Exercise Therapy Basics

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Exercise and movement is one of the original four pillars that defined the physiotherapy profession's scope of practice in the royal charter which was granted in 1922, the other three being massage, electrotherapy and kindred methods of treatment. Interpretation of the latter phrase was the subject of a briefing paper in 2008.

Looking through Frontline month by month, there are normally plenty of post-grad courses dealing with the use of hands on techniques (massage) including both soft tissue and joint based therapy. Similarly "kindred methods" such as acupuncture receive wide coverage within physiotherapy and the emphasis on electrotherapy both at undergraduate and postgraduate level is still quite high.

But what about exercise?

While some training is given at undergraduate level it may be very brief and varied and basic knowledge often harps back to post war rehabilitation programmes such as those described by Delorme and Watkins (1946) and then catapults forwards to fairly recent research on muscle balance. Often it seems that the mountain of research on exercise within the sports science field has largely passed us by which perhaps is due in part to the fact that physiotherapy did not become an autonomous profession until 1977 and prior to that had to rely on clinical guidance from the medical profession, a situation which could thwart creativity and originality in exercise prescription. If we are honest, how often do we spend our time on hands on techniques and patient education only to give out a standard exercise sheet for the patient to use at home?

Would we do this if we were training a top level athlete? Athletes often draw on the knowledge of exercise physiologists, biomechanists and sports psychologists for both strength & conditioning and rehabilitation. I would argue, however that the rehabilitation programme you prescribe for "Margaret Smith's OA knee" should be of the same standard as that of the athlete (with apologies to any Margaret Smiths out there as this is fictitious in this context). Both have the same bones, muscles and tissues and while getting the high level athlete back to competition can be perceived as important, the need for Margaret Smith to be able to go up and down stairs, walk to the shops and carry out day-to-day activities are all as important to her as winning a gold medal. Margaret deserves a modern, clinically reasoned and evidence based programme to the same standard as the other physiotherapy techniques which we use and I must confess that I am a little embarrassed to say that she may not often get it.

To begin to tip the balance back in favour of exercise, let's look at some fundamental principles underlying exercise prescription for rehabilitation.

Exercise changes the body

When your patient exercises the immediate changes you see are the exercise *response*. Cardiopulmonary and local muscle alterations seen during exercise gradually slow down as the body returns to normal upon exercise cessation and if the exercise bout is repeated, the same changes occur. However, over a period of time the body becomes better at coping with the exercise and longer term changes representing exercise *adaptation* occur. Examples of exercise responses include sweating, increased respiratory rate and changes in regional blood flow while adaptations manifest as improved heart rate recovery, maximal oxygen uptake and muscle strength.

Overload

To facilitate effective tissue adaptation exercise must challenge the body and this challenge is called *overload*. When the body is overloaded tissue breaks down at a microscopic level and rebuilds itself to become stronger, a process called *supercompensation*. To achieve this, exercise must challenge the body to a greater extent than normal day-to-day activities. Adaptation to exercise (a physical stress) can be understood in terms of psychological stress through the principles of the General Adaptation Syndrome (GAS) first described by Selye in the 1930s. The GAS consists of three phases:

1. *alarm* phase represented by the classic "fight or flight" mechanisms.
2. *resistance* phase when the body tries to cope with the imposed stress.
3. *exhaustion* when the body has depleted its coping mechanisms.

The key to the GAS is that the body can either positively adapt (*Eustress*) by, for example becoming stronger through weight training or negatively adapt (*Distress*) by, for example suppressing immune function through overtraining.

When the imposed stress is exercise the GAS is modified slightly. The initial physical stress (exercise) is an overload which is at a higher level than that normally encountered and will cause physiological, biomechanical and physiological body reactions. Immediately after training, fatigue in all three areas causes the body to be less able to react to an imposed stressor, for example, following heavy weight training, muscles feel exhausted and the mind lacks motivation. The process of recovery happens gradually and may take a couple of days and even up to a week where the imposed stress is very great such as after running a marathon. As the body adapts, pre-exercise levels are restored but the adaptation continues (supercompensation) so that the body becomes better equipped to cope with imposed stress.

During this period further exercise can cause the whole cycle to be repeated but this time as the starting point or fitness level is higher so the compensation is greater. For this reason the period of supercompensation is often referred to as the window of opportunity. Two key points emerge from this process; firstly, that the body has to be given the opportunity to adapt and secondly, the next training period must occur during the window of opportunity. Clearly if the next training period occurs too soon the body will not have finished adapting but if it is too late the body will have returned to pre-training fitness levels.

This has important connotations for treatment planning. Tissue adaptation could be impaired if treatments are either too far apart or too close together or where home exercise is performed too often. Similarly, an overload which is too great or too small may be ineffective.

Reversibility and individuality

The old adage "use it or lose it" applies equally well to exercise. Failure to overload tissue sufficiently (detraining) will result in loss of the benefits gained as part of the training adaptation. Detraining must itself be differentiated from tapering which involves the gradual reduction in training volume to give a physical and psychological break from the rigours of continuous training. Tapering allows muscle to repair micro-damage caused through intense training, especially following eccentric actions and to replenish the energy stores of muscle phosphocreatine & glycogen and liver glycogen. Tapering can also be used to prevent the boredom, staleness or plateauing that can occur with continuous training and, although this is mostly relevant in sports training it clearly has a place in rehabilitation to maintain motivation and patient compliance.

The training responses of individuals are not equal and those of us who go to the gym will have had the frustrating experience of knowing someone who started their gym regime a long time after us improving more quickly. Changes that relate to a specific person represent individuality and everyone reacts slightly differently to training stimuli. This can be attributed to, for example the differences in growth rate which are largely genetically determined and the regulation of the cardiovascular and respiratory systems. Knowing this it becomes clear that standard exercise sheets are only useful as an aide memoir and exercise must be individually prescribed in the same way as the dosage of an electrotherapy machine is individualised to each patient or a manual therapy technique is adapted and modified to suit the tissues beneath your hands.

Structuring a rehab programme

A simple pneumonic is useful when planning your patients' rehab programmes – FITT which stands for **F**requency, **I**ntensity, **T**iming, and **T**ype. When considering training **frequency** consider why tissue changes. To instigate significant change we know we need to overload the tissue and challenge it further than simple day to day activities. For example, someone with a minor knee injury may stand and sit from a chair and so use their quads but when we prescribe quads exercises the intensity must be greater than that of simply sitting down and standing up again. There is, therefore a distinction to be made between activity and training. The challenge to the tissue is happening as the patient trains but the adaptation occurs during rest so if the training frequency is too great, i.e. the patient undertakes too many workouts there will not be enough time for tissue adaptation to occur. Frequency is generally expressed as the number of training periods for example twice each day or 3 times each week.

Intensity is relevant to how hard an exercise is. This is normally measured in strength training in comparison to the maximum weight that can lifted once, with stretching it is how far as a proportion to the maximum range of movement (ROM), for example 60% max ROM or 80% max ROM. Cardviovascular or aerobic intensity is normally measured by pulse rate (BPM) but may be measured more accurately using maximal oxygen uptake (VO2max) or for power events (anaerobic), the onset of blood lactate accumulation (OBLA).

Timing is the duration of the exercise, for example running for 20 minutes or 1 hour or holding a stretch for 40 seconds rather than 10. It also refers to the duration of a repetition for example using a very slow or superslow technique in weight training to emphasise muscle contraction or lifting a weight at a normal rate but lowering very slowly to emphasise an eccentric muscle contraction, also known as negative rep. These two training variables are intimately linked as the slower rep in resistance training means that the target muscles are contracting for a longer period and so training intensity is also increased. This type of training is often used in advanced, high intensity strength training but is also a useful technique when a patient has plateaued during a rehab programme.

Type is the category of exercise such as strength training, aerobics, stretching, plyometrics, each of which can be sub divided depending on which of the fitness components is targeted.

Fitness components

Patients often talk about strength exercises or stretches as though each action was completely separate. In fact very few exercises are completely pure and most have a variety of individual components, for example the bench press exercise in a gym is categorised as a strength movement but it also stretches the chest. For some individuals it may be better to remove the weight element and simply give them a wooden pole to perform the action, making sure that the bar goes onto the chest completely creating stretch focus. To categorise an exercise we must determine each component of the exercise and, for convenience these can be described as 'S' factors.

S factors of fitness	
Health related	Task related
• Stamina • Suppleness • Strength	• Spirit • Speed • Skill • Specificity

Health related factors

- Stamina. This refers to both cardiopulmonary and local muscle endurance. It is important, following injury to restore cardiopulmonary fitness, such as that used in aerobic training because further injury can occur when a person becomes fatigued such as towards the end of a sports game or even in a daily living task such as the end of a gardening session. Local muscle endurance is equally important in holding exercises (isometric contraction) and stability training.

- Suppleness or flexibility training is important to rehabilitation and vital to sporting performance. There are several types of stretching exercise such as static (hold), dynamic (movement) and PNF (reflex) and it is important that both the type of and ROM of the stretch should match the demands of any activity which the patient will carry out regularly, e.g. limiting a fire-fighter to a controlled static stretch of the gastrocnemius will not adequately prepare them to rapidly climb ladders.

- Strength includes concentric, eccentric and isometric varieties all of which are important components of an exercise and it is essential that the type of strength training matches the precise requirements of an activity. Concentric strength is force generating and accelerates, eccentric strength accepts force and decelerates while Isometric strength holds a joint and is often seen as a co-contraction of both agonist and antagonist. As a clinician, ask yourself honestly how often do you consider these differences? They can be vital; a ballistic action that combines concentric actions immediately after an eccentric lengthening of a muscle is essential to a throwing action for the shoulder musculature but it is also the movement used to put on a heavy coat.

Task related factors

- The term spirit involves psychological factors which are important to general training for both health and sports performance and must be considered during rehabilitation. Motivation, how satisfied a person is with their own body and a positive outlook on life fall into this category as does personality type and their anxiety / stress levels and the way a person reacts to injury. If an injury prevents a person from earning a living or puts an athlete out of a major competition there may be a large emotional reaction and the patient's psychological state may be similar to that of the grief encountered in life threatening conditions. In general sports psychologists recognise three phases of response to injury which we can learn much from in daily clinical practice.

1. Injury focussed. This is the initially stage where the patient questions why and how the injury happened.
2. This leads to behaviour changes and the patient becomes agitated, feeling disbelief, and often dwelling on self pity.
3. Finally, acceptance where the patient becomes positive and engages in coping mechanisms.

The latter phase is where exercise is key as it gives the patient the chance to actively participate in their own treatment. Remember also that pain and pain relief is often contextual. While we often glibly use terms such as pain impulses in nerves, this term is erroneous as we know that it is the brain's interpretation that categorises the nervous impulses that may travel along different nerves and be carried slowly or quickly as pain in an attempt to protect the body from further injury. Initially moving a joint which has been previously injured may cause neural stimulation interpreted as pain, over time however the use of exercise therapy can change this interpretation and graded exercise is used extensively in pain management.

- Speed in this context also encompasses power. Speed is how fast we move while power is how quickly we can move a resistance both of which are important for explosive actions in sport and vital components of the final stages of rehabilitation. Another aspect of speed is muscle reaction time and is especially important to joint stability. If we take an ankle sprain as an example, the lateral ligaments of the ankle have been overstretched and the patient needs their muscles to compensate to keep their ankle stable on uneven surfaces. While the ankle muscles can be strengthened using weight training, this increased strength is of no use to the patient if their muscles do not contract quickly enough, i.e. in the gym it may take 2 seconds to perform a heel raise action to strengthen the ankle, however it may take only 0.25 seconds to sprain an ankle on rough ground so, if your patient only uses weight training to rehabilitate their ankle the muscles will not have learned to contract quickly enough to prevent further injury. Therefore, once the ankle muscle has been strengthened more strength is not needed, the patient now needs to maintain the strength and work on encouraging the muscles to contract more quickly. This is the function of speed training.

- Skill is important to all actions but especially those involving complex movements. Following injury a patient can develop movement dysfunction – they move differently to avoid the pain of an injury and this becomes a habit. It is often more important to regain movement quality before movement quantity and this is especially the case with the complex skilled actions seen in sport. Failure to address skill can place stress on previously healthy areas and cause fresh injury. If we use the example of the ankle injury mentioned previously, often, the patient will walk with their ankle turning out after injury and if this change in movement is not corrected it will place stress on the knee, hip and lower back eventually leading to pain or secondary injury in these parts of the body.

- Specificity. When a muscle is strengthened its make-up actually changes, it becomes larger and tighter and there are alterations in the chemicals it contains (physiological adaptation). In addition, the way the brain controls the movement itself becomes smoother and more coordinated (neurological adaptation). This constitutes the training adaptation during which the patient makes changes that are a direct reaction to the training itself. The exact adaptation will closely reflect the type of exercise performed and so we say that the muscle adaptation is specific to the demands placed upon it. A simple pneumonic for this is SAID; **S**pecific **A**daptation to **I**mposed **D**emand. The *adaptation* in the patient's body as a result of exercise will always closely match or be *specific* to the exercise performed (*imposed demand*).

As an example, two people run marathons and they each want to reduce their times and go for a personal best. If one of them trains by running long distances and the other by running short sprints who will be more successful in reducing their times? The person who runs distances is undergoing training that accurately reflects the actions and endurance required in marathon running. Short sprints will build mainly strength and speed and so, although the person using sprint training is getting fitter, the fitness is not the type required for a marathon race. This runner's body has adapted but the changes do not closely match those needed for running the marathon, they are not truly specific.

Another illustration is this simple rehab example. A patient recovering from a knee injury is given quads exercises because their thigh circumference is less on the injured side than on the uninjured leg. Initially they perform straight leg raises to ensure that they do not have an extensor lag, they then progress to short range quads and finally knee extensions using a weight over the ankle. Over the weeks they progress the exercise by performing 3 sets of 10 reps of an increasing weight until they are able to lift the same weight on their previously injured leg as they can on the uninjured side and the quads wasting has gone. They are then discharged as the pain, wasting and weakness that the injury caused in the leg has now resolved. This seems logical and, to a limited extent it is, however some months later the patient returns, complaining that their knee is giving way especially if they are caught off guard stepping from a kerb or down from the last step of the stairs.

Why did this occur? The rehab used an open chain position and focussed on strength with a greater emphasis on concentric strength. The problem the patient is now experiencing results from closed chain during eccentric actions or loss of eccentric control. To ensure that rehab, and so the adaptation of the muscle is specific to their daily requirements the quads exercises should have progressed, prior to their discharge, to closed chain movements of varying speeds with an emphasis on eccentric control and endurance.

Summary

Exercise therapy, although one of the original four pillars of our profession has become de-emphasised. Other professions have taken the lead in this essential field and physiotherapists need to regain lost ground if they are to remain at the forefront of rehabilitation. A basic knowledge of exercise science helps build a sound foundation for the effective prescription of exercise therapy but this knowledge is often not well covered in our basic training.

Knowledge of exercise
is well known in the management of sporting injury but needs to move into the general stream of day-to-day rehabilitation. This article introduces concepts of training adaptation, overload and reversibility and individuality.

Guidance is given on structuring a rehabilitation programme using a simple FITT pneumonic, and 'S' factors of fitness.

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