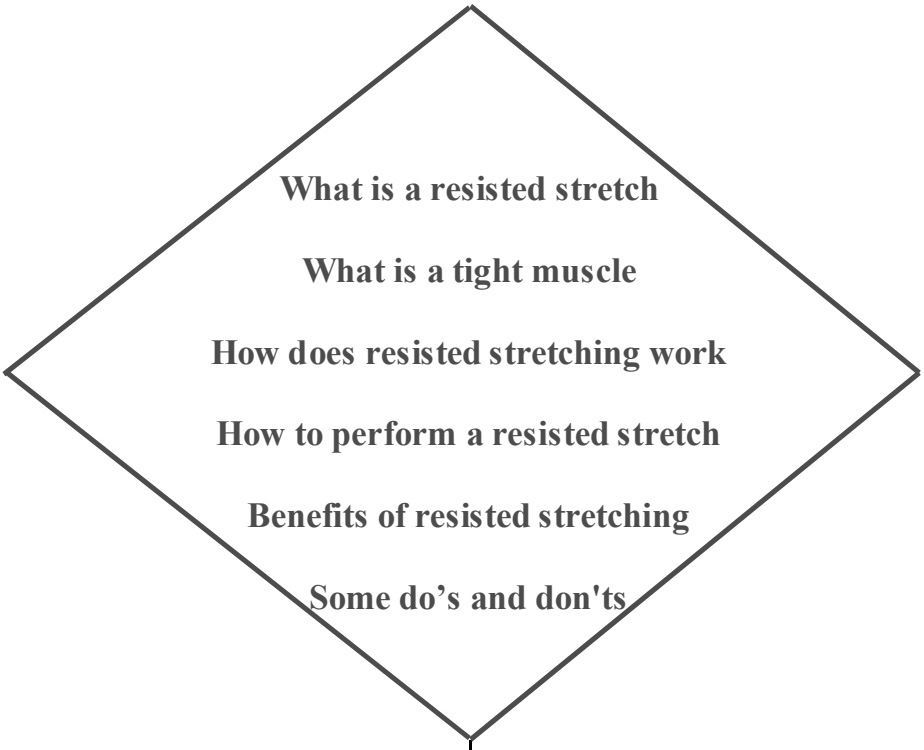
THE LONG AND THE SHORT OF RESISTED STRETCHING
THE MOST EFFECTIVE TOOL IN THE BOX
By Sheena Livingstone DARM RMT DSM SMTO

At least 90% of your clients will present with pain resulting from muscle tightness. Resisted stretching, also known as isometric stretching or post isometric relaxation, is not only one of the most effective ways of releasing tight muscles, but also one of the most pain free methods – certainly a bonus for both you and the client. This article will look at:



WHAT IS A RESISTED STRETCH?

A resisted stretch has two phases:

A passive phase where you, the therapist, move the joint to the point of muscle tension

An active phase where the client contracts the stretched muscle against a resisting force (usually the therapist) This is an isometric contraction ,ie there is no movement of the joint.

This technique (resisted stretching) *was applied to tight, tender muscles that are commonly associated with musculoskeletal pain and was systematically tested on 351 muscle groups in 244 patients. The method produced immediate pain relief in 94%, lasting pain relief in 63%, as well as lasting relief of point tenderness in 23% of the sites treated.*

Lewit & Simons, Aug 1984

Fig 1

Muscle Energy Technique is a form of resisted stretch

Muscle Structure

Muscles consist of bundles of muscle fibres (fascicles), which stretch the length of the muscle.

Muscle fibres:
There are two types of muscle fibre

- Extrafusal muscle fibres
  - ◊ Consist of myofibrils actin (thin filaments) and myosin (thick filaments)
  - ◊ These myofibrils are split into sections called sarcomeres that are separated from each other by areas of dense material called "Z discs".
  - ◊ Their function is to contract muscle
- Intrafusal muscle fibres
  - ◊ Contain the proprioceptors that recognise that a muscle is stretched.
  - ◊ The two main proprioceptors are the muscle spindles in the belly of the muscle and the golgi tendon organs at the musculotendinous junction.

Muscle Contraction

Muscles contract using the sliding filament mechanism (Figure 2). Within each sarcomere, the myosin "pulls" the actin filaments towards the centre, thus shortening the sarcomere which in turn shortens the muscle fibre. Note, that although the length of the sarcomere changes, the lengths of the actin and myosin filaments remain the same - the length of the sarcomere is a consequence of the extent to which these filaments overlap. In Figure 2, this means that the Z discs come closer to each other and both the H and I bands become smaller.

Muscle Relaxation

When the myosin heads on the thick filaments relax they release their hold on the thin filaments, thereby allowing them to slide back to their "relaxed" positions in which the I bands and H zones appear again.

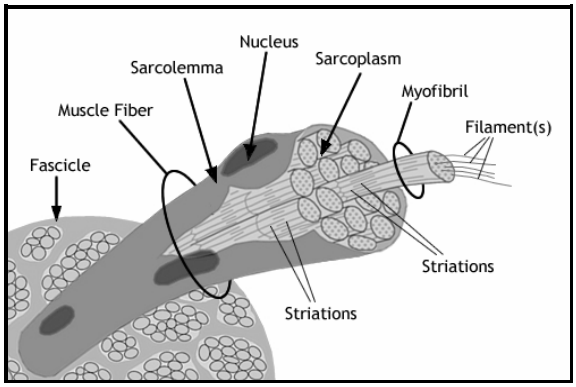
Muscle contraction can only take place when there is sufficient calcium and ATP present. In the absence of these, the actin filaments slide back to their resting state.

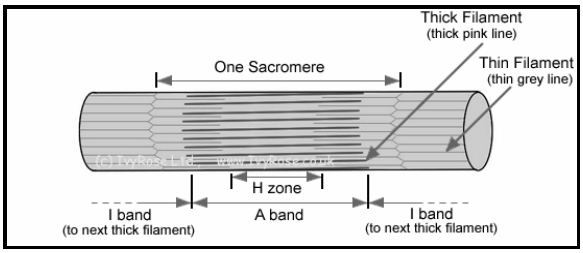
However, muscles do not always return to their "best resting length" - see Figure 4.

In essence, muscles have four lengths:

- Maximally contracted (you cannot partially contract a muscle)
- Best resting length
- Current resting length
- Maximum elongation past best resting length

Figure 4 gives a schematic view of each state. Note how the myosin remains static whilst the actin moves towards and away from the centre. **A tight muscle is one that is at current resting length rather than best resting length,** ie when the muscle relaxes it does not return back to best resting length. It is our job as therapists to restore this muscle back to its best resting length. This is where we can use **resisted stretching.** →

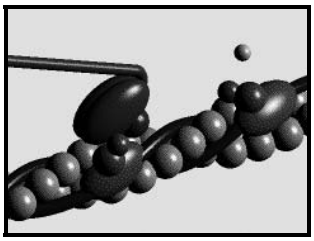




Sarcomeres are sections of myofibril that are separated from each other by areas of dense material called "Z discs".
The sarcomeres are also described in terms of the bands/zones within which one or both of the two filaments occur.
These bands/zones are illustrated in the diagram above:
The "A band" is a relatively darker area within the sarcomere that extends along the total length of the thick filaments.
The "H zone" is at the centre of the A band of each sarcomere. As shown below, this is the region in which there are only thick filaments, and no thin filaments.
The "I band" is the region between adjacent A bands, in which there are only thin filaments, and no thick filaments.
(Each I band extends across two adjacent sarcomeres.)
In the diagram above, the Z discs are represented by the zig-zag lines that form the boundaries between adjacent sarcomeres.

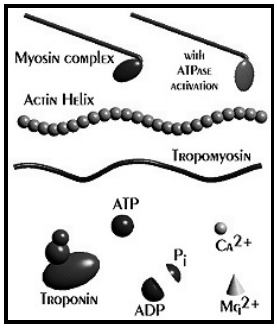
www.ivy-rose.co.uk/Topics/Muscle_Cell

Fig 2

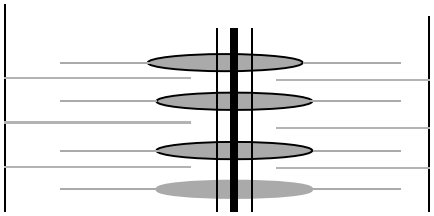


NISMAT website

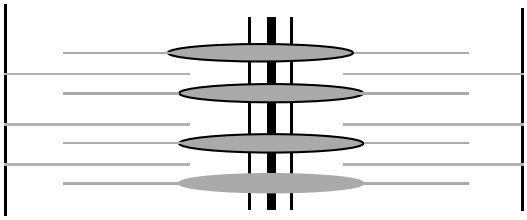
Fig 3



MAXIMUM CONTRACTION

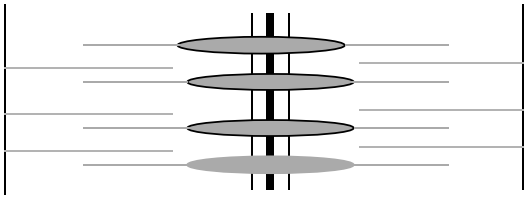


CURRENT RESTING LENGTH



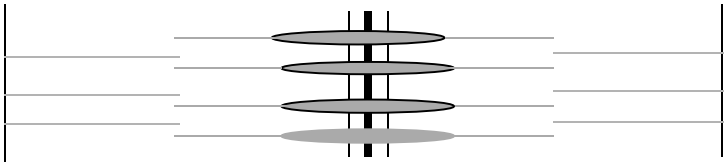
Current resting length is the length that muscles return to after contraction. It is often shorter than the best resting length, particularly in the weight bearing muscles of the lower extremities. This is a direct result of years of gradual shortening of the weight bearing muscles due to repetitive movement, e.g. walking, and a lack of proper stretches, which would have taken the muscles back to best resting length.

BEST RESTING LENGTH



Best resting length is 25% greater than maximum contracted length. This is where a muscle should return to after contraction

MAXIMUM ELONGATION PAST BEST RESTING LENGTH



Maximum elongation past best resting length is a fully stretched muscle. It is 60 – 70% longer than best resting length. The limit of the elongation is dictated by myosin and actin, which must retain an overlap.

Fig 4

Continued on page 26

'The Long and Short of Resisted Stretching' continued from page 10

HOW DOES RESISTED STRETCHING WORK?

As previously stated, there are two types of muscle fibre – extrafusal muscle fibres and intrafusal muscle fibres. The extrafusal fibres contain the myofibrils actin and myosin, which contract the muscle whilst the intrafusal fibres contain the proprioceptors that recognise that a muscle is stretched. The two main proprioceptors are the muscle spindles and the golgi tendon organs.

Muscle contraction can be either voluntary or involuntary. In skeletal muscle, involuntary contractions are initiated by the proprioceptors either to prevent injury or to maintain posture/balance.

There are three ways that involuntary contraction can take place in skeletal muscle:

- Stretch reflex
- Lengthening reaction
- Reciprocal inhibition

Stretch Reflex or Myotatic Reflex

When a muscle is stretched the muscle spindle triggers the stretch reflex (see Figure 5), an involuntary contraction of the stretched muscle, which prevents overstretching of the muscle. The more sudden the change in muscle length, the stronger the muscle contraction. As the stretch is held, the muscle spindle becomes accustomed to this new length and reduces the signal for the muscle to contract.

Lengthening Reaction or Inverse Myotatic Reflex

When muscles contract they produce tension at the musculotendinous junction. This is where the golgi tendon organs are situated. When the tension exceeds a certain threshold, it triggers a lengthening reaction (see Figure 6), which inhibits the muscles from contracting and causes them to relax. This helps protect the muscles, tendons and ligaments from injury.

Holding a stretch for a prolonged period of time will allow this lengthening reaction to occur, thus helping the stretched muscles to relax.

Reciprocal Inhibition

When a muscle contracts, generally the opposing (antagonist) muscle has to relax to allow the desired movement - reciprocal inhibition (see Figure 7). This can be used to the therapist's advantage when trying to release a tight muscle. Contracting the antagonist to the tight muscle will help to trigger the reciprocal inhibition reflex in the tight muscle, thus relaxing it.

How does resisted stretching use these involuntary contractions?

In any form of stretching we are triggering the involuntary contraction of muscles, i.e. stretch reflex, lengthening reaction or reciprocal inhibition. By using resisted stretching we can further the advantages that this gives us.

In a passive stretch:

- Muscle is stretched
- Muscle contracts due to stretch reflex
- Muscle relaxes as it adapts to this elongation and/or the lengthening reaction relaxes the muscle.

Note - in the same way as when a muscle contracts, some of the fibres contract fully (they cannot partially contract) and some remain at rest. Similarly, when a muscle is stretched, some fibres are elongated and some remain at rest. →

Continued on page 28

THE STRETCH REFLEX

There are two types of intrafusal muscle fibre - nuclear bag fibres and nuclear chain fibres. These two types of fibre are responsible for the two components of the stretch reflex, the dynamic component (nuclear bag fibres) and the static component (nuclear chain fibres).

The dynamic component of the stretch reflex lasts for only a few seconds. When the muscle is stretching, the nuclear bag fibres fire rapidly, but it quickly adapts. As soon as the muscle stops changing length, and holds a new position, these fibres adapt to the new length and stop firing.

The static component lasts for as long as the muscle is stretched. This ensures that the brain is still aware of the state of the muscle after the nuclear bag fibres have stopped firing. The nuclear chain fibres also respond when the muscle is stretching, but they maintains a firing rate after the muscle has stopped moving (essentially, they are non-adapting).

It is the firing of these two types of intrafusal muscle fibres that triggers the involuntary contraction of the muscle being stretched. This is called the stretch reflex or myotatic reflex.

Fig 5

LENGTHENING REACTION

The second set of proprioceptors, the Golgi tendon organs, is embedded in the tendon. The Golgi tendon organs begin to fire when the tension on the tendon is so great that there is danger of injury. This firing inhibits the contraction of the muscle via an inhibitory interneuron and the muscle relaxes. This is called the lengthening reaction or inverse myotatic reflex.

Fig 6

RECIPROCAL INHIBITION

When an agonist contracts, in order to cause the desired motion, it usually forces the antagonist to relax. This is called reciprocal inhibition.

Fig 7

'The Long and Short of Resisted Stretching' continued from page 26

When we add an isometric contraction to the stretch as in resisted stretching, not only do we get the gains of a passive stretch, but in addition:

- More fibres are recruited in the stretch on application of the isometric contraction.
- Fibres already in a stretched position (before the onset of the isometric contraction) are prevented from contracting by the lengthening reaction and stretch to a greater extent.
- Immediately after the isometric contraction, there is a brief period when the muscle is unable to respond to further excitation. Hence, in the absence of the stretch reflex, the muscle can be lengthened unhampered.

For the complete cycle see Figure 8.

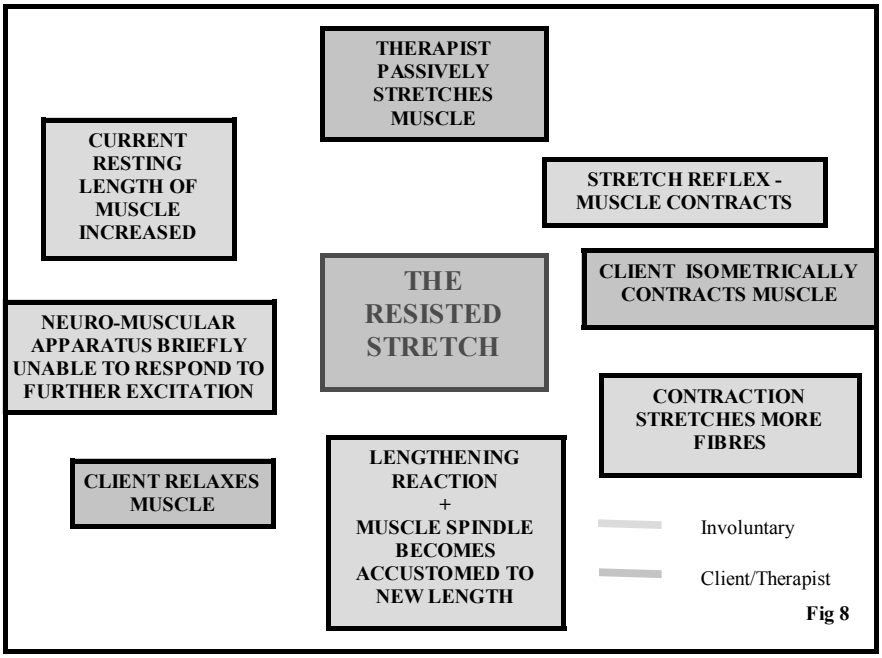


Fig 8

Continued on page 30

'The Long and Short of Resisted Stretching' continued from page 28

How to perform a resisted stretch

1. Take the muscle to the point where it meets resistance. Hold for 15-20 seconds, then bring back from that position slightly.
2. Client isometrically contracts muscle to approximately 20% of strength capabilities.
3. Hold the contraction for 5-10 seconds or longer, depending on the size of the muscle.
4. Client relaxes fully and the muscle is passively stretched to new position.
5. Hold stretch for 15-20 seconds in new position.
6. Repeat contractions and progressions until no further progress is made (usually 2-3 times).

At this point the muscle is at its Maximum Elongation Past Best Resting Length (see Figure 2).

If there is tension in a traumatised muscle, it may be too painful to contract. In this instance, the antagonist muscle can be used to provide the contraction and take advantage of **reciprocal inhibition** (see Figure 7).

BENEFITS OF RESISTED STRETCHING

- Quickly reduces muscle tension
- Increases current resting length
- Strengthens the tensed muscle
- Less painful than many other types of stretches
- By stretching the muscle, it is possible to engage a higher percentage of muscle fibres in a subsequent contraction
- When a muscle is relaxed it stores energy. The longer the muscle, the more energy is stored. However this energy is dissipated as heat if not used within a certain period of time

SOME DO'S AND DON'TS

Do

Isolate the muscle group

Ensure that the stretched muscle is fully relaxed

- The client cannot use the muscle being stretched, e.g. do not stretch a hamstring whilst standing. If a muscle group is involuntarily contracted, doing work and expending energy to maintain a position, the muscles cannot relax back to their resting length and therefore the stretch cannot begin.

Allow time for the muscle to adapt to the stretch.

Do Not

Put too much tension on the muscle.

- The stretch reflex will cause over contraction of the muscle and it will therefore take a long time for the tension to dissipate.

Use resisted stretches on children or adolescents.

- They tend to be very flexible already and there is a possibility of overstretching the muscle.

References:

Barany; Mechanism of Skeletal Muscle Contractions

Appleton; Stretching and Flexibility – Physiology of Stretching

Stark; The Stark Reality of Stretching

Jenkins, Kemnitz, Tortora; Anatomy and Physiology

Curtin School of Physiotherapy Educational Resources - Stretching

San Diego State University College of Sciences - Biology 590 - Human Physiology

NISMAT Exercise Physiology Corner: Muscle Physiology Primer

Ward, *et al; Foundations for Osteopathic Medicine* (2nd ed.). Eds **Williams and Wilkins**, Philadelphia: Lippincot

Marco Linari, Roberto Bottinelli, Maria Antonietta Pellegrino Massimo Reconditi, Carlo Reggiani and Vincenzo Lombardi; (2003) The mechanism of the force response to stretch in human skinned muscle fibres with different myosin isoforms; *J Physiol* 554, 335-352

Lewit & Simons; Myofascial pain: relief by post-isometric relaxation

www.ivy-rose.co.uk/Topics/Muscle_Cell

Sheena Livingstone DARM RMT DSM SMTO practises in Advanced Remedial Massage, Remedial and Sports Massage and Swedish Massage in West Linton, Peebleshire. She can be contacted on 01968 661282.