The Science Behind MAT™

Source: http://www.muscleactivation.com/science.html

By: Greg Roskopf, MA

Muscle Activation Techniques (MAT) is a system designed to evaluate and treat muscular imbalances, I will expand on the process of evaluation in response and the use of isometrics at this point, and will move to substantiate other issues relating to these concepts later in this format.

MAT has taken basic components of physiology and biomechanics and transferred them into a systematic approach for evaluating and treating the biomechanical relationships relating to chronic pain or injury. The evaluation and treatment procedures developed by MAT are substantiated and validated by many components relating to muscle physiology.

The program is based upon the monitoring and restoring the capability of muscles to contract. When looking at the physiology of a muscle contraction, as the muscle (extrafusal fibers) is placed under a stretch, the muscle spindle (intrafusal fibers) sense tension as they are also placed under a stretch. The sensory receptors that encompass the intrafusal fibers send information back to the CNS, stimulating the alpha motor neurons, which in turn, sends feedback back to the muscle telling it to contract in order to resist the tension. This is a normal response to a muscle when placed on a stretch.

In comparison, if the extrafusal fibers of a muscle shorten due to contraction, the muscle spindle or intrafusal fiber would also shorten and be placed on a slack. This in turn would make the muscle incapable of regulating the load being placed on the muscle. An adaptation by the CNS, allows for increased gamma motor neuron stimulation resulting in increased feedback to the intrafusal fibers. The intrafusal fibers resist the shortening, increasing the stimulation of the alpha motor neurons, again creating the feedback loop which allows the muscle to accommodate the load. This is the normal spindle response when a muscle is contracting.

If a muscle has been traumatized, due to factors such as trauma or overuse, the sensitivity of the spindle will be lessened and the muscle will become less capable of regulating tension relative to a stretch or a load. The result is a reduction in the gamma motor neuron stimulation allowing the muscle spindle to shorten as the extrafusal fibers contract. The more that the muscle shortens, the greater slack and less responsive is the muscle spindle. This results in decreased proprioceptive input into the muscle as it moves into this position. The actin and myosin crossbridging excessively overlap, creating inefficiency in the muscles' capability to contract as it moves into the shortened range. Also, relative to biomechanics, the muscle has its greatest mechanical advantage when a 90 degree force angle is created. This results in a decreased force output from the muscle as the force angle moves away from 90 degrees. Therefore, both neurologically and biomechanically, when a muscle has been traumatized, and has altered feedback from the nervous system, there is a reduced capability for the muscle to contract as it moves into the shortened position. This information has become the foundation to both the evaluation and treatment processes related to MAT.

There are many resources that can validate these issues and can be forwarded on request. Relative to the evaluation process, the goal is to determine whether or not specific muscles that support a joint have the proper neurological input necessary to perform its function. Whether acting as a prime mover, synergist or stabilizer, each muscle must be capable of performing its function as forces are being placed upon a joint. If a muscle does not have proper neurological input, then it will not be able to perform its function efficiently and this leads to positions of vulnerability. The goal of the MAT evaluation process is to find out

where the body displays these positions of vulnerability or weakness.

To evaluate for positions of weakness, the MAT evaluation consists of a 2-step checks and balances procedure:

The 1st step in the MAT evaluation is a joint specific ROM exam. This evaluation of ROM is designed to identify for limitations in motion along with the identification of asymmetrical motion. The philosophy behind the MAT ROM exam is that when muscle tightness is noted, it is a representation of muscle weakness as opposed to muscle tightness. Rather than looking at the cause of ROM limitations being caused by muscle tightness, the limitation in motion is addressed as a weakness in the muscle or group of muscles that move the joint into the position of restriction. This philosophy works off of the concepts related to the *Law of Reciprocal Inhibition*. This law states that when a muscle contracts, it sends an inhibition response to the antagonist muscle in order to allow for normal joint motion. This law is true, based upon the assumption that normal neurological input is being sent to the contracting muscles. Therefore, if proper neurological input is **not** being sent to the contracting muscle or group of muscles, which could be caused by a variety of potential factors, then the impulses that would inhibit contraction of the antagonist muscles will also be affected. This allows for the muscle spindle of the antagonist muscle to become more active, which in turn becomes more tonic. This increase in tonicity of the muscle results in muscle tightness.

Therefore, the philosophy of MAT is substantiated by this concept: If a contracting muscle does not have proper feedback from the nervous system, then the opposing muscle will become hyperactive and its resting length will be altered. The goal with MAT is to provide proper balance between the agonist and antagonist muscle, in order to not only enable adequate motion, but to also allow for adequate strength and stability throughout that ROM. When a muscle has had altered feedback from the nervous system, its capability to contract efficiently becomes altered, therefore, mobility and stability are both negatively affected.

MAT conceptual thought process.

To properly understand MAT, you must consider many factors. If the proprioceptive input to a muscle has been altered, then the tension of the opposing muscle has also been altered. If you increase ROM in the tight muscle, through stretching or massage, have you improved the capability of the opposite muscle to contract? Also, how do you know?

MAT is about creating a checks and balances system. A systematic approach designed to allow practitioners to check their work. This is why the joint ROM exam is so vital. If you see a limitation in joint motion, then you must consider 2 factors: What muscle or group of muscles is tight, along with, what muscles are not able to function properly that may have caused the antagonist muscles to tighten up? This goes back to the physiological foundation that states that an inhibited muscle has the least amount of proprioception as it moves into the shortened position. This can make a muscle very inefficient as it moves into the shortened range. Therefore the consideration is that, since the muscle is so inefficient in this position, why would the body let the joint move into this unstable position? Is the tightness a form of protection by the body, not allowing the joint into the position of instability? That is what the MAT evaluation and treatment is based upon. The joint ROM exam provides information to let the practitioner know what motions the body is protecting itself from. The goal of MAT is to identify these areas of protection and attempt, not only to improve mobility, but also to improve the stability through the new found motion. The consideration is that if we increase motion in the tight muscle, through any form of modality, how do we know if we have violated part of the body's protective mechanism? We must know that when we increase ROM through modalities such as stretching or massage, that there is also stability

through that increased range. MAT provides the checks and balances system to make sure that this happens. This is why MAT works as a great adjunct to all forms of therapies.

The 2nd step in the MAT evaluation is a follow up to the ROM exam. The ROM exam is designed to evaluate joint motion in all positions of extremes in order to determine where the body cannot achieve its motion. The information from the ROM exam gives the practitioner an idea of what muscle or group of muscles may not be functioning at optimal levels. Once a limitation of ROM is identified, then the particular muscles that move the joint into that position must be evaluated in order to determine if there is proper neurological input. It involves the evaluation of strength of the muscles in their shortened range. The tests are performed as isolated muscle strength tests, however, with the MAT approach; the concept behind conventional isolated strength testing has been altered. MAT is looking to identify positions of instability. Based upon what has been addressed, these positions of instability will display themselves in the shortened position of a particular muscle. Therefore, the isolated strength tests are performed in the shortened position of each muscle. This shortened position is also a “position of extreme”. To my knowledge, evaluations of strength are not typically performed in extremes of ROM. It is important to note that by moving into the shortened position, there is more of a chance that the shortened muscle is being emphasized. Although there are other muscles that may work synergistically with the identified muscle, a weakness in a particular test demonstrates that the muscle that emphasizes the motion is inhibited.

MAT strength tests are not designed to evaluate directly for levels of strength. It is a neuro-proprioceptive response test designed to evaluate whether there is proper neural input to the muscle of group of muscles which provide stability in the extreme of motion. It is not a true “strength” test, since it is an evaluation of whether or not a muscle can contract when a force is applied, as opposed to an evaluation of how strong the muscle is. Conventional muscle strength testing is usually based upon the foundation of “break testing”. With break testing, the practitioner typically continues to ramp the load being applied to the muscle until the muscle can no longer withstand the force. Studies have shown that in break testing the force applied can exceed 75 lbs of force. With neuro-proprioceptive response testing, the practitioner is trained in precision so that at no time should the force applied surpass 30 lbs of force. It is a form of evaluation designed to see: “can a muscle contract, and can it contract now” rather than determining the strength of the muscle. Timing plays a key role in neuro-proprioceptive response testing. It provides an indication of whether a muscle has proper neural input to adapt to forces applied in every day function.

It is recognized that there is much controversy regarding the validity of isolated muscle strength testing, however, with the combination of changes in the form of testing combined with an intense 10 month training program, MAT is attempting to minimize the inconsistencies that have been demonstrated through isolated strength testing over the years. Although subjective, the skill still comes into the hands of the practitioner. In the evolution of MAT, we have used a FET system (a hand held device which measures force application) to be able to analyze the forces being applied by the practitioner. The testing showed a consistency in pressures regardless of whether the muscle demonstrated proper or improper input. This testing confirms that it is a measurement of proprioception rather than muscle strength. In many forms of therapy there is a subjective component to the evaluation and treatment. These include: physical therapy, chiropractic, massage therapy, acupuncture and various forms of strength and functional training protocols to say the least.

With MAT, the goal is to minimize the inconsistencies that come with the subjective aspect, but to also provide another aspect of evaluation to confirm the results. Since the ROM exam is an indicator of muscle weakness, then the strength tests only act as a confirmation of muscle imbalances. Following correction of

the muscle inhibition/weakness, the inhibition response is sent to the antagonist muscle allowing that muscle to relax. This in turn increases ROM in the tight muscle. Thus, ROM becomes the primary feedback tool. The representations of improved strength capabilities reaffirm this twofold response: that the increase in mobility will directly correlate with the increased capability of the muscle to contract.

As far as the MAT treatment goes, there are 2 forms of treatment that can improve the neurological connection to the muscle; they include corrective isometrics, and precision manual therapy techniques. The manual therapy techniques are only addressed in the 10 month internship since it takes a great degree of hands on skills in order to be effective in that form of treatment. As for the corrective isometrics, these can be implemented by any practitioner working in the health or rehabilitation fields. The corrective isometric procedures are based upon a principle used in neuro-rehabilitation. The principle is called gamma biasing. As noted in the evaluation information, an inhibited muscle has the least amount of proprioceptive input in a shortened position. In this position, the spindle is under slack. The spindle sends feedback back to the brain based on stretch a stretch that creates tension. This tension is least recognized in the shortened position of a muscle. Through the principles relating to gamma biasing, the goal is to increase gamma motor neuron input to the intrafusal fibers in order to increase the capability of the muscle to withstand a load as it moves into the shortened position. By performing low intensity, isometric contractions with the muscle in its shortened range, there will there is less spindle stretch lag and unloading affects which make the muscle more responsive to resistance. This allows for an increase input from the CNS, which in turn, results in an increase in muscle strength. It is important to note that when performing concentric contractions alone, there may be a resultant unloading of the muscle spindle and decreased facilitation from the stretch reflexes as the muscle moves into the shortened range, therefore, concentric contractions are ineffective and even detrimental when attempting to improve proprioceptive input to an inhibited muscle.

In the MAT treatment protocol, the goal is to “jump-start” the muscle that demonstrates weakness. Once a position of weakness has been identified, corrective isometrics are performed with that muscle in its shortened position. 6 sets of 6, low load, isometric contractions are performed, having the client contract further into the shortened position against resistance. With each contraction, there will be a correlating increase in ROM further into the shortened range. Once activated through corrective isometrics, the client can then proceed with concentric and weight-bearing exercises in order to reinforce the strength of the muscle and integrate it into functional movement patterns.

To substantiate this process, at the MAT clinic in Denver, we have performed case studies using the two variables of treatment: The ROM exam and the correlating isolated muscle strength tests, to determine if using the MAT techniques for evaluation and treatment actually had a carryover in “functional” movement. With the ROM exam being the indicator of muscle weakness, we took 15 clients with a mean average of 27 degrees of motion internal rotation of the femur at the hip (hip flexed to 90 degrees). 11 of the 15 clients demonstrated a weakness of the TFL through isolated strength testing. The TFL was used as the primary muscle involved in this position due to its anatomical function of hip flexion abduction and internal rotation. Following treatment of the TFL, all 11 clients demonstrated a positive test on relative to TFL strength. Along with the demonstrable strength improvement, there was an immediate mean increase in ROM of 13 degrees in the 11 clients that were treated for TFL weakness. Through the combined evaluative protocols, the results demonstrate an improvement in both mobility and stability in the position of internal rotation of the femur with the hip flexed to 90 degrees.

With the MAT system, since the evaluation and treatment procedures are analyzing stresses on isolated muscles in the open chain, there has been much controversy in regards to whether there can be a carry

over into functional or weight-bearing activities. As a follow up to this study, we also evaluated these clients on a Tekscan force distribution system, designed to analyze how forces are being distributed during gait and function. In the 11 clients treated for weakness of the TFL, all 11 demonstrated an improvement in how the forces were being distributed through the feet in the performance of a 1-legged squat. This confirmed that through improving the function of an isolated muscle, there will be a direct carryover into how the forces are being distributed in weight-bearing activities.