Botulinum Toxin injection

EMG and Electrical Stimulation-Guided Localization

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EMG and stimulation guided BoNT therapy

Electromyography (EMG) and Stimulation guidance is a technique used during botulinum toxin (BoNT) injections to enhance the accuracy of targeting specific muscles, especially in the treatment of movement disorders such as dystonia, spasticity, and muscle spasms.

Benefits

Improved Precision

EMG guidance allows clinicians to accurately localize the intended muscle, which is particularly beneficial for deep, small, or difficult-to-palpate muscles.

Enhanced Outcomes

Studies suggest EMG-guided injections can lead to improved therapeutic outcomes, reduced adverse effects, and greater patient satisfaction.

Reduced Complications

Accurate targeting may lower the risk of side effects such as weakness in non-target muscles and may allow for lower toxin doses, potentially reducing the risk of antibody development and cost.

Clinical Considerations

➢When to Use EMG Guidance

Highly recommended for limb, oro-mandibular, laryngeal dystonia, and deep or small muscles where palpation is unreliable.

Less necessary for superficial, easily palpable muscles (e.g., in blepharospasm or hemifacial spasm).

➢Limitations

Requires additional equipment and training.

Slightly more time-consuming and potentially more uncomfortable due to the use of EMG needles.

Not universally required for all BoNT injections; clinical judgment is important.

EMG-Guided Injection

➢Principle

Uses a needle electrode to detect electrical activity in the target muscle. The clinician confirms correct needle placement by observing muscle activation on the EMG monitor, often asking the patient to contract the muscle to verify location.

➢Advantages

Particularly useful for confirming needle placement in awake, responsive patients. Increases injection accuracy and helps avoid non-target muscles.

➢Best for

Patients who can cooperate with voluntary muscle activation; situations where precise muscle targeting is essential.(e.g.,lower limb)

Stimulation-Guided Injection

➢Principle

Uses a needle that delivers a small electrical current to stimulate the muscle. Correct placement is confirmed by observing a visible or palpable muscle twitch in response to stimulation.

➢Advantages

Especially valuable for patients who are unresponsive, sedated, or unable to voluntarily contract the muscle (e.g., children, those under anesthesia). Provides direct confirmation of muscle identity through elicited contraction.

➢Best for

Non-cooperative patients, or when EMG signals are difficult to interpret.

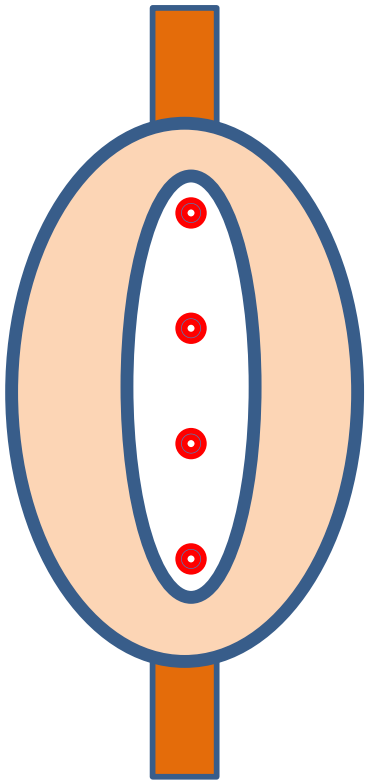
EMG vs Stimulation Guidance

Feature	EMG-Guided	Stimulation-Guided
Confirmation	Muscle electrical activity	Visible/palpable muscles
Patient Cooperation	Required for best results	Not required
Best Use Case	Responsive patient	Unresponsive/sedated patients
Accuracy	High	High
Common Applications	Dystonia, spasticity	Pediatrics, deep muscles

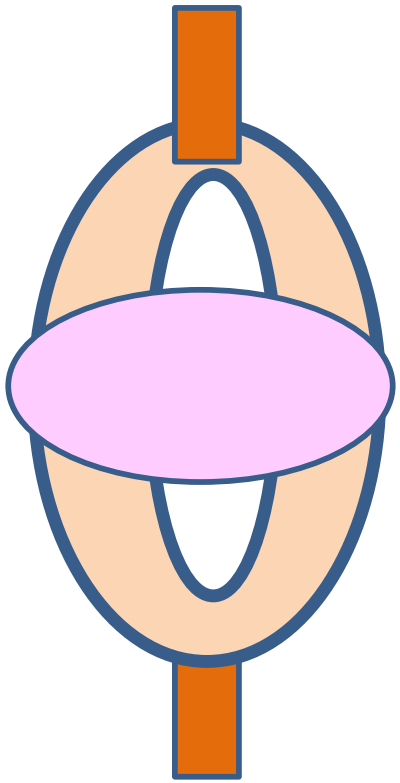
EMG vs Ultrasound Guidance

Feature	EMG-Guided	Ultrasound-Guided
Identifies active muscles	Yes	No
Visualized anatomy	No	Yes
Useful for deep/small muscles	Yes	Yes
Patient comfort	Lower	Higher
Avoids vessels/nerves	No	Yes
Clinical efficacy	Similar	Similar
Preferred for	Dystonia, muscle overactivity	Complex anatomy, safety for

BoNT injection method



multiple injection



single injection

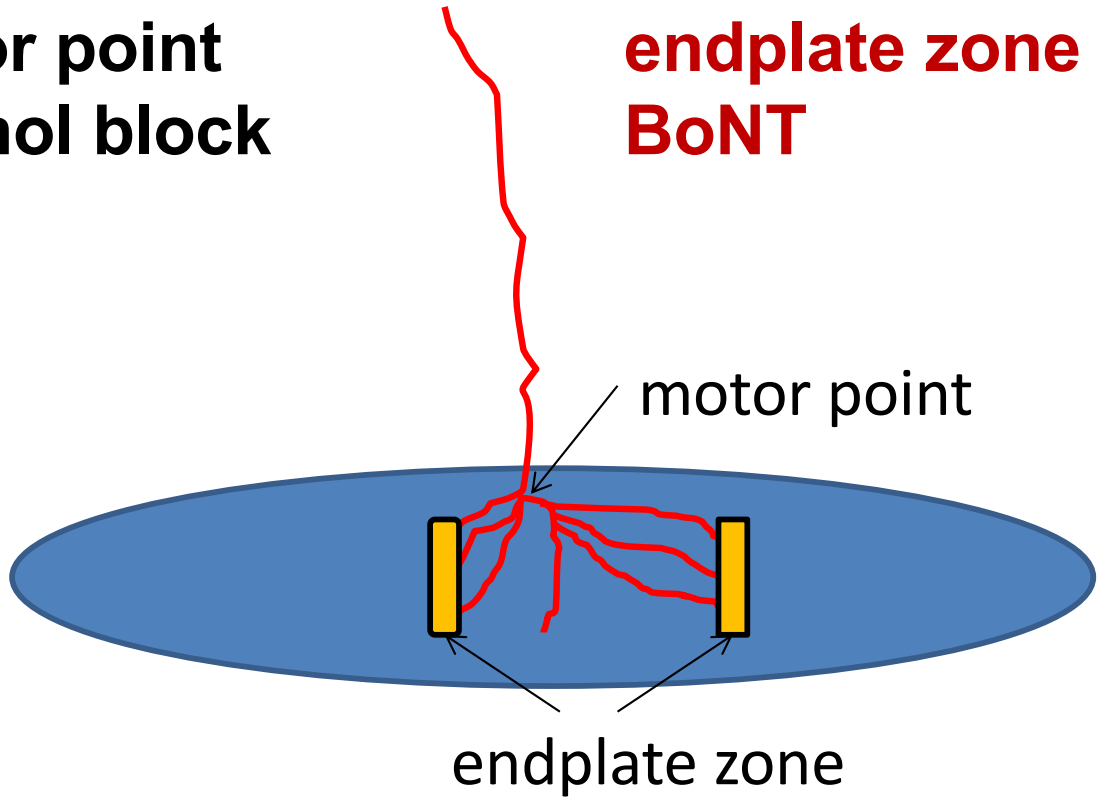
Why is EMG useful in BoNT treatment?

Muscle Identification	EMG accurately locates target muscles, particularly those that are deep or hard to identify through palpation.
Spasticity vs. Contracture	EMG helps clinicians differentiate between spasticity, which may respond to BoNT, and fixed contracture, which typically does not.
Abnormal Activity Confirmation:	EMG offers real-time insights into involuntary muscle activity, aiding in precise injections.
End-Plate Zone Localization	EMG enhances the accuracy of toxin delivery to areas of optimal neuromuscular transmission, enhancing treatment efficacy.
Safety and Accuracy	Implementing EMG with anatomical landmarks ensures safer needle placement and reduces the risk of targeting non-affected tissues.

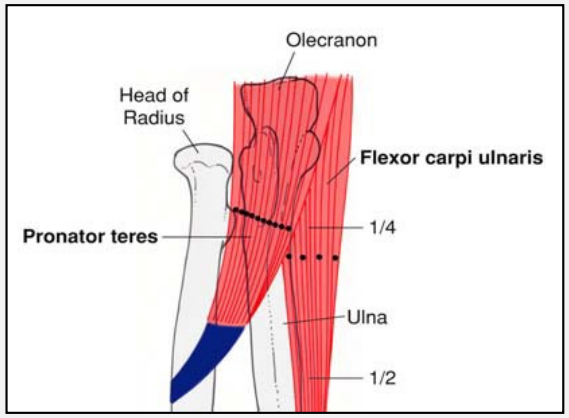
Effective injection site

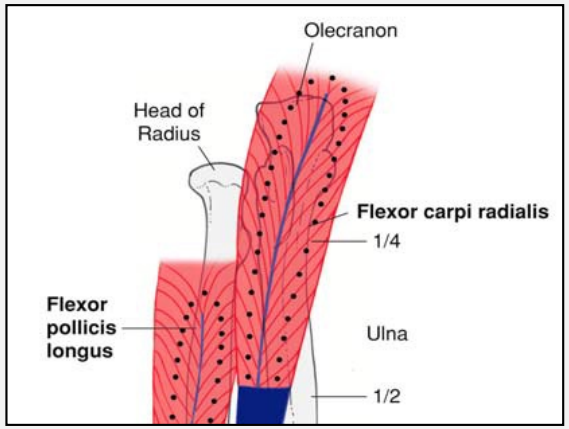
Motor point
Phenol block

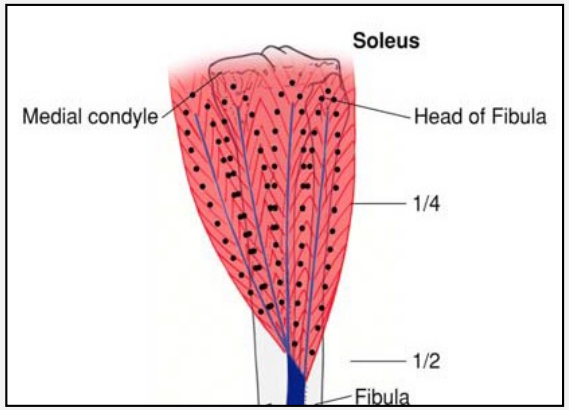
endplate zone
BoNT



Pennation and motor endplate zone







unipennation

biceps, triceps
Pronator teres
adductor longs and brevis

bipennation

Flexor pollicis longs
Flexor carpi radialis

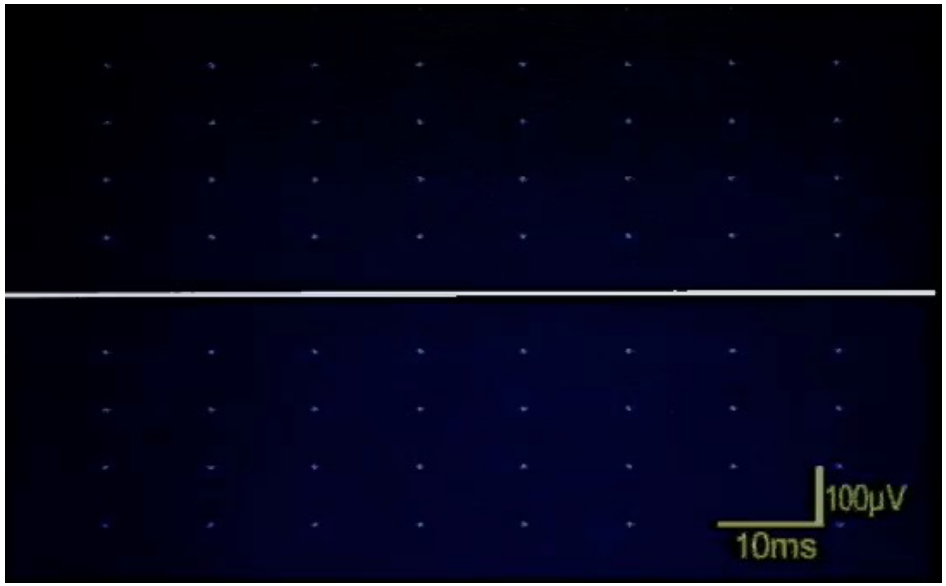
multipennation

Flexor digitorum superficialis
Flexor digitorun profundus

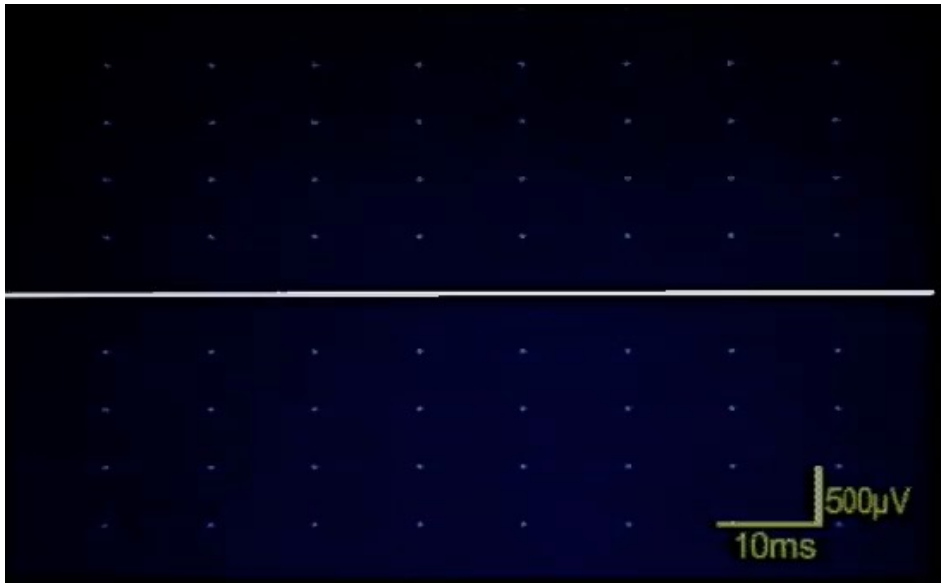
Campenhout AV. Developmental medicine & Child neurology 2010

EMG may detect end-plate zone

end-plate noise

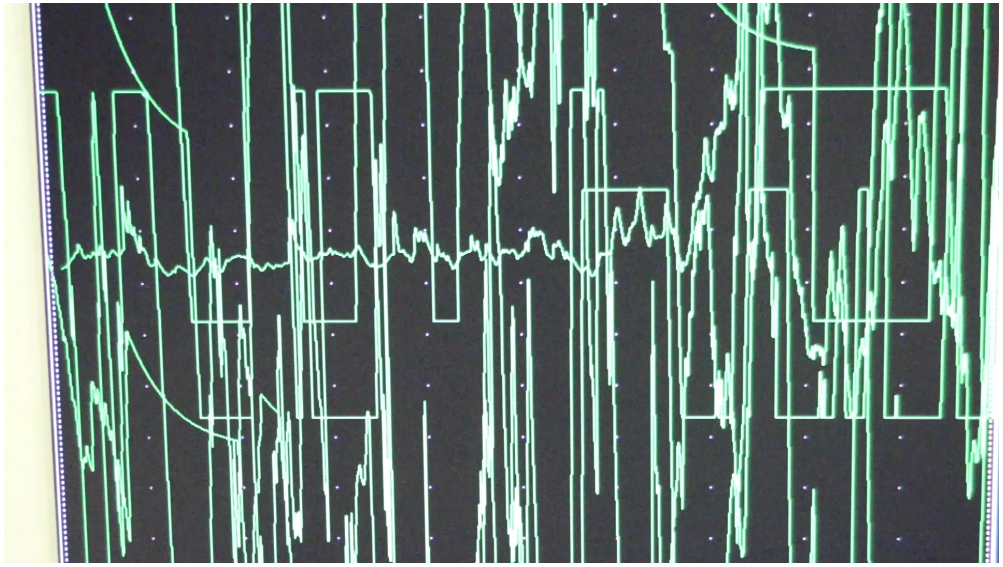


end-plate spike



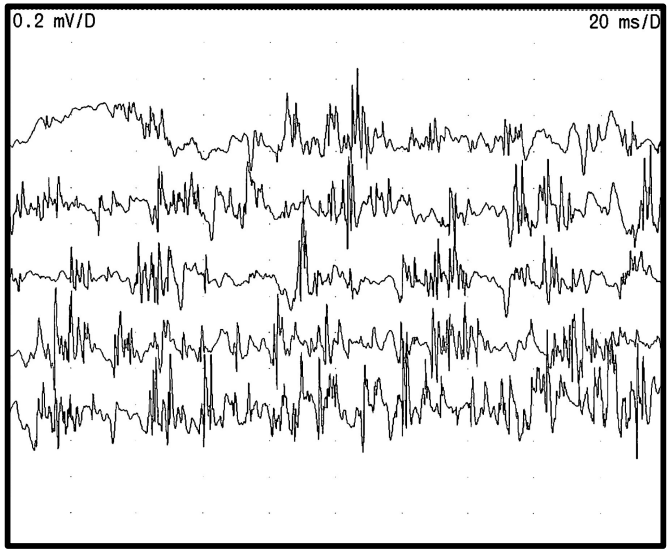
EMG guided injection (focusing)

30 G Needle
27 G Needle
23 G Needle

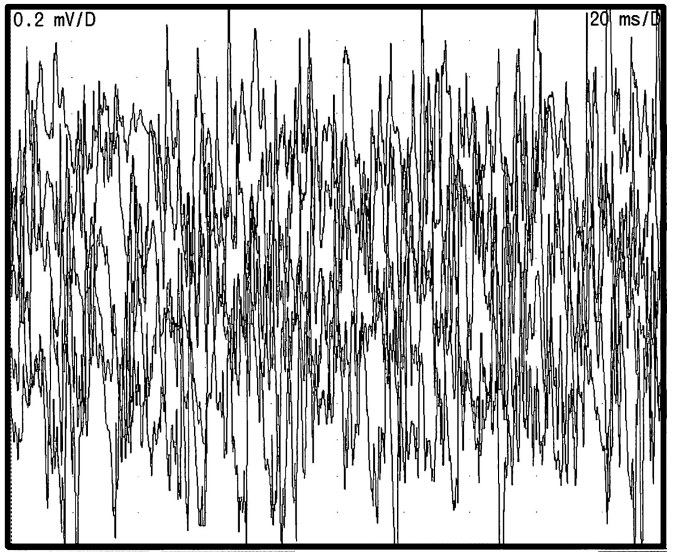


Semi-quantitative analysis of EMG activity

mild (+)



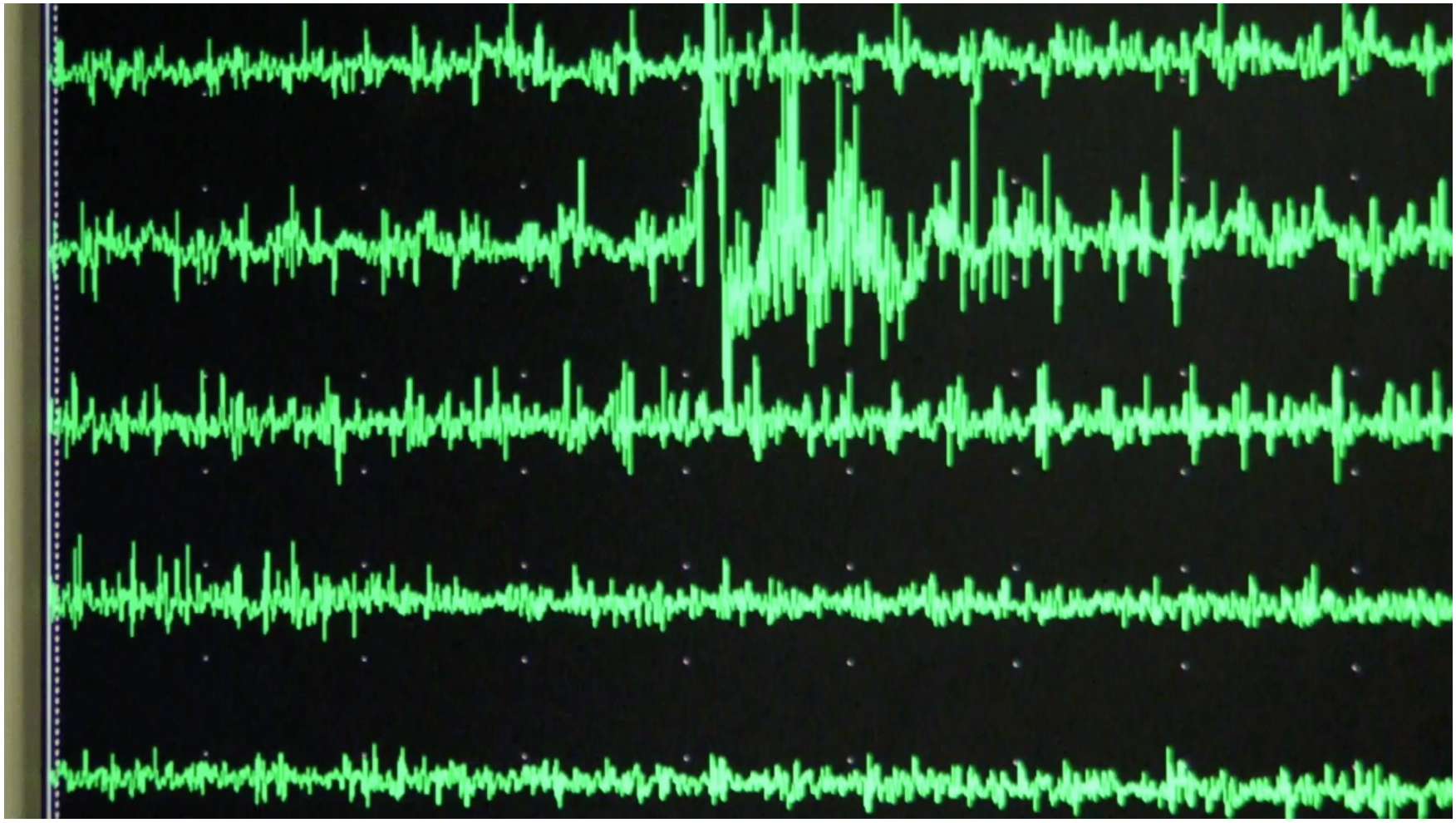
moderate (++)



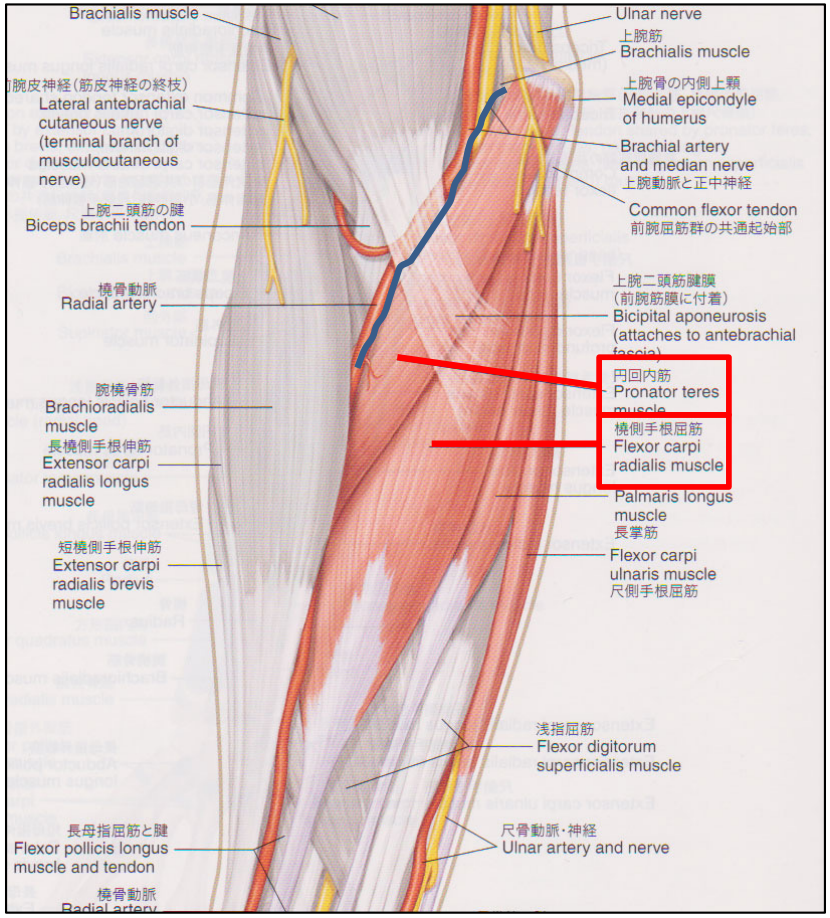
severe (+++)

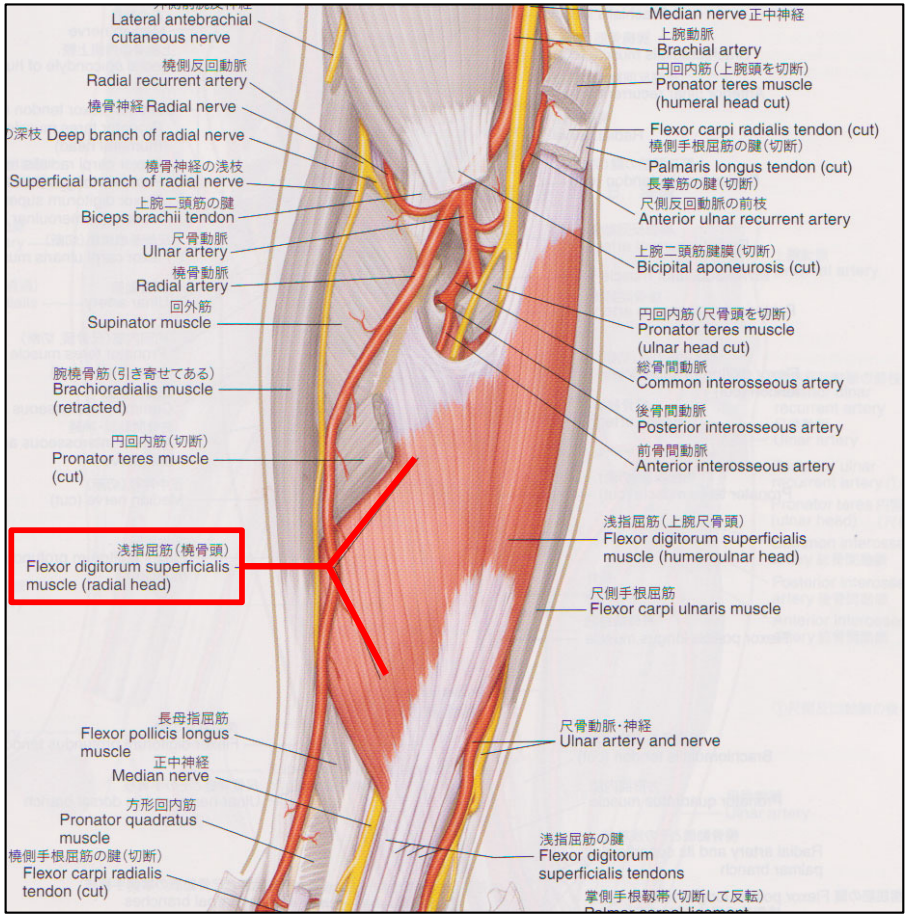
The dosage can be adjusted based on EMG activity.

Rapid stretch
: A method to accurately identify the target muscle

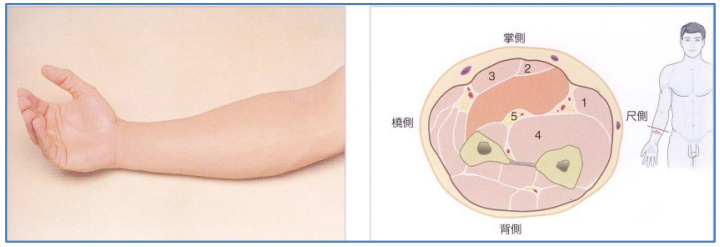


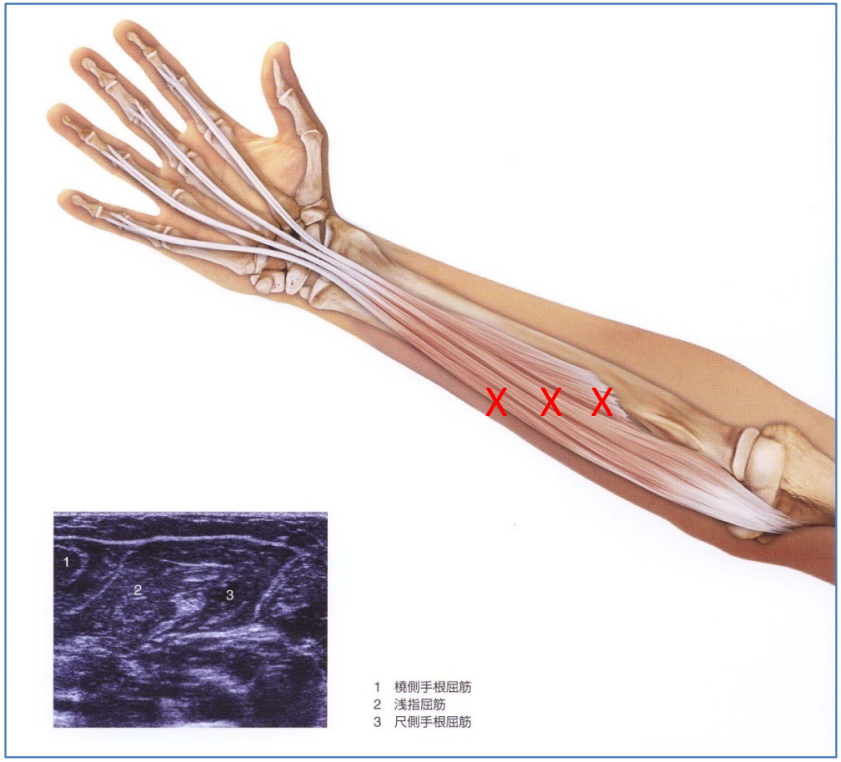
Golden triangle muscles
（PT, FCR, FDS）





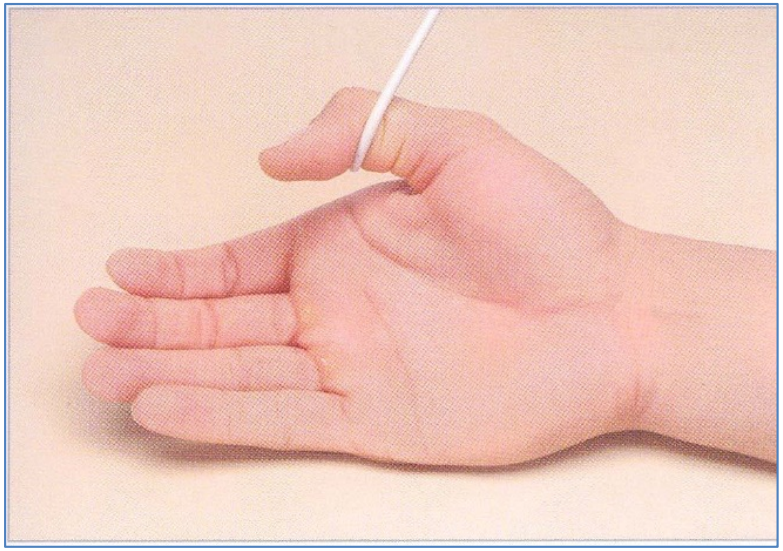
Flexor digitorum superficialis

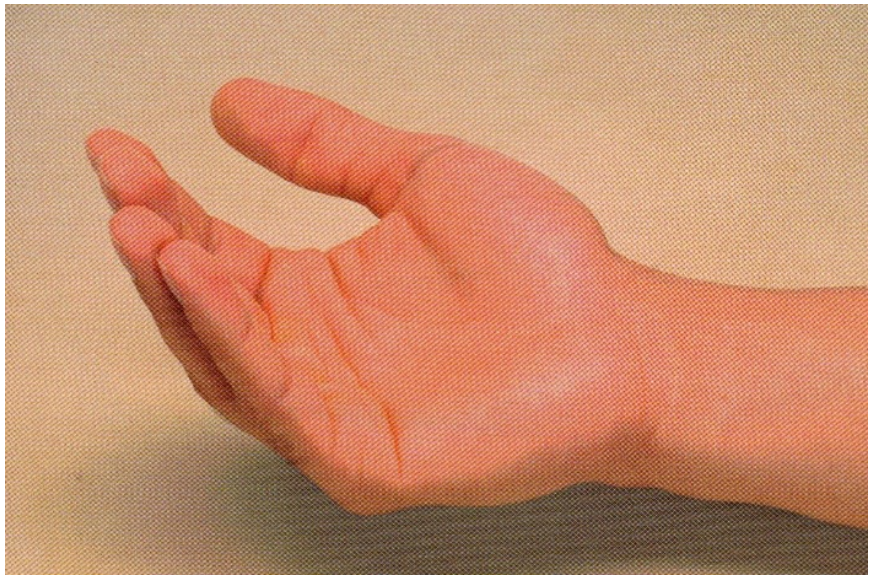


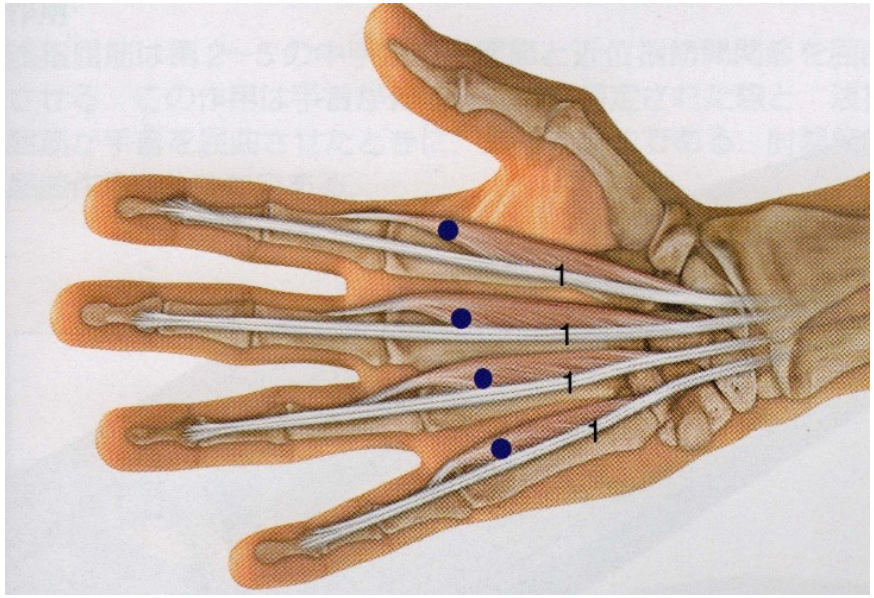


The muscle bundles are separated for each fingers.

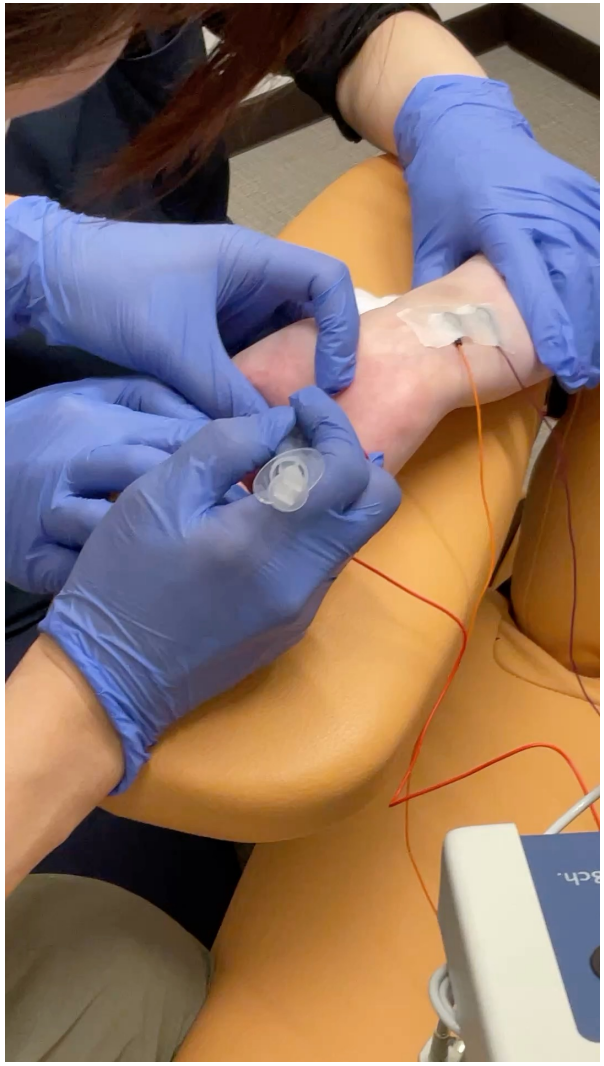
Adductor pollicis
Lumbricals manus 1-4







clenched hand deformity



Adductor pollicis

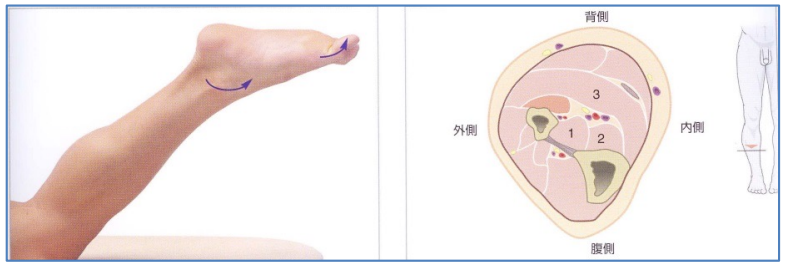
Lumbricals manus

Neuro-stimulation

- **In distal lower-limb muscles, abnormal muscle contractions may not be easily observed in the supine position.In such cases, electrical stimulation using an inserted needle electrode can be applied to observe the movement of the target muscle.**
  - **Stimulus duration: 0.01–0.1 ms**
  - **Stimulation current: < 5 mA**
  - **Stimulation frequency: 1–2 Hz**

- **If the stimulation current required is < 1 mA, it is highly likely that the needle is inserted into the end-plate.**

Flexor halluces longus



10-11cm from ankle, medial from Achilles tendon
Dysport 40-140 MU