

The Neurological Mechanism Of Needle-Grasp in Acupuncture

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Abstract: The subjective appreciation of "Teh Ch'i" is probably related to the stimulation of nociceptors, proprioceptors and interoceptors at the neurovascular hilus ("the motor point"). The *objective* component of Teh Ch'i Phenomenon consists of local muscle spasm occurring at the point of stimulation. The needle is seen to be "grasped" or "sucked in." This paper discusses its possible neurological basis. There are two types of needle-grasp—*superficial* and *deep*. The latter occurs only at Type I (motor point) acupuncture points within the muscle layer and is probably related to the gamma-loop. The functional characteristics of the muscle spindle and the gamma-loop are reviewed. In neuropathy and following denervation, the phenomenon of "denervation supersensitivity" develops. Muscles and peripheral receptors become supersensitive to transmitter substances and to different forms of stimuli. When needle agitation occurs in a partially denervated or neuropathic muscle, the intense local muscular contraction causes the needle-grasp and in extreme cases bending of the needle. Needle-grasp is usually most obvious at tender motor points.

SOME NEUROPHYSIOLOGICAL aspects of the subjective appreciation of "Teh Ch'i"—a combined feeling of soreness, heaviness or pressure, numbness, fullness or distention have been previously discussed.¹ The vague and ill-defined sensations are probably related to the stimulation of afferent fibers arising from nociceptors, proprioceptors and interoceptors concentrated at the motor band of muscle near the neurovascular hilus and deep to that area of skin most accessible to

minimal electrical stimulation—the motor point. It is now recognized that many acupuncture points (Gunn's Type I) correspond to muscle motor points.² These deeper receptors, unlike exteroceptors which respond to stimuli from the external environment, give rise to poorly localized sensation of the deep-seated variety.

The objective component of the Teh Ch'i Phenomenon consists of local muscle spasm occurring at the point of stimulation. The needle is seen to be "grasped" or "sucked in."³ This needle-grasp may be occasionally so intense that some considerable tractive force has to be exerted to extract the needle when it may be found to be bent (Fig. 1). What is the neurological basis of the needle-grasp? Why is it sometimes absent and sometimes present and so intense?

Types of Needle-Grasp

Any experienced practitioner of acupuncture will be familiar with the two types of needle-grasp.

- a) *Superficial*—this occurs when the needle has penetrated the skin for only a millimeter or so. Upon rotation of the needle, the skin around the needle contracts and when traction is applied to the needle, the skin puckers and is lifted by the needle point (Fig. 2). This superficial contraction is distinct from the deeper variety occur-

ring in muscle and may occur at any point on the skin. The skin is composed of two layers of distinctive structural properties and embryological origin. The dermis or corium is a connective tissue layer of mesenchymal origin which is covered by the epidermis, an epithelial layer derived from embryonic ectoderm. Deep to the dermis lies a layer of loose irregular connective tissue forming the superficial fascia (hypodermis or subcutaneous layer), which in turn is bound to the underlying tissues by a dense fibrous deep fascia corresponding to the epimysium of muscle blocks (see Fig. 3). The dermis gives the skin its mechanical strength by virtue of the high proportion of collagen fibers intermingled with fibers of elastin. The superficial grasping of the needle is probably related to local contraction of these fibers of elastin.

- b) *Deep or Muscular*— this deep needle-grasp occurs only at Type I (motor point) acupuncture points within the muscle layer. Although the vague and ill-defined subjective feeling of Teh Ch'i is a constant finding when the needle is accurately placed in the neurovascular hilus, the objective component only occurs under certain circumstances (to be discussed).

Muscle Proprioceptors and the Gamma-Loop

The proprioceptors in mammalian muscle consists of the muscle spindle and the Golgi tendon organ. A review of the functional characteristics of the muscle spindle and the gamma loop is important for an understanding of the Teh Ch'i needle grasp.⁴

Muscle and joint proprioceptors are responsible for signaling physical changes in the musculoskeletal tissues. They are of three main categories and are related to joint position and motion, muscle tension and muscle length. Proprioceptors around joints (capsule and ligaments) are the Ruffini endings. They do not have a selective influence via segmental relay pathways but influence postural and locomotor patterns at higher centers

(cerebellum and cerebral cortex). The proprioceptors at musculotendinous junctions are the Golgi tendon receptors which respond to changes in force or tension. They are responsive only when a muscle contracts against a load with their afferent input proportional to muscle tension regardless of muscle length. Their input excites *inhibitory* interneurons that synapse with motor neurons controlling the same muscle. The proprioceptors at muscle spindles are more complex and are relevant to the Teh Ch'i needle-grasp phenomenon. The muscle spindle, about 3 millimeters in length, is enclosed in connective tissue and is part of the essential feedback mechanism by which skeletal muscle is controlled (Fig. 4). Their intrafusal fibers (as opposed to the extrafusal fibers of the rest of the muscle bulk) are innervated by gamma motor fibers originating in the ventral horn and passing through the ventral root. (Extrafusal fibers are innervated by the alpha motor neurons). Afferent neurons are from the primary endings or annulospiral endings wound around the intrafusal fibers. There are also secondary flower-spray endings on both sides of the annulospiral endings. Both primary annulospiral and secondary flower-spray endings are sensitive to stretch of the central portion of the spindle. The afferent discharge of the spindle on the motor neurons of the same muscle is *exitatory*, thus, when a muscle is stretched, the spindle reflexively stimulate it to control and resist stretch. Conversely, shortening of the muscle favors relaxation. Through interneurons and collaterals, spindle activity also determines the activity of antagonists and synergists. The spindle is, in effect, the sensory component of the muscle-stretch or myotatic reflex — the same mechanism operation in the so-called "tendon reflex" tests. Stimulation of a hypersensitive spindle sensory mechanism leads to hyperexcitation of the same muscle and contributes towards the muscle spasm seen in the Teh Ch'i Phenomenon. (Agitation of the needle is specific since these receptors are mechanoreceptors). The gamma-loop is sometimes viewed as the "automatic gain control" of the length-regu-

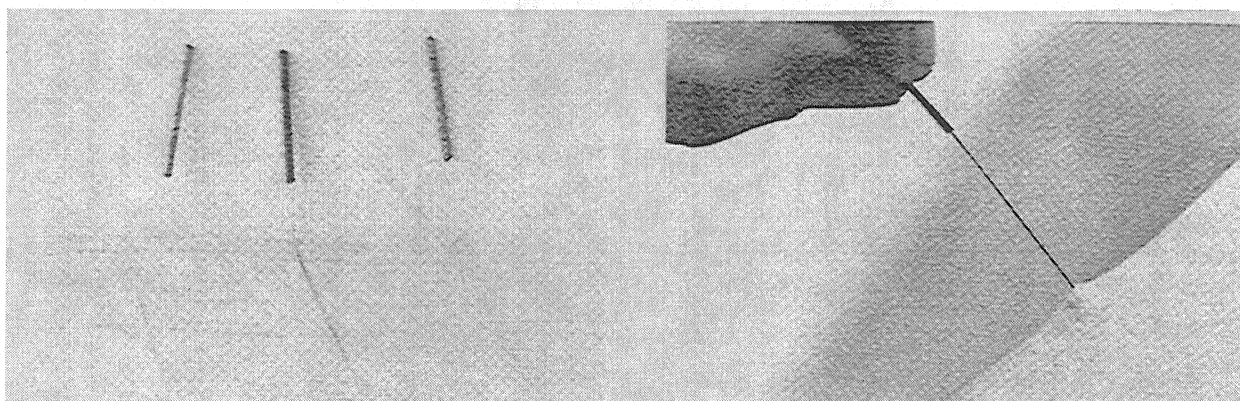


Fig. 1.

**Bent Needles Resulting from Deep Intense
"Needle-Grasp" of Teh Ch'i.**

Fig. 2

**Superficial (or skin) type of needle-grasp which
can occur at any skin point and is not necessarily
associated with Teh Ch'i.**

lating mechanism for each muscle. Disruption of this mechanism with motor and other dysfunctions is sometimes labeled as "somatic dysfunction" or the "osteopathic lesion",⁵ that is "a facilitated segment of the spinal cord maintained in that state by impulses of endogenous origin entering the corresponding dorsal root. All structures receiving efferent nerve fibers from that segment are, therefore, potentially exposed to excessive excitation or inhibition." Since the central nervous system also has regulatory control, hypersensitivity may occur in anxiety states and tension syndromes.

Denervation Supersensitivity and The Gamma-Loop

Muscle tonus is a state of continuous mild contraction of muscle dependent upon the integrity of the gamma-loop and their central connections. Atonic muscles are soft and flabby. Hypertonic muscles are rigid and spastic. Normal muscle at rest has a certain resilience rather than absolute flabbiness. The maintenance and control of muscle tone is dependent upon the normal function at six levels: (a) The precentral motor cortex, (b) the basal ganglia, (c) the mid-brain, (d) the vestibulum, (e) the spine, and (f) the neuromuscular system.

In neuropathy and following denervation there occurs a number of characteristics changes in the functional properties of mus-

cles and peripheral receptors. These become supersensitive to transmitter substances and to different forms of stimuli. In normal muscle, the muscle fiber membrane zone containing receptor sites activated by acetylcholine is confined to that area immediately adjacent to the end-plate, but following injury or after denervation the area sensitive to acetylcholine spreads along the surface membrane until the entire fiber responds to the agent.⁶ A similar increase in the number of receptors also occurs at autonomic and other synapses.⁴ When an acupuncture needle is inserted into normal muscle at a motor point, the afferent barrage via the primary Ia fibers and the monosynaptically relayed alpha efferent message may yield a slight contraction of its homonymous muscle in the vicinity of the stimulating needle. However, when needle agitation occurs in a partially denervated or neuropathic muscle (with hypersensitive receptors from denervation supersensitivity), the afferent barrage is increased. The resulting magnified alpha efferent then initiates intense local muscular contraction causing the needle-grasp and in extreme cases bending the needle. The needle-grasp of the Teh Ch'i Phenomenon is usually most obvious at those motor points which are tender to palpation⁷ since sensitivity of nociceptors is also heightened following denervation. Similar positive feedback mechanisms of hypersensitive nociceptor loops probably account for the "Trigger Points" of the myofascial syndrome.⁸

Fig. 3.
Schematic cross section of the histology of the skin.

- A & B — Epidermis.
- C — Dermis (rich with collagen and elastic fibers).
- D — Subcutaneous fat.
- E — Deep fascia.
- F — Muscle.
- G — Superficial nerve plexus.
- H — Deep nerve plexus.
- J — Cutaneous nerve.

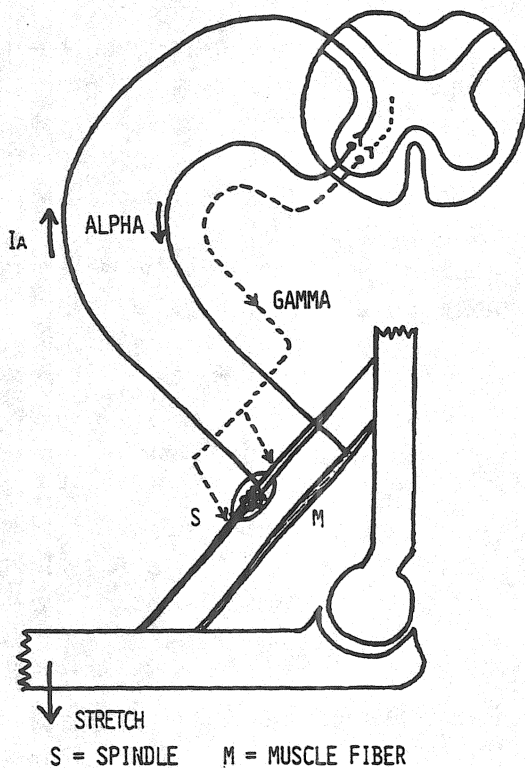
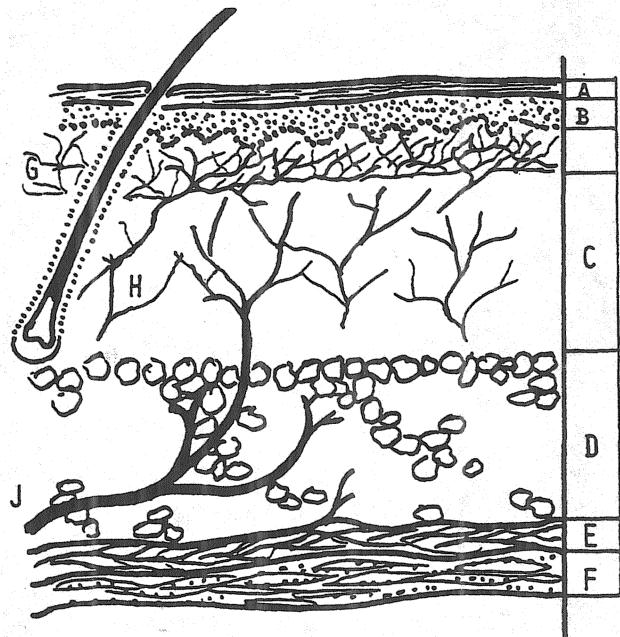


Fig. 4. Gamma Loop.

A gamma (γ) motoneuron is shown innervating the intrafusal muscle fibers of a muscle spindle. Excitation of gamma motoneurons by pathways, such as segmental reflex paths or tracts descending from the brain (indicated by the broken line approaching the gamma motoneuron cell body), will cause the contraction of the polar regions of muscle spindles. This results in stretch of the equatorial regions of the spindles, with distortion of the afferent terminals belonging to group Ia fibers. The group Ia fibers that discharge will excite alpha (α) motoneurons to the same and to synergistic muscles through the monosynaptic reflex pathway (and inhibit alpha motoneurons to the antagonist muscles).

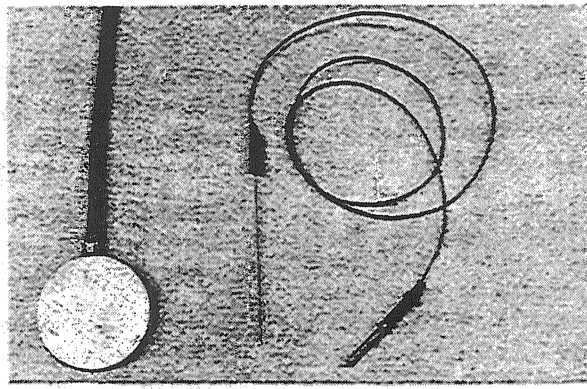


Fig. 5.

Right— Monopolar needle (electrode) as used in electromyography. Entire needle is teflon-insulated except at the very tip.

Left— Indifferent electrode used in conjunction with the above.

Electrodiagnostic Findings

In our studies, a monopolar electrode is used. The monopolar electrode is constructed from stainless steel wire sharpened to a pointed tip and then insulated with Teflon except for the very tip (Fig. 5). Sterilization is by autoclaving. The electrode is inserted into the muscle and a surface electrode is used as the indifferent. Normal muscle at rest is electrically silent, but at the motor zone of innervation, end-plate "noise" may occur. This consists of miniature end-plate potentials (MEPP) which are non-propagated sub-threshold depolarizations. They may occasionally augment to evoke a propagated action potential in one or more muscle fibers.⁹ End-plate noise is not a constant finding, but when it occurs, it is a good indication that the needle tip is in the motor zone of innervation. In neuropathy, electrodiagnostic findings are related to (a) the presence of axonal failure, (b) primary damage to myelin, (c) a combination of both lesions and/or (d) anterior horn cell or neuronal disease. The electromyographic criteria of neuropathy⁹ include: an increase of insertion activity, a higher content of polyphasic action potentials, a prolongation of the mean duration of motor unit action potentials but with mean amplitude normal or decreased and a partial interference pattern obtained despite maximal voluntary effort. Abnormal spontaneous activity such as fibrillations, fasciculations and positive sharp waves may appear when

there is denervation or axonal degeneration. In mild neuropathy, the abnormalities in the electromyogram are not overwhelmingly obvious but present as subtle changes from the normal state.⁸ In our studies, we have observed that tenderness at a motor point and strong needle-grasp or local muscle contractions occur together and in varying degrees paralleling the electromyographic findings of neuropathy.

Summary

The ancient and well-known phenomenon of "Teh Ch'i" or "needle sensation" has both subjective and objective aspects. The neurological basis of the peculiar subjective sensation has been previously described. This paper discusses the probable neurological mechanism for the needle-grasp and postulates it to relate to the gamma-loop and muscle spindle which may become hyperexcitatory in the presence of neuropathy and denervation supersensitivity.

Needle grasp is of two varieties: (a) Superficial, and related to elastic connective tissue of dermis, and (b) deep and related to muscle. The superficial variety occurs at all acupuncture points but the deep variety occurs only at muscle motor points or Type I acupuncture points. Intense needle-grasp is not a constant finding and is probably present only when the muscle spindle is hyperexcitatory as in neuropathy or partial denervation.

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