1,1,1	10,10,10,10
Cable flys	Superset	1,1,1	12,12,12
Theraband internal rotation		1,1,1	10,10,10
Bent over row	Superset	1,1,1,1	10,10,10,10
Bench stepping		1,1,1	10,10,10
Cable rows		1,1,1,1	12,12,10,10

Phase 3:

Phase 3 exercises should be seen as a separate programme on its own. Players should complete their other strength training independently of the rehabilitation exercises.

The guidelines for training are as follows:

1. Frequency – x3/4 a week
2. Intensity – Increased repetitions, low load (2/3 x 15/20)
3. Progression – should be made in consultation with a rehabilitation specialist. Sets and repetitions can also be increased to 4 – 5 sets of 15 – 20 repetitions

AUTHORS' BIOGRAPHIES

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