Returning to full function after shoulder injury – regaining movement flow

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Full functional recovery following a shoulder injury involves a complex interaction between localised tissue recovery, integration with other body segments and restoration of neuromuscular control towards skilled movement. All three areas are key to full functional recovery. When relearning skilled movement, how we teach and correct exercises is as important as exercise selection.

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1 Understand some theoretical concepts of motor learning retention and transfer.
2 Be aware of current research related to functional rehabilitation of the shoulder.
3 Develop a systematic approach to progression of functional shoulder exercises.
4 Effectively include motor control and skill acquisition techniques into a functional rehabilitation programme following shoulder injury.

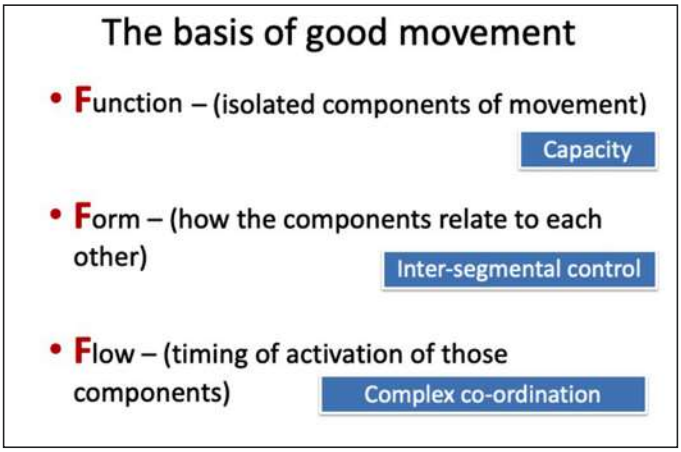

FIGURE 1: The basis of good movement

Introduction

The basis of good movement can be considered in three broad areas, as shown in figure 1.

- **Function** (or capacity) relates to aspects such as tissue resilience and stages of healing, isolated range of motion and joint specific muscle strength, as well as an intact sensory and motor neural structure. All of these factors provide essential foundations on which to build functional recovery.
- **Form** relates to the ability to link capacity across segments of the body and how they relate to each other. Inter-segmental control is key to the transfer of energy from ground reaction force through lower limbs and trunk to the upper limbs.
- **Flow** refers to the timing of activation in delivering a smooth co-ordinated movement needed for sports-specific movement patterns, requiring a higher level of expertise.

Developing functional capacity

Although the emphasis of this article concentrates on linking segmental control and restoration of co-ordinated movement, this first stage is vital to ensure maintenance of the quality of movement as rehabilitation progresses. Restoring capacity of the shoulder girdle includes both glenohumeral and scapulothoracic control. However, very rarely do we use isolated shoulder girdle movement unless it is very fine movement, which is where the link to inter-segmental control becomes important.
When developing function or capacity in the shoulder girdle, there is some evidence to guide us on targeting muscle groups if working towards addressing an insufficiency. Figure 2 provides some examples of this.

The importance of the concavity-compression mechanism has been reported by Magarey & Jones (2003), when a relatively modest compression force can resist significant translation of the humeral head on the glenoid (Mahksous *et al* 2004). Uhl *et al* (2003) also reported that closed kinetic chain weight bearing exercises stimulate co-activation of shoulder stabilisers.

When targeting shoulder girdle capacity, we also need to consider strength endurance as part of that programme. This is particularly significant when you consider that swimmers have been reported to make approximately 16,000 shoulder revolutions a day (Pink & Tibone 2000) and, in a typical road race, cyclists use the upper limbs in a weight

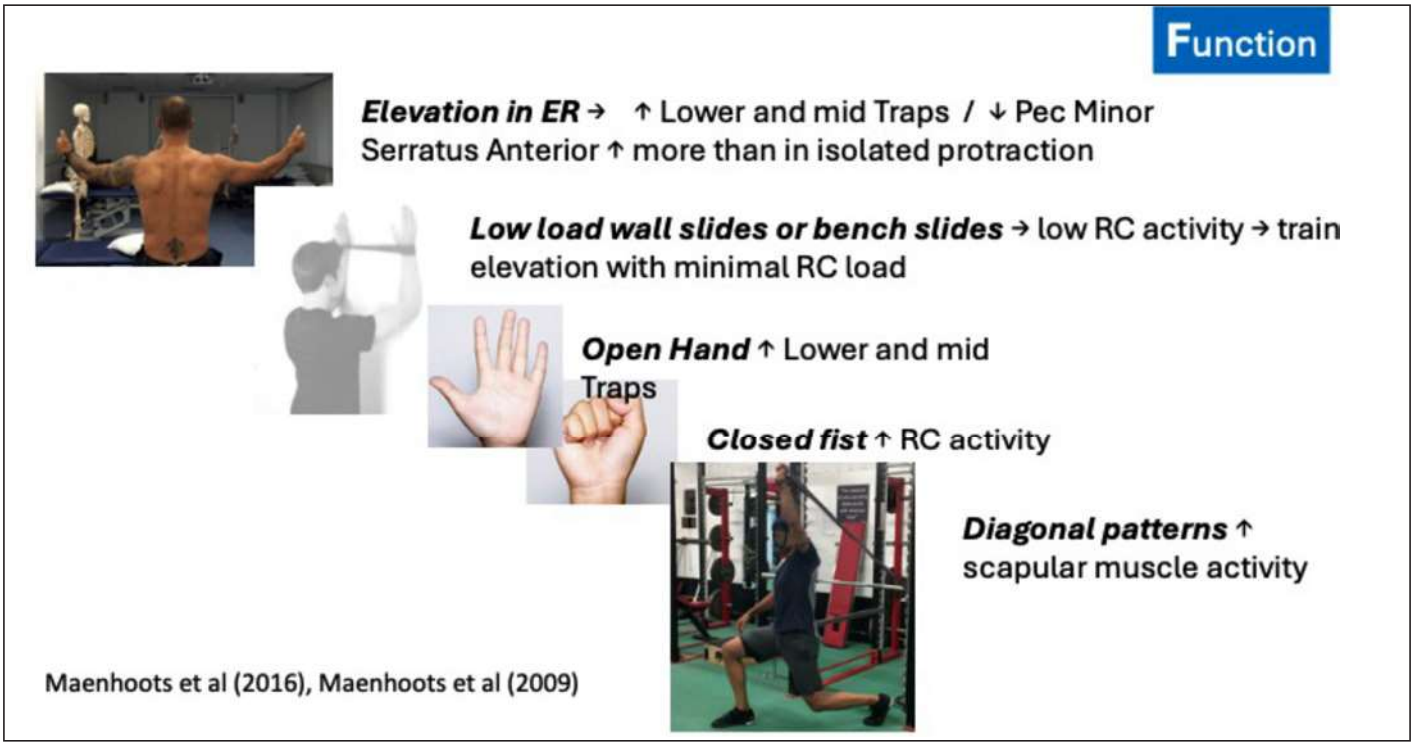

FIGURE 2: Exercise selection for function (capacity)

bearing position to stabilise the trunk and lower limbs for lengthy periods (Turpin & Watier 2020). There is also some evidence demonstrating a reduced ability to detect where the arm is in space following fatigue of rotator cuff muscles (Tripp *et al* 2007). If these muscles with a stabilising function exhibit a sense of reduced joint position, then it would follow that they are less able to contribute to a co-ordinated movement pattern. This needs to be addressed in terms of ensuring that endurance work is included once initial control is established.

Patients will also be more vulnerable at the end of a rehabilitation session if fatigue affects neuromuscular control in this way. Consequently, the order of exercises given in any one session requires attention.

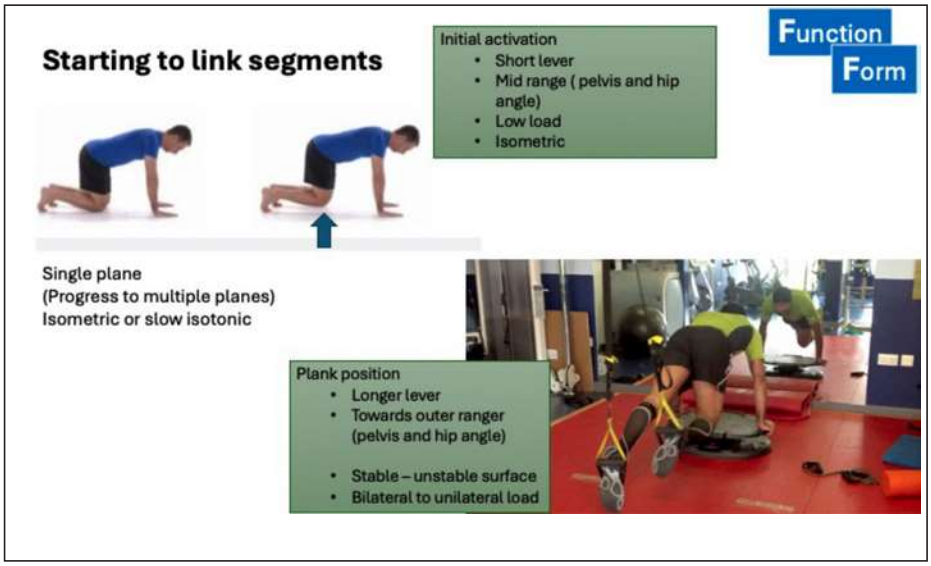

FIGURE 3: Linking function to form in closed kinetic chain exercises

Developing form through inter-segmental control

An underpinning principle is that there are few sporting actions that use an isolated segment or muscle group. Therefore, rehabilitation includes introducing multiple segmental control and co-ordination of often complex movement patterns at some point in the return-to-sport journey.

Functional shoulder movements in sport typically involve transferring energy between limbs or segments and that requires both capacity and co-ordination. Martin *et al* (2014) demonstrated this in tennis players, where individuals with shoulder impingement were less efficient at transferring energy from the trunk through the shoulder to wrist and hand. This suggests that integrating core or trunk control with the shoulder would improve functional ability. Similar thinking is supported by Kaur *et al* (2014) and Richardson *et al* (2020) with lower limb and trunk activation increasing shoulder girdle activity. Figures 3 and 4 demonstrate some exercises using both open and closed kinetic chain examples.

> "REHABILITATION FOR RETURN TO SPORT SHOULD INCLUDE MULTIPLE SEGMENTAL CONTROL AND CO-ORDINATION OF COMPLEX MOVEMENT PATTERNS"

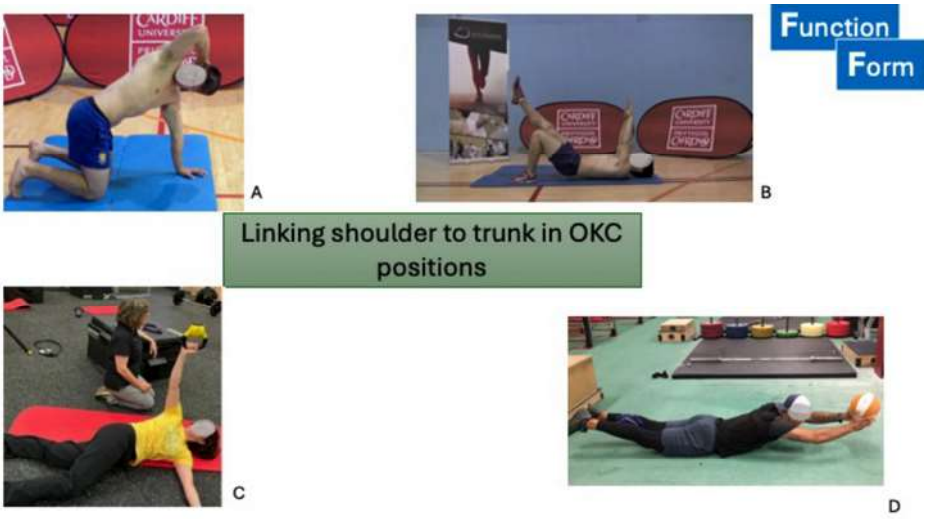

FIGURE 4: Linking function to form in open kinetic chain exercises

The exercise examples in figure 3 illustrate how we start to link segments in weight bearing. An initial starting point could typically be four-point kneeling, with a shorter lever to keep a lower load on the shoulder, using an isometric muscle action in a single plane. This can be progressed to a longer lever in a plank position, reducing the stability of either base of support, as well as introducing isotonic muscle action. This requires control of trunk and lower limb movement over a stable shoulder.

As an alternative, figure 4 also illustrates examples of linking segments but with the arm in an open chain position.

(A) This is a four-point kneeling start with trunk rotation, whilst bringing the shoulder girdle around with the trunk, but controlling a dissociation between segments by keeping the pelvis fixed.
(B) This is a simple single leg bridge with arms elevated, ensuring the arms point to the ceiling, whilst the trunk angle moves underneath.
(C) This exercise requires a similar effort of the upper limb to (B) but involves a trunk rotation dissociation. The weight in the hand is light, acting to provide some compression in the shoulder to help stimulate shoulder girdle activation, as previously mentioned.
(D) Lower limb and trunk extension work in conjunction with end range shoulder elevation.

All these exercises can be useful for sports that require open chain control, and these examples are particularly useful for a swimming action.

Developing flow

In addition to being able to dissociate control across segments, efficient transfer of energy requires good co-ordination of timing and effort of muscle activity. First, it is necessary to have capacity in each segment, but without refining co-ordination, the capacity or function gained will not be useful.

Kaur *et al* (2014) demonstrated that simultaneous activation of the lower limbs and trunk, such as in a lunge or step position, increases serratus anterior activity in a forward punch movement. The timing of this movement through the kinetic chain is a key conclusion here, indicating that it is not merely about having an ability to dissociate across segments during a slow movement. Relearning that activation pattern for efficient and effective movement involves use of motor learning theories to enhance this skill.

FIGURE 5: Developing flow

Figure 5 shows some examples of techniques to re-establish flow and that these can be done even in the earlier stages of rehabilitation, with low load exercises.

In a simple four-point kneeling, weight transference exercise, introducing some decision-making on which direction the free arm moves to touch a target will prompt learning through varied practice, as well as cognitive demand. A step movement, such as a lunge, will also initiate a learning response towards developing the timing of muscle activation through the kinetic chain, and adding an unpredictable load to the elevated arm will generate a varied movement pattern that facilitates ongoing learning. Similarly, changing the plane of movement and direction of the load will also introduce variability and the resultant learning will increase the degrees of movement available in that functional activity.

This is also the point at which exercises need to become more sport specific, building on the co-ordination gained.

Coaching good movement

Re-establishing smooth co-ordinated movement must be a learned process. Therefore, how we teach, correct and progress exercises, as well as how we structure a session, will have an impact on skill retention and transfer to function.

Providing an environment that encourages implicit learning, where the

individual has to work out a solution to the movement themselves, has been shown to be more effective for functional performance. This effect is emphasised with concurrent complex tasks (Masters *et al* 2008). However, in earlier stages where the individual is coping with altered sensory input as well as reduced functional capacity, it is still very relevant to deliver explicit learning where clear rules are given regarding limb placement and targeted muscle activity (Kal *et al* 2020).

The disadvantage for retention and transfer is that use of explicit learning has a much higher cognitive demand which is likely to impede the more complex, faster movements needed in later stages. As physiotherapists, we should be mindful of the advantages and disadvantages of both explicit and implicit learning. This is especially relevant when considering the cues we give during an exercise, with internal cues directing attention to specific joint or muscle activity encouraging more explicit learning.

Conversely, providing either an external cue such as an obstacle or mark on a wall, or an analogy for the movement, will encourage more implicit learning. Knowing when to switch between the two can have a positive impact on the success of rehabilitation.

Another aspect we can manipulate is the exercise order within a session. Random sequencing, where exercises are frequently changed, facilitates retention and transfer of the skill in the longer term, whereas block sequencing through repetition encourages faster initial learning but is less effective in the longer term or in skill transfer (Rendell *et al* 2020). These options demonstrate the complexity for us as practitioners to get the balance between the short-term goals of achieving the correct isolated movements, and the longer-term goals of restoring skilled function and transfer to competition.

REVIEW SUPPORTING QAP

This article provides an in-depth framework for shoulder rehabilitation, focusing on three key areas: capacity, form, and flow. Capacity involves restoring tissue resilience, range of motion, and muscle strength. Form emphasises inter-segmental control for efficient energy transfer across the body, while flow addresses the timing and co-ordination of movements essential for sports-specific activities.

Understanding these components enables physiotherapists to guide patients through the recovery process, ensuring the integration of motor learning principles and current research into functional rehabilitation and have a clear insight about how to design a rehabilitation programme for whatever the level of function your patient may want to return to, whether high-level athlete or weekend warrior.

It is important to have a systematic approach to exercise progression, incorporating explicit and implicit learning techniques to optimise skill retention and transfer. Initial rehabilitation stages focus on restoring shoulder capacity, followed by developing form through multi-segmental control and, finally, refining flow with co-ordinated movement patterns.

Nicola has highlighted the need for endurance training and proper exercise sequencing to prevent fatigue-related neuromuscular issues. This approach ensures athletes regain optimal shoulder function, with practical applications tailored to clinical and sports settings. Although this is not new, it is good to be reminded of the need for this approach and why rehabilitation sometimes falls short. It is useful to remember the three "Fs" with visual prompts that we can take straight into our clinics.

Reviewer
Katie Knapton

Summary

There are three main factors to consider in optimising recovery for return to sport or activity: function, form and flow. How we structure our interventions and the instructions we give will also impact recovery in the short and long term. Modifying our communication as rehabilitation progresses will ensure that we help the individual develop the movement skills throughout the kinetic chain to produce efficient and effective shoulder function for return to sport.

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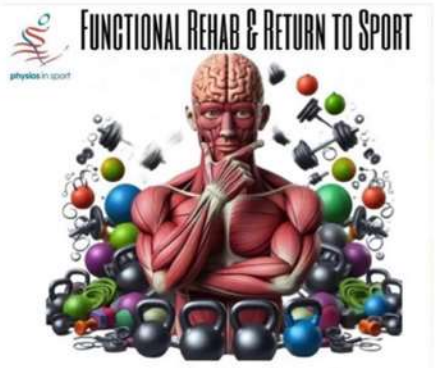
Nicki Phillips is a tutor on the Functional Rehabilitation in Sport course, run by the Association of Chartered Physiotherapists in Sport and Exercise Medicine (ACPSEM). It has 20-plus hours of online learning and a two-day practical workshop to develop reasoning in exercise selection and progression for return to sport or activity. It is suitable for anyone who treats active individuals in a clinic or in a sport setting. Contact **info@physiosinsport.org** for details.



References

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