Multi-Modal, Device-Assisted-Soft-Tissue-Mobilization in Physical Rehabilitation

A White Paper on the Therapeutic Applications of G5® Devices and Vibrotactile, Soft-Tissue Therapies

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INTRODUCTION

The following is an introduction to the therapeutic application of electro mechanical, device-assisted-soft-tissue-mobilization and vibrotactile therapies in physical rehabilitation. Specifically, this will serve to introduce the reader to the unique characteristics of the G5® device line as well as some of the various anatomical and physiologic aspects to this form of therapy.

DESCRIPTION OF THE G5® DEVICES

G5® has been manufacturing electro-mechanical massage and percussion devices for more than 50 years. The company's catalog offers a range of devices that offer variations on the distinctive, patented, core functionality of the foundational, prototypical, G5® device. Several core features serve to differentiate G5® devices from other such devices on the market (see Table 1.1).

DISTINCTIVE FUNCTIONAL FEATURES OF G5® THERAPEUTIC DEVICES

- Unique, patented, directional stroking action allowing the therapist to affect superficial and deep tissue.
- Robust, reliable motor designed for continuous daily use.
- Powerful motor and drive action prevents device action from being arrested by dense tissue.
- Transverse (tissue glide/friction) and Perpendicular (Percussion) plane action.
- Quiet motor action even at maximal capacity.

Table 1.1 – Unique features of G5 devices.

The first (and arguably most distinctive) feature of the G5® devices is the patented, directional stroking action of the devices' therapeutic interface. The therapeutic interface is mounted on a specially designed platform that allows for a unique degree of excursion along a plane that is parallel to the surface of the patient's body. This action was originally designed to mimic the action of a massage therapist's hands as it glides over tissue. This said, the manner in which this action is coupled with a powerful motor, affords the G5® devices a unique effect level – the ability to deliver varying rate cycles of transverse friction to the treatment target at rates not possible by hand. This not only achieves a very appealing degree of comfort for the patient but also affords the therapist the ability to affect soft tissue in a very useful way. This latter effect makes the G5® devices amenable and complimentary to a range of manual therapies (incl. myofascial release, scar manipulation, assisted muscle and tissue lengthening, sensorimotor therapy and massage.)

Fig 1.1 (Above) The TherAssist® - an example of a popular therapy device in the G5® range.

Each G5® device is driven by a powerful and reliable motor that is designed and intended for constant daily use. The devices are built for high-volume, therapy environments. Unlike most other massage-therapy-type devices on the market, G5® devices cannot be arrested at the treatment end by even the densest tissue (e.g. a heavily muscled athlete). That is, even when one buries the treatment head deeply into the patient's tissue, the motor and treatment head configuration is powerful enough to overcome the resistance, continuing to cycle. This makes the G5® line ideal for deep-tissue massage and therapeutic applications wherein the therapist routinely addresses deep, dense, soft tissue structures. Despite the exceptional power delivered by the G5® motors, most therapists that are introduced to the devices for the first time are surprised to note that they can conduct a normal conversation while standing directly next to the G5® machine that is operating at maximal output – the machines run exceptionally quietly. This allows for multiple devices to be used simultaneously as one might find in a multi-treatment-bay, multiple practitioner, busy therapy environment.

Fig 1.2 (Above) Some of G5®'s Modified Therapy Surface Applicators

A final series of features unique to the G5® line, relate to the ability of these devices to be rapidly and easily modified within seconds through the attachment of specially designed (and patented) treatment head applicators in order to deliver a variety of multi-modal, treatment effects. While the primary, robust, transverse friction has already been described, this is not the only action available. Through specially designed fittings that can be set in place within a few seconds, the therapist is able to deliver a considerable percussive force via the percussion fitting. If a therapist wishes to address trigger points, a unique trigger point fitting affords the user a comfortable and easy way to address these in a manner not possible with the hand. Other fittings allow for other clinical actions, including, the facilitation of rapid cream/gel absorption, various massage effects and superficial and deep soft tissue mobilization.

G5® electro-mechanical, multi-modal, soft-tissue mobilization, massage and percussion modalities have been used by therapists to compliment and in some instances, replace, their "hands on" techniques. This affords the therapist a range of benefits, including but not limited to enhanced therapeutic effectiveness, reduction in physical effort, especially when performing deep massage or percussion routines and consequent savings in time.

What follows is a description of the scientific theories and research behind some of the treatment applications of the G5® electro-mechanical-soft-tissue-mobilization devices.

BRIEF HISTORY OF VIBRATION, RHYTHM AND PERCUSSION IN REHABILITATION

The history of rhythmic therapies, vibrotactile stimulation and therapeutic percussion in healthcare is not a short one. In fact, Wernham, widely credited with introducing osteopathic medicine to England, stated that rhythm has been part of Osteopathic medicine since its inception (Wernham, 2003). References to manual techniques can be dated far further back than that. Excavation of the Ma Wang Dui tomb (dated 168 BC) in the Hunan Province, China revealed, among other medical scripts, references to specific massage techniques such as compression (an), gliding (mo), rubbing (fu) and percussing (ji) (incidentally all achievable with a G5® device). While the use of machine-assisted massage and percussion methods is relatively newer, this type of application is enjoying rising popularity in a variety of rehabilitative fields including, physical therapy, massage, chiropractic and even sports training.

The G5® company itself has been building devices designed for massage for over 50 years. The company's founder, Henri Cuinier, was a French engineer formerly with the Renault. Cuinier invented, patented and began manufacturing the first G5® Massage Devices in Marmande, France in 1957. In recent times, G5® has enjoyed the greatest surge in the popularity of their devices among manual therapists who deal in soft tissue rehabilitation techniques. As a new wave of manual and instrument-assisted soft tissue techniques has emerged over the past 20 years, therapists have sought out devices to improve productivity and effectiveness while sparing their hands (see discussion below on common, occupational hand complaints in manual therapists.)

SOFT TISSUE THERAPIES (MYOFASCIAL AND INSTRUMENT ASSISTED SOFT TISSUE MOBILIZATION)

Soft-tissue injuries might involve damage to the muscles, ligaments, tendons or fascia/myofascia. Such injuries can occur via overuse (repetitive injury) or misuse (e.g. under-conditioning or traumatic injury of specific tissues). The use of instrument-assisted soft-tissue mobilization (IASTM) to treat such injuries has been on the rise over the past two decades among manual therapy health care practitioners in rehabilitation (e.g. physical therapists, chiropractors, massage therapists and trainers.) This is mainly due to the fact that current manual and instrument-assisted soft tissue mobilization methods are proving to be superior to traditional therapies in many ways in the treatment of many soft tissue conditions. For example, Yadav and Lakshmiprabha (2012) demonstrated the superiority of myofascial release approaches in the treatment of plantar fasciitis vs. therapeutic ultrasound.

While there are a number of techniques and a number of proprietary instruments associated with these methods, the fundamentals of this form of treatment are the same. Basically, the typical treatment involves the identification of compromised tissues followed by the application of vigorous friction to the target tissue using an implement that typically resembles a bladed edge of some kind.

The medical literature has produced an impressive and growing body of research that supports the application of instrument-assisted methods in the treatment of chronic ankle instability (Schaefer & Sandrey, 2012), Achilles tendinopathy (Papa, 2012; Miners & Bougle, 2012), and Plantar Fasciitis (Holtz et al, 2012), to name a few. Instrument-assisted, cross fiber techniques have also been demonstrated to accelerate ligament healing (Loghmani & Warden, 2009; Loghmani et al, 2007).

One of the proposed physiologic mechanisms behind the positive soft tissue changes that occurs in response to the application of IASTM is that the tissue disruption caused by a high friction device causes fibroblastic proliferation to the target tissue, which results in positive tissue regeneration and subsequent recovery of tissues such as ligaments (Gehlsen et al, 1999; Davidson et al, 1997). In simpler terms, this occurs when during the application of IASTM, abnormal densities in tissue, such as scar tissue are broken up, which reinitiates the healing process. This begins with the delivery of blood to the target area, essentially bringing healing substances, many of which are stored in white blood cells, to the micro-injury site (the site of tissue disruption caused by treatment). This begins the process of repair by the laying down of new collagen tissue. This can be an immensely valuable effect in chronic soft tissue injuries where the healing process typically stagnates, leading to less compliant, persistent, nagging, painful tissue. Any seasoned runner, triathlete or high-level athlete would instantly recognize that description of symptoms.

IASTM (instrument assisted soft tissue mobilization) is enhanced in a number of ways through the use of G5® devices. Firstly, while most IASTM approaches require significant energy expenditure and dexterity on the part of the therapist, G5's electro-mechanical devices require little to no effort as the therapeutic friction is generated by the motor and device applicator. Secondly, being that all G5® devices are driven by motors that can achieve a higher cycling rate than the human hand, these achieve a vastly superior degree of friction at the contact site, which leads to more rapid tissue disruption, enabling the therapist to achieve the therapeutic effect in a drastically shorter amount of time. Furthermore, the therapist is able to cover a greater surface area in a single session than would be possible with manual methods.

The third benefit is that simply put, machines do not fatigue. This means that the treatment experience is more consistent for patient and therapist, no matter how high the volume of patients the therapist might be serving in a day.

Finally, many patients report that the high rate of friction delivered by the G5 devices is actually more comfortable and less painful than typical IASTM applications. Remember that in order to reinitiate first-stage healing via IASTM, the practitioner is essentially creating a "micro" re-injury of the soft tissue, which may cause discomfort during the procedure and bruising afterward. Some may experience soreness for a day or two following treatment. It is not difficult to imagine how with drastically shortened treatment application times, how the patient experience is markedly enhanced. Furthermore, by activating the body's own pain-gating mechanism via a higher rate of friction, each session is significantly less painful (*see* discussion on the neurology of vibrotactile therapy below.)

Overall, the G5® devices are ideal for soft tissue mobilization techniques. In recognition of this superiority in certain capacities, a number of practitioners consider the use of G5 devices as an entirely unique type of modality, distinct from current IASTM methods: Mechanical-Device-Assisted-Soft-Tissue-Mobilization.

While soft tissue conditions are ubiquitous in sports, occupational and common injuries and while the benefits of new, more effective methods of addressing soft tissue injury are valuable in orthopedic rehabilitation, the benefits of vibrotactile therapies do not appear to be limited to the soft tissues of the body.

THE NEUROLOGY OF VIBROTACTILE STIMULATION

The joints, tendons, muscles and soft tissues of the body are richly innervated with receptors that are vital for proprioception (sense of movement and position in space), dynamic joint stability and the generation of movement. Current research strongly supports the idea that soft tissue injuries lead to changes in the nervous systems control of the body.

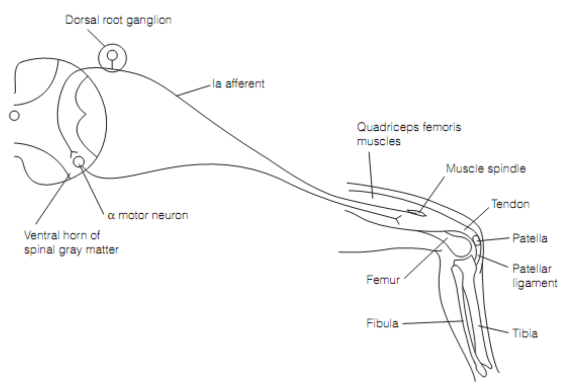

Fig 1.3 (Above) The basic muscle reflex loop demonstrating the mechanism whereby stretch of muscle and tendon is conveyed via peripheral nerves to the spinal cord to facilitate active tension of the stretched muscle. This mechanism is vital for joint stability. This is the same initial pathway that conveys proprioceptive information to the higher centers of the brain, leading to a perception of body position and direction of movement.

It is now a widely accepted principle in neurologic rehabilitation that stimulation of the nervous system and brain by sensory stimuli will lead to changes in brain connectivity and function. Simply put, the brain is capable of healing injured connections and forming new ones when stimulated via the senses. While there are a number of sensory pathways by which to access the brain (e.g. vision, hearing, touch, taste etc), the medical literature supports the idea that significant changes in nervous system function that can be brought about via the application of vibratory stimuli (Mileva, 2009).

Katusic & Mejaski-Bosnjak (2011) demonstrated that vibrotactile stimulation had a robust effect on spasticity and motor performance in children with cerebral injury. This study demonstrated significant improvements in motor performance, facilitation of rotation, postural trunk stability, head control and selectivity of movement. Muller et al (2002), revealed impressive effects of therapeutic vibration in improving pathologic cognitive processes after Traumatic Brain Injury (TBI) via muscle vibration. In demonstrating how vibratory stimuli applied to one region of the body can have an effect on other regions via the central nervous system, Han & Lennerstrand (1999) demonstrated changes in oculomotor control and eye position in strabismic (abnormal eye deviation) patients following neck muscle vibration.

While the aforementioned studies demonstrate central nervous system effects, other studies have demonstrated peripheral nerve changes. For example, one study demonstrated significant reductions in pain and improvements in sensation in patients with diabetic neuropathy, affecting the feet (Hong, 2011). The issue of pain reduction is an important one to every healthcare practitioner dealing with musculoskeletal complaints.

MECHANISMS OF PAIN REDUCTION ASSOCIATED WITH VIBROTACTILE THERAPIES

The gate control theory of pain revolutionized medical understanding of pain when it was introduced in 1965 by Melzack & Wall. In simple terms, the theory described how the activation of large nerve fibers, the kind that convey signals generated from muscle spindles and receptors that are activated by vibration, block the transmission of pain to the brain at the level of the spinal cord (Kumar & Rizvi, 2014; Moayedi & Davis, 2013). Subsequently, the theory has been supported by other studies that have demonstrated this effect in greater detail (De Koninck & Henry, 1990).

While these studies have demonstrated the "pain gating effect" at the spinal cord, other studies have demonstrated pathways by which modalities such as vibratory stimuli can actually "drown out" painful stimuli at the level of the Thalamus and Cortex of the Brain (Kakigi & Shibasaki, 1992). It has taken a long time for these theories to reach clinical practice in a meaningful way but this is changing. Neuromodulation is a rapidly growing field that has primarily focused on the use of large diameter pathways (the type through which vibratory signal travel) to reduce pain (Luan et al, 2014).

While many of the prevailing theories related to pain describe the nervous systems response to the injury of tissue (i.e. how injury to tissue results in pain signals transmitted via peripheral nerves to the central nervous system), a burgeoning area of research and discovery in recent times has revealed how irritation to the peripheral nerves themselves can promote and sustain chronic pain and cause tissue compromise in the area surrounding the irritated nerve. Many healthcare providers have attempted to address Neuropathic pain through pharmacology with mixed results. Based on current research and empirical process, many practitioners are now recommending addressing neuropathic pain with a combination of therapies rather than just monotherapy (Kerstman et al, 2013). In simple terms, therapies that address the mechanical and chemical irritation of the peripheral nerves (especially the cutaneous sensory nerves) have huge potential in addressing neuropathic pain and neurogenic inflammation (This author has utilized G5® devices as part of a combined modality treatment approach to address peripheral neurogenic inflammation and pain to good effect.)

There are few areas where rapid reduction in pain and inflammation is more valuable than in competitive sport.

APPLICATIONS OF MULTI-MODAL, DEVICE-ASSISTED-SOFT-TISSUE-MOBILIZATION IN SPORT AND PERFORMANCE

Our discussion thus far has dealt with the aspects of soft tissue mobilization methods for the purposes of treating soft-tissue pathology. This said, we have not addressed the prolific and popular use of massage in sports. Within the field of massage, the term "Sports massage" is generally defined as a collection of massage techniques performed on athletes or active individuals in order to facilitate recovery or treat injury. Three of the classic and most common techniques employed in sports massage are effleurage, petrissage, and deep transverse friction massage. Each technique has unique technical characteristics.

Effleurage techniques are typically performed along the length of a muscle, most often in a distal to proximal flow. Petrissage involves kneading, wringing, and scooping, generally performed with deeper pressure. Deep transverse friction massage (also known as cross-friction massage) is performed by using the fingers to apply a force moving transversely across the target tissue.

G5® mechanical massage devices offer the therapist the ability to not only mimic these effects without the burden of hand and arm fatigue but also the ability to deliver a unique level of pressure and friction simply not attainable by human hand. This is particularly relevant in the popular transverse friction massage techniques. It is this added dimension of higher rates of friction, percussion and vibration can markedly enhances the already widely appreciated benefits of sports massage.

Whole body vibration has emerged over recent times as a popular method of improving muscle tone and evoking improvements in neuromuscular function. The literature provides such examples as improvements in jump height (squat jump) in the range of 22% in height and 18% in power (Di Giminiania et al, 2009), trunk muscle stability and function (Ye & Yuen, 2014) and maximal isometric knee extension and lumbar extension strength (Osawa & Oguma, 2011).

PHYSIOLOGICAL CHANGES ASSOCIATED WITH MASSAGE THAT ARE LIKELY ENHANCED BY ELECTRO-MECHANICAL-SOFT-TISSUE-MOBILIZATION

- Increased circulation to the area of restriction delivers oxygenated blood and nutrients to the tissue and remove harmful metabolic waste product.
- Increased venous and lymphatic drainage decreases local swelling and edema caused by tissue inflammation
- Elasticity and flexibility of connective tissue elongates connective tissues secondary to mechanical loading
- Increased temperature causes an increase in elasticity and stretch of muscle

Table 1.2 – Likely physiological benefits of massage and multi-modal, elecro-mechanical, soft-tissue mobilization.

It is conceivable that by utilizing electro-mechanical soft tissue devices that are capable of delivering multiple, tactile modalities, the therapist is capable of harnessing the benefits of massage (see table 1.2) while simultaneously delivering a modality that has been shown to produce positive neuromuscular effects in performance.

While the obvious benefit is that this combination of effects is simply not possible by hand, another added effect in terms of reduction in occupationally related injury to the therapist themselves should be considered.

REDUCING FATIGUE AND OCCUPATIONAL INJURIES IN MANUAL THERAPISTS

Performing deep-tissue work can be challenging for the therapist. There are common injuries that plague manual therapists (incl. massage therapists, physical therapists and chiropractors), especially those who work in high volume clinical environment where they routinely engage in using the hands for repetitive manual, soft-tissue manipulation and mobilization techniques (Green & Goggins, 2006). These include thumb pain, wrist injury (incl. tendinosis), tenosynovitis, shoulder, neck and back pain. The use of a powerful, electro-mechanical-soft-tissue manipulation tool such as the G5 devices can drastically reduce load and strain on the therapist's body while conversely delivering a great deal of therapeutic pressure to the patient with relatively minimal effort. This leads to a more consistent quality of care on the part of the therapist and patient.

SUMMARY

In consideration of the various dimensions of the therapeutic effect offered by multi-modal, electro-mechanical, soft-tissue mobilization, it is clear that the G5® devices are an appealing option for manual, rehabilitative therapists of any kind that are seeking to reduce treatment times, improve patient comfort and promote better therapeutic outcomes. In utilizing a G5® device, the practitioner acquires a versatile extension of their technical repertoire that has been shown to be adaptable to most soft-tissue approaches. This translates to a negligible learning curve in terms of immediate clinical applications and benefits.

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