Motor Points and Motor Lines

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Abstract: Since it is now generally accepted that acupuncture points correspond to motor points, this paper reviews the nature of motor points. The motor point is the surface projection onto skin of the muscle zone of innervation (or motor band). This skin site over the motor band shows greatest sensitivity to percutaneous electrical stimulation because the terminal branches of the muscle motor nerve lie closer to the skin there and are thus most accessible for stimulation. An understanding of the nature of a motor point is essential for the practice of acupuncture on a scientific basis.

WITH THE RECENT identification of many acupuncture points corresponding to motor points,[1/2/3] a review of the nature of the motor point seems appropriate.

If an electrical stimulus of sufficient strength and duration is applied directly to an innervated muscle or to its nerve of supply, a brisk contraction will result. Muscle contraction may also be evoked by applying the electrical stimulus through pierced skin using a needle electrode or across intact skin using a percutaneous electrode. Duchenne (1833) found that for any muscle, percutaneous stimulation and contraction was most easily obtained when the stimulus was applied to one particular small area of skin overlying that muscle. He named these areas "points of election," believing that the muscle tissue directly under those points was especially responsive to electrical stimulation. He was also the first to use alternating current and suggested the name "Faradic." Other workers subsequently showed that the localized hyper-responsive skin zone corresponded approximately to the point at which the innervating nerve penetrated the muscle. Bourguignon determined the position of these points on the skin and by careful dissection showed that they were surface projections of the points at which motor nerves entered the deep surface of the muscle. Coers developed a technique for vital staining of neuromuscular biopsies and demonstrated in muscle spindles underlying the motor point a zone of low threshold excitability roughly perpendicular to the main direction of muscle fibers.[4] In these zones of maximum excitability he found a terminal band of innervation. Coers thus felt that the motor point corresponds not necessarily to the entrance of nerves into muscles but rather to the region where terminal elements are found in abundance near the surface. The motor point is therefore an anatomical entity and not a physiological property of muscle fibers.

Each skeletal muscle usually receives one nerve of supply (limbs, face and neck), although where a muscle obviously retains its segmental arrangement (e.g., abdominal wall), its nerve supply may be multiple.[5] After dividing into several small branches, the nerve of supply, together with the principal blood vessels, enters the deep surface of the muscle nearer to its origin at a small, elongated oval

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area, *the neurovascular hilus,* which is fairly constant in position for each muscle.

Each nerve contains motor, sensory and autonomic fibers. The motor fibers comprise the alpha efferents from the anterior horn motorneuron to extrafusal muscle fibers and gamma efferents to muscle spindles. The autonomic efferents supply vascular smooth muscle. The sensory fibers are from muscle spindles, neurotendinous organs, terminals in fasciae and nociceptors of as yet undetermined origin. Once the nerve has entered the muscle at the neurovascular hilus it breaks up into a plexus which runs in the epi- and perimysial septa before entering endomysial spaces around the muscle fibers. The alpha efferents then branch and terminate in the individual muscle fibers. These terminals are not scattered uniformly throughout the muscle but are distributed within a fairly narrow *transverse motor band* near the center of the muscle (from where most muscle spindle afferents also originate). (Fig. 1). Within the transverse motor band or zone of innervation the somatic motor axons break up into branches, each of which terminate on an individual muscle fiber (at the light microscope level) in the specialized structure — the *motor end-plate.*

In normal muscle, electrical stimulation produces contraction *indirectly* via the nerve since muscle fibers themselves have a higher threshold to stimulation than intramuscular fibers. This effect is particularly manifest when stimulation occurs in a region of the muscle rich in nerve fibers — the *transverse motor band* or *zone of innervation.* In a like manner, the skin site over the transverse motor band shows greater sensitivity to percutaneous stimulation (using a faradic current) with the terminal branches of the motor nerve in the muscle motor band nearer the skin surface accessible for stimulation. This surface area represents the *motor point* which is identified clinically as the site where a twitch may be evoked in response to minimal electrical stimulation.[6] This transverse motor band of innervation is a fixed anatomic site — the skin overlying the motor point may be drawn aside (Figure 2), shifting the point which responds to the neurometer, but the transverse band of innervation in muscle remains unaltered and may be confirmed by stimulation. Charts of the location of motor points (corresponding to Type I acupuncture points) were first made by the German neurologist Wilhelm Erb,[7] and these points have been in use for many years to study intensity-duration curves and determine the extent of denervation since a muscle deprived of its nerve supply responds via muscle fiber contraction at a higher threshold to galvanic current. Failure to find a motor point is in itself diagnostic of complete denervation of muscle. In a denervated muscle, instead of isolating the motor point, the examiner will find a fairly uniform but lower excitability over the entire muscle.

Muscle motor points are not the only areas of skin especially responsive to electrical stimulation. There are several areas in the body where a motor nerve becomes so superficial that the application of relatively low currents will be transmitted to all the muscles supplied distal to the point of stimulation. These skin projections are known as *motor lines.*[8] Most of the motor lines are half an inch to an inch in length but occasionally may be no larger than a point. Stimulation of the nerve on its motor line will produce contraction in several distal muscles simultaneously. Whilst there is only one motor line for each nerve there are some muscles which have two or more bellies and hence, there may be two or more motor points to these muscles (e.g., biceps brachii and gastrocnemii). (See Fig. 3).

The exact location of a motor point may vary slightly from patient to patient, though the relative position follows a fairly fixed pattern. Some motor points are superficial and are easily found while others belonging to deeper muscles are more difficult to locate.

Obviously the mode of entry of the principal nerves and arteries of supply to muscles is of great value in the diagnosis and treatment of injuries affecting them. A detailed study initiated by the Nerve Injuries Committee of the Medical Research Council was published in 1955 following special dissections prepared for the purpose. Their publi-

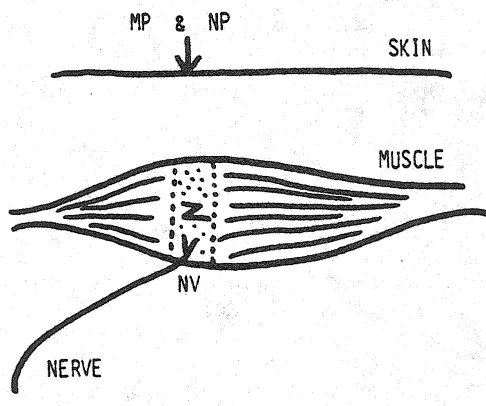

Figure 1.

NV — Neurovascular hilus.

Z — Transverse motor band of muscle *or* zone of innervation.

MP — "Motor Point" — *Projection* of underlying Z zone onto surface.

NP — Skin point where neurometer shows lower resistance to D.C. current.

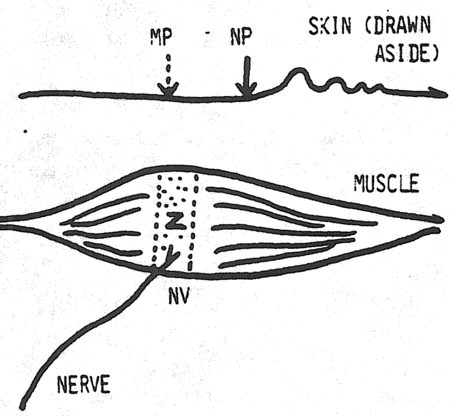

Figure 2.

When skin over the zone of innervation is drawn aside, the NP may be shifted, but the MP which is still over unmoved Z remains unaltered and may be confirmed by stimulation. The depth from skin surface of Z therefore varies according to thickness of subcutaneous tissue and position of muscle (but once recognized as in muscle tissue, it is in practice easily found).

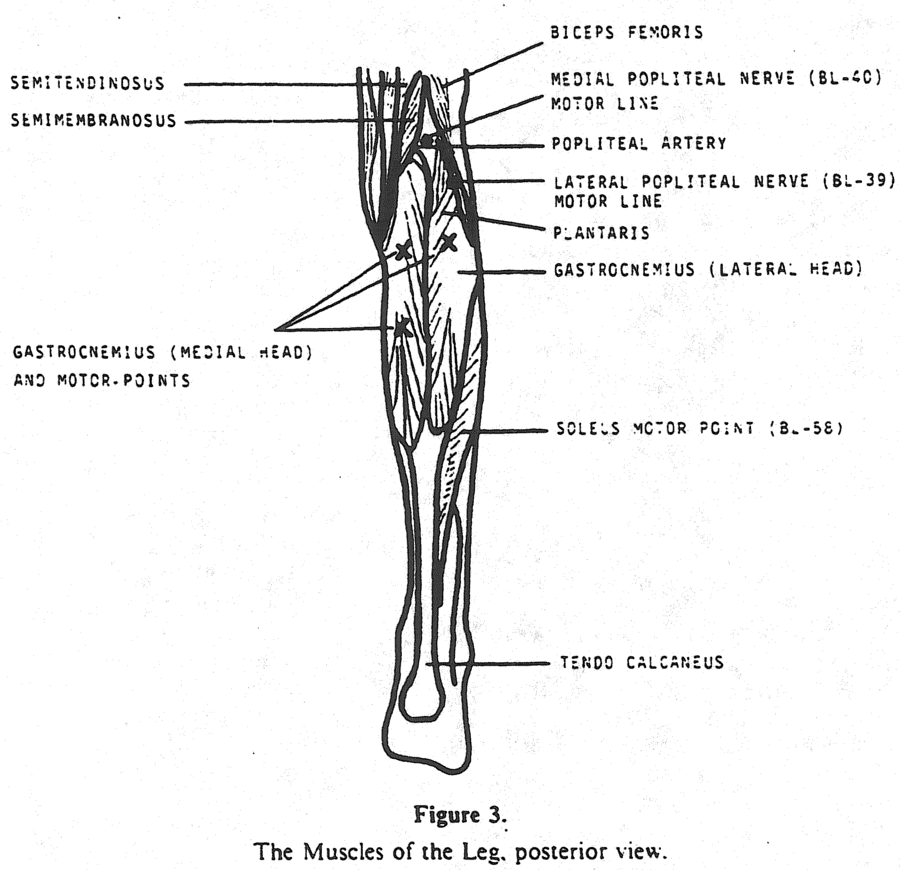

Figure 3.
The Muscles of the Leg, posterior view.

cation in the form of an atlas with excellent illustrations must be considered as essential study material for the scientific acupuncturist.[9]

In electromyography there is usually no electrical activity in normal resting muscle except at the zone of innervation where two types of spontaneous discharges or "end-plate noise" may be detected. The diaphasic potentials are considered as miniature end-plate potentials (MEPP) originating in muscle fibers and these sometimes augment to evoke a propagated action potential in one or more muscle fibers. The other short duration negative deflection potentials which may be seen probably represent the summated activity of non-propagated potentials;[10] however, these potentials are not a constant finding.

In acupuncture studies, it is important to realize that when a stimulating needle is not exactly at ethe band of innervation, the relative afferent barrage will be smaller but not entirely "zero."[11] This may account for the unexpected (positive) results in some clinical trials where the control group consisted of needle insertions placed in tissues not too distant away from from known acupuncture points.

Tenderness at motor points or myalgic hyperalgesia representing hypersensitivity of nociceptors is frequently associated with peripheral neuropathy and denervation supersensitivity and has been reported in relation to low back pain,[12] cervical spondylosis,[13, 14] and trigger points.[15]

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