MET Variations: Possible Neurological Mechanisms

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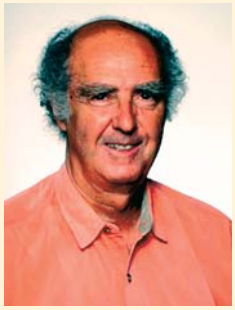

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The most basic application of Muscle Energy Technique (MET) involves the use of isometric contractions (Mitchell F Jr., Moran P S, Pruzzo N 1979, Magnusson et al. 1998) to assist in modification of muscle and joint behaviour. Variations on this basic theme involve the use of isotonic concentric, or eccentric, contractions (Schmidt 1999), or a series of rhythmically pulsating contractions [44], instead of, or as well as, basic isometric variations.

Definition of MET: Basic isometric MET involves a muscle, or group of muscles, being voluntarily contracted, in a specified direction, for a defined length of time (commonly 5 to 7 seconds), involving submaximal effort, with the contraction being matched by the practitioner/therapist's effort, so that no movement occurs. (Mitchell & Mitchell 1995, Mitchell 1976)

- MET has been shown to improve joint range of motion, including spinal joints [20, 26]
- MET has been shown to improve muscle extensibility more effectively than passive, static stretching – both in the short and long term. ([10, 12, 36)
- In addition studies offer support for the hypoalgesic effects of MET – for example in relation to spinal pain. [4, 6, 50]
- Myofascial trigger point deactivation has been shown to be enhanced by use of MET [7, 13, 48]

The question therefore arises as to what mechanisms may be involved in producing these benefits, of increased range of motion (ROM), greater extensibility, and reduced pain.

Note: Much of the research from which conclusions regarding MET efficacy and mechanisms are drawn, relates to studies involving proprioceptive neuromuscular facilitation (PNF) stretching. [47, 16]

PNF (and MET) stretching may involve one of 3 variations [16]:

- Contract-relax (CR), in which the muscle being stretched (the *agonist*) is contracted and then relaxed, before stretching
- Agonist contract-relax (ACR), in which contraction is of the *antagonist*, rather than the muscle to be stretched (the *agonist*). The confusing title of ACR should be ignored. The approach relies, it is suggested (see below), on reciprocal inhibition.
- Contract-relax agonist-contract (CRAC), involves a combination of the two methods (CR and ACR) listed above.

Proposed MET mechanisms

Kuchera & Kuchera [24] as well as Denslow et al. [9] have speculated on the neurological mechanisms that may follow use of MET (CR version).

- They hypothesise that the effects may result from the inhibitory Golgi tendon reflex, activated during the isometric contraction that leads to reflex relaxation of the muscle, as a result of post isometric relaxation (PIR).
- An alternative reflex effect has been suggested in which an isometric contraction of the antagonist(s) of affected muscle(s) induce relaxation via reciprocal inhibition (RI). (ACR version)

Some studies support the concept of neurological muscle inhibition, following MET isometric contraction. For example Moore & Kukulka [40] found that a strong brief depression of the soleus H-reflex occurred, for about 10 seconds, following sub-maximal isometric plantar flexion contractions, probably as a result of pre-synaptic inhibition.

However simultaneous monitoring of the tibialis anterior muscle's EMG activity revealed minimal

activity, consistent with rest, so excluding the possibility of reciprocal inhibition. [40]

Since many studies have demonstrated that active motor activity plays a minimal role in producing resistance to stretch [32, 35], the question remains as to whether low-level motor activity plays a role in limiting the passive stretch of a muscle.

Self-evidently, in order for it to be accepted that MET produces increased muscle length, by means of reflex muscle relaxation, low-level motor activity needs to be shown to play a role in limiting passive stretching of muscle, *and this has not been possible*. [16]

- Ballentyne et al. [2] suggest that the PIR theory is poorly supported by research. Citing EMG evidence they note that "*various studies have shown that passive stretch does not influence the electrical activity of the hamstring muscle* [22, 30] *demonstrating that low level muscle contraction does not limit muscle flexibility, disputing the proposal of [such] a neurological mechanism.[i.e. PIR]*"
- Lederman [25] states that the PIR model ignores the complex and dominant influence of the central nervous system.
- Fryer [14] points to the lack of evidence supporting muscle contraction as a factor in restricted joint ROM, or in spinal dysfunction.
- Magnusson et al. [32] found that low-level EMG activity was unchanged following isometric contractions, or passive stretching.
- Magnusson [34] has demonstrated that increases in muscle length, following 90 seconds of passive stretching, occurs without any change to the low-level EMG activity of that muscle
- More recently Fryer [16] has speculated that although the exact mechanism by which increased muscle extensibility occurs, remains unclear, it probably involves both neuro-physiological and mechanical factors, possibly including viscoelastic and plastic changes in the connective tissue elements of the muscle. In fact Fryer maintains that although MET techniques produce greater ROM changes than static stretching, they also produce greater EMG activity in the muscle undergoing the stretch.
- Regarding PIR and RI Fryer [16] states that: "*Although it is accepted that these reflex pathways exist, their role in post-isometric relaxation has not been established.*"

Alternative explanations

So if PIR and RI are not the neurophysiological mechanisms that lead to the effectiveness of MET, in increasing joint ROM, or extensibility of soft tissues, and analgesia, what does produce these results ? The phrase *'increased tolerance to stretch'* has emerged to describe *what* happens, although it does not explain *how* it happens.

- At its simplest this explanation observes that if, after an isometric contraction, the same degree of effort is used, as was employed to take the muscle or joint to its end of range, before the contraction, no increase in range or extensibility occurs.
- Magnusson et al. [33, 35] measured the degree of applied effort used during passive knee extension, before and after the hamstrings were stretched to the point of pain. They found that both ROM and passive torque were increased following the contraction – *because subjects were able to tolerate a stronger stretch*.
- Ballantyne et al. [2] confirmed these findings by showing that when the degree of post-test force applied to the muscle remained constant (i.e. the same as used in pre-testing), *no change in length took place*, suggesting that a single application of MET *created a change in tolerance to stretch*.
- Fryer [16] explains: "*The application of MET would appear to decrease an individual's perception of muscle pain, and is greater than that which occurs with passive stretching. Stretching and isometric contraction stimulate muscle and joint mechanoreceptors and proprioceptors, and it is possible that this may attenuate the sensation of pain. … MET and stretching appear to produce lasting changes in stretch tolerance, and so the mechanism is likely to be more complex than just gating at the spinal cord, and may also involve changes in the higher centres of the CNS.*"
- Hamilton et al. [23] suggest that techniques – such as MET – that stimulate joint proprioceptors, via the production of joint movement, or the stretching of a joint capsule, may be capable of reducing pain by inhibiting the smaller diameter nociceptive neuronal input at the spinal cord level.

What else might produce MET's analgesic effects?

Brodin [4], Cassidy et al. (1992b) and Wilson et al. [50] have all reported that there is a reduction in spinal pain, following application of MET. These reports therefore support the evidence described above, of an *increased tolerance to stretch*, of muscles treated by MET.

- Degenhardt et al. [8] report that concentrations of several circulatory pain biomarkers (including endocannabinoids and endorphins) were altered following osteopathic manipulative treatment incorporating muscle energy, and other soft tissue techniques. The degree and duration of these changes were greater in subjects with chronic LBP than in control subjects.
- McPartland [31] and others [1, 43] note that the endocannabinoid (eCB) system, like the better-known endorphin system, consists of cell membrane receptors, endogenous ligands and ligand metabolizing enzymes. Two cannabinoid receptors are known: CB1 is principally located in the nervous system, whereas CB2 is primarily associated with the immune system. Two eCB ligands, *anandamide* (AEA) and 2-

arachidonoylglycerol (2-AG), are mimicked by cannabis plant compounds. McPartland reports that: *"AEA and 2-AG are not stored in vesicles like classic neurotransmitters. Rather they are synthesized "on demand" from precursor phospholipids in the neuron cell membrane and immediately released into the neural synapse.* [43] *The eCB system dampens nociception and pain, and decreases inflammation in myofascial tissues.*

- Agarwal et al. [1] suggest that cannabinoids mediate analgesia largely via peripheral type 1 cannabinoid receptors (CB1), in nociceptors

Neurologically mediated analgesia

Fryer & Fossum C (2008) have hypothesized a neurological explanation for the analgesic effects of MET.

- A sequence is suggested in which activation of muscle mechano-receptors and joint mechano-receptors occur, during an isometric contraction.
- This leads to sympatho-excitation evoked by somatic efferent's and localized activation of the periaqueductal grey that plays a role in descending modulation of pain.
- Nociceptive inhibition then occurs at the dorsal horn of the spinal cord, as simultaneous gating takes place of nociceptive impulses in the dorsal horn, due to mechano-receptor stimulation.

Alternative to standard isometric contraction versions of MET

- An isotonic eccentric stretch is one in which the practitioner overcomes the effort of the contracting muscle, stretching and simultaneously toning it [28, 41, Kolar 1999].
- A concentric isotonic contraction tones the muscle that is active
- Ruddy [44] suggested that the effects of what he termed *rapid resisted duction* (i.e. pulsed iso-

MET choices and variables that might involve features that modify underlying mechanisms

- *Should the isometric (or isotonic) contraction commence at the resistance barrier, or short of it?* Janda (1978), Lewit (1999) suggest acute problems require commencing at the restriction barrier, while chronic problems require commencing just short of the barrier.
- *How much effort should the patient use: 20 % of strength, or more, or less?* PNF methodology sometimes involves full strength contractions, while MET usually involves less than 30 % of available strength [11, 27, 28].
- *For how long a time should the isometric effort be held: 7–10 seconds, or more, or less? 5* seconds is is suggested as an optimal period for an isometric contraction [10, 15, 36, 45].
- *How many times should an isometric contraction (or its variant) be repeated?* Carter [5] indicates 3 repetitions; Osternig [42] and Ballentyne et al. [2], found 2 repetitions produced optimal extensibility and ROM gains.
- *Instead of a single maintained contraction, can a series of rapid, low amplitude (pulsing) contractions be used?* Ruddy [44] suggested *rapid rhythmic (pulsed)* isometric alternative to sustained contractions.
- *In what direction should the contraction effort be made – towards the resistance barrier, or away from it (direct or indirect – involving use of antagonist or agonist)?* Local conditions, and patient sensitivity might suggest an alternative to contraction of the agonist, involving an effort away from the restriction barrier; Ruddy's [44] method suggests contractions towards the restriction barrier (i.e. contracting the antagonist(s)).
- *What source of resistance should be offered to the patient's effort – for example by the practitioner/therapist, by gravity, by the patient, or by an immovable object?* All variations are suitable, depending on circumstances.
- *Should the patient's effort be matched, overcome or not quite matched (isometric, isotonic eccentric/isolytic, isotonic concentric)?* A clinical choice to use an isometric contraction relates to a need to subsequently stretch the tissues, whereas isotonic variations relate to an additional need to tone (isotonic concentric), or to simultaneously stretch and tone (isotonic eccentric) [28, 29].
- *Should a held breath (respiratory synkinesis) be used to enhance the effects of the contraction?* Lewit [27], Janda [19], advocate inhalation and a held breath, during the contraction, and movement to – or through – the restriction barrier, on exhalation, as optimal synchronisation of respiration to assist with MET use.
- *Should specific eye movements (visual synkinesis) be used to enhance the effects of the contraction?* Lewit [27] has noted that direction of gaze *away* from a restriction barrier, enhances a contraction, and *towards* the direction of stretch, enhances ease of application, when attempting to increase range of motion.
- *Should the muscle or joint be taken to its new barrier, following the contraction, or beyond the initial barrier?* Lewit [27], Liebenson [28] advocate movement to a new barrier, after contraction, in acute conditions; and beyond the barrier, to induce stretch, in chronic conditions.
- *Subsequent (to a contraction) should a stretch be totally passive, or should the patient actively participate in the movement?* Clinical experience suggests patient assistance in movement to a new, or through an old barrier, post-contraction, facilitates the process. [19, 27], 28, 29]
- *What is the ideal length of time to hold a subsequent (to MET) stretch?* Greenman [18], Feland et al. [10], Smith & Fryer [46], have demonstrated that 5 seconds is a sufficient time to obtain an optimal gain. In extensibility or ROM.
- *What is the ideal frequency of application of MET?* Wallin et al. [49] demonstrated an advantage in maintaining increased hamstring extensibility when MET/PNF style methods were applied once weekly, while further gains were achieved when applied 3 times weekly. Klein et al. [21] suggested twice weekly applications were optimal.
- *Should MET be used alone, or in a sequence with other modalities, for example positional release methods such as strain/counterstrain, or ischaemic compression/inhibitory pressure techniques?* There is evidence of value in combining MET with other modalities, for example in treatment of trigger points [7, 13].

metric contractions) include improved local oxygenation, enhanced venous and lymphatic circulation, as well as a improved static and kinetic posture, due to the effects on proprioceptive and interoceptive afferent pathways
- These variations, along with their particular influences, appear to produce identical benefits in terms of increased ROM and extensibility of soft tissues as described in relation to basic MET methodology.

Conclusion

- MET appears to increase range of motion of joints and extensibility of muscle by means of an as yet unidentified mechanism, expressed as *'increased tolerance to stretch'*.
- Previously assumed mechanisms, including Post Isometric Relaxation and Reciprocal Inhibition do not appear to be major contributors to the benefits deriving from use of MET.
- MET leads to marked analgesic effects
- A number of pain related biomarkers have been identified that may explain the analgesic influence of MET, including the increased tolerance to stretch

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