Botulinum toxin-injections guided by EMG and electrical stimulation

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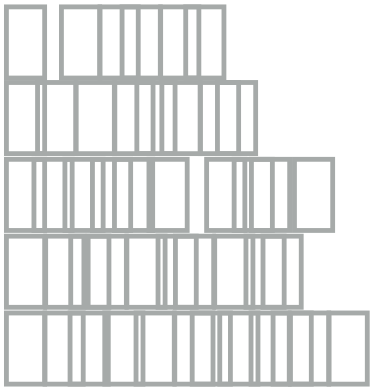
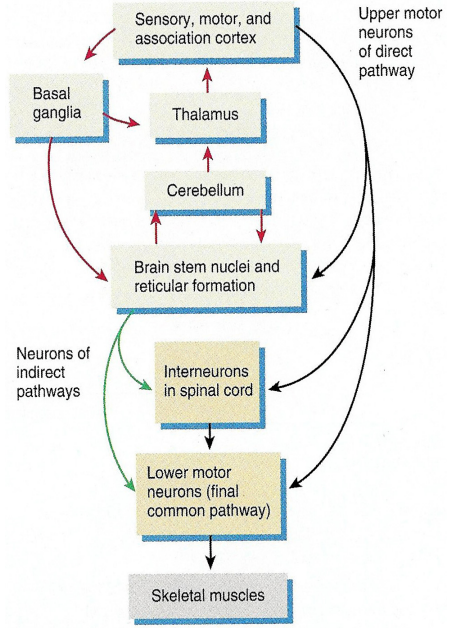
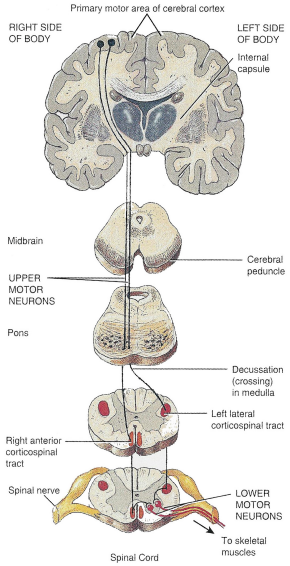
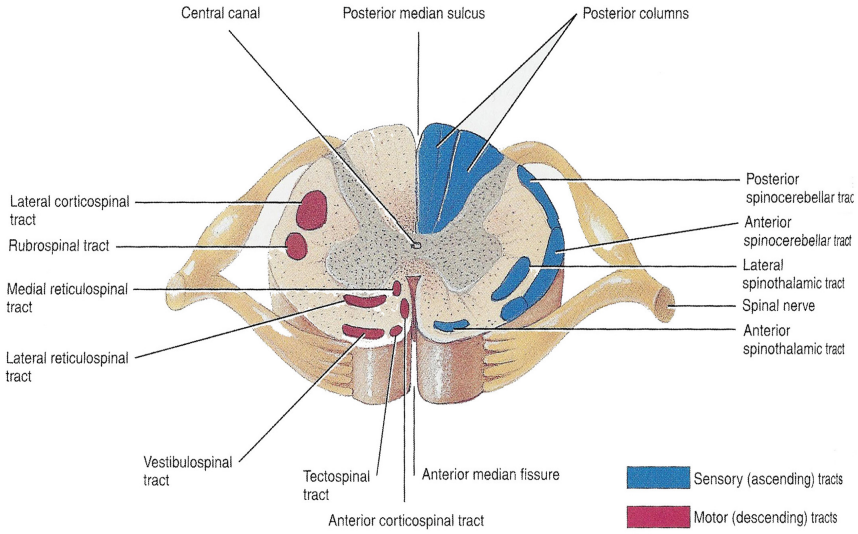


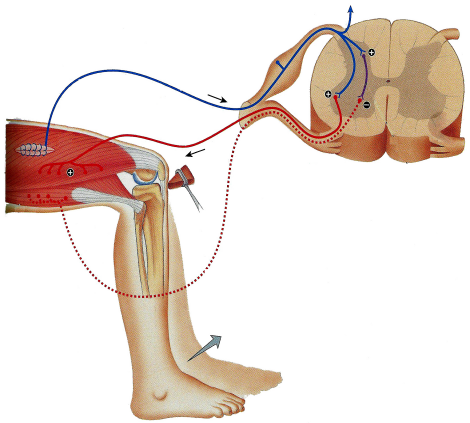




”Pyramidal tract”
”Corticospinal pathway”

Only 5-10% of the fibrers in this pathway are **direct** corticospinal, the remaining runs in ‘parallel pathways’





The corticospinal tract ”inhibits” the spinal reflexes underlying and interacting with voluntary motor acts; both distal och axial.

‘Extra pyramidal tracts’ modulates spinal reflex activity, mainly within axial and postural muscles.

Examples of clinical indications

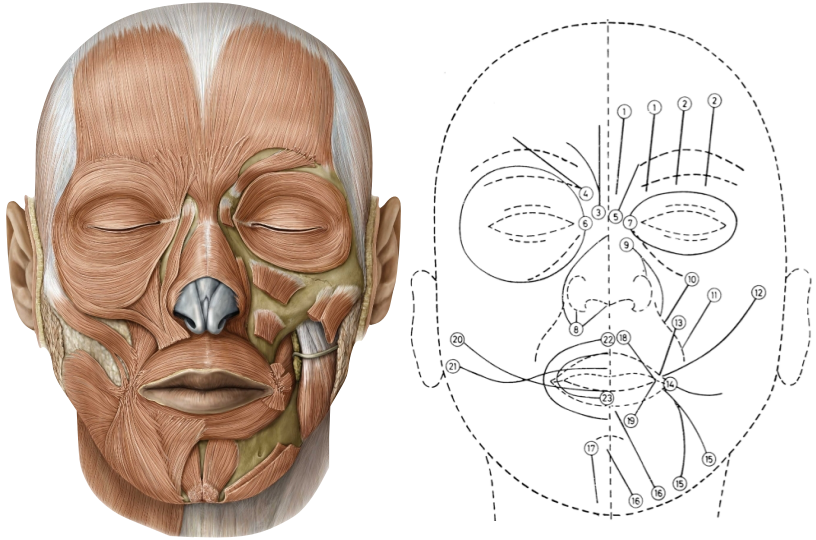
- Dystonias (eg. hand/arm, neck, ocorofacial)
- Spasticities
- Pain syndromes elicited/provoked by muscular pain and/or muscular tension states

Support to:

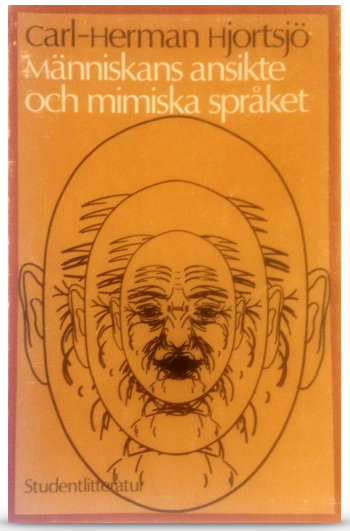
- Choose ‘the right’ muscle/muscles for treatment
- Verity needle position in the muscle
- Find muscles under suboptimal conditions (poor voluntary control; complex anatomy)
- Optimize intramuscular deposition of toxin (lower dose, more muscles within max. dose)
- Increase ‘injection reproducibility' for treatments
- Improve dose planning within and between treatment occasions

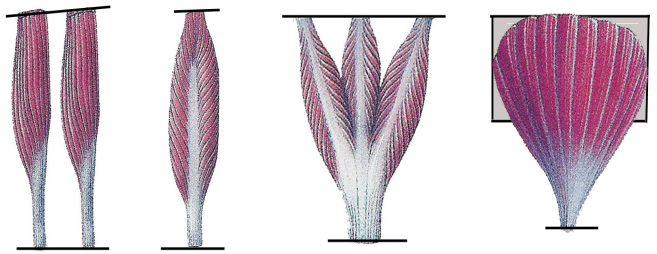
Optimal treatment effect is obtained if

- ‘The correct’ muscle(-s) are selected for treatment
- Toxin is deposited close to the end plate zone
- Toxine is deposited central in the muscle and/or in an adequate muscle fascicle



(after C-H Hjortsjöö)

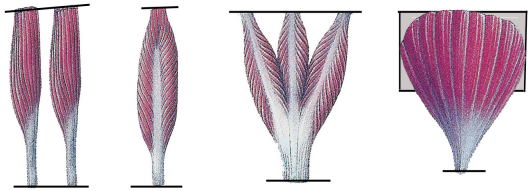




What/which is the (smallest) functional unit…?

“Muscle Compartmentalization: Twice the Muscles, Three Times the Actions”

Joseph L. Demer[1,2] and Robert A. Clark[1]. SteinEye Institute[1] and Department of Neurology[2], University of California Los Angeles

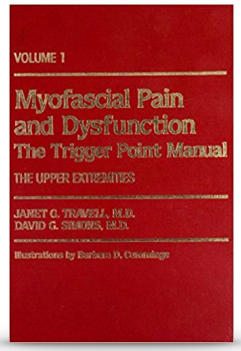


On the Function of Muscle and Reflex Partitioning

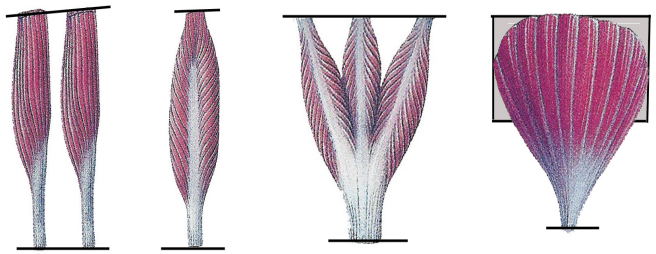
Windhorst U, Hamm TM & Stuart DG

Behavioral and Brain Sciences · December 1989

DOI: 10.1017/S0140525X00024985

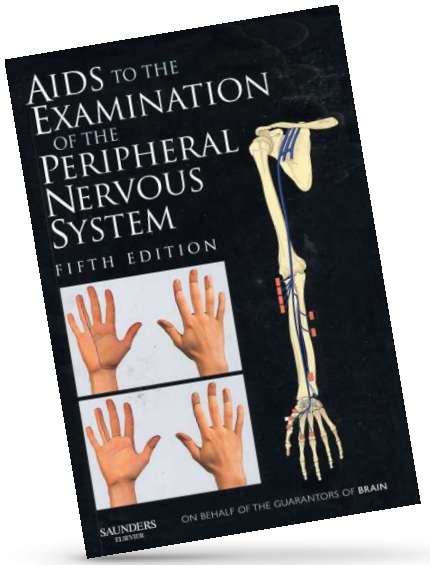


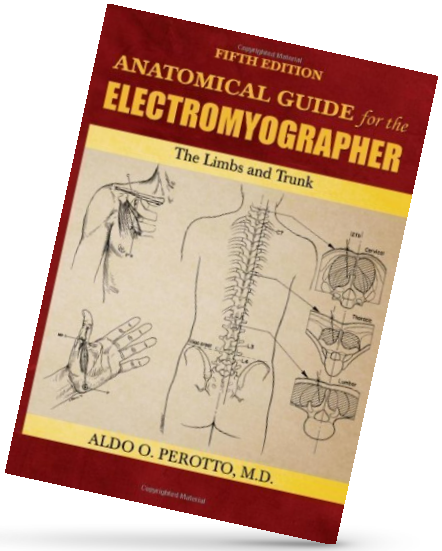
Simons, Travell & Simons:
Myofascial Pain and Dysfunction; The Trigger Point Manual,
Baltimore 1999, Williams & Wilkins

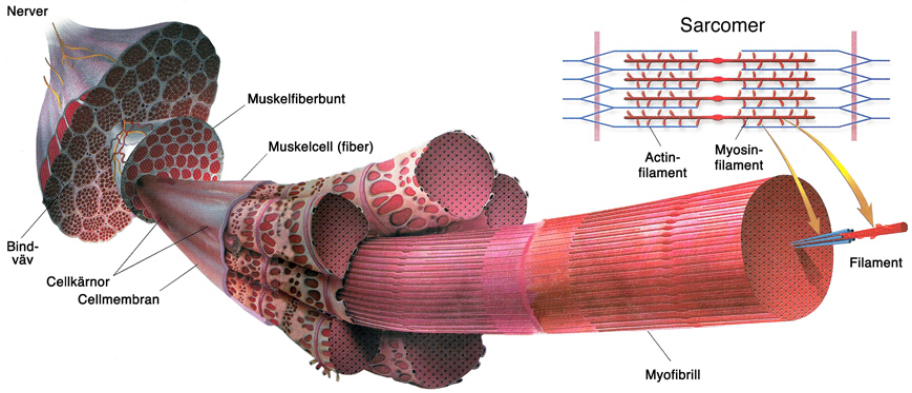


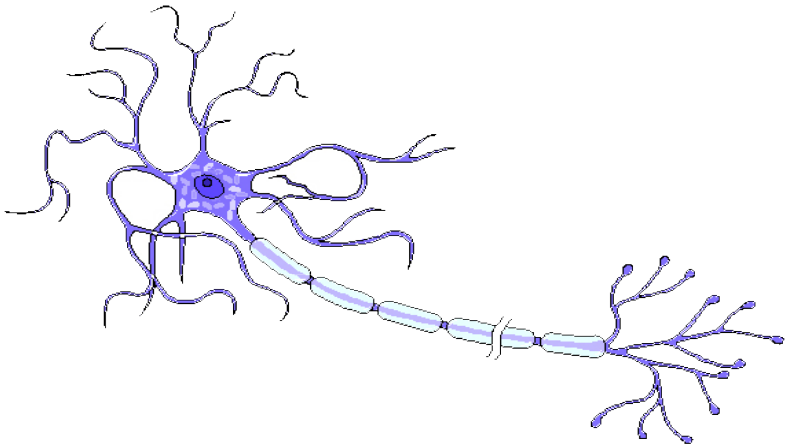
'Multidimensional' considerations at injections:

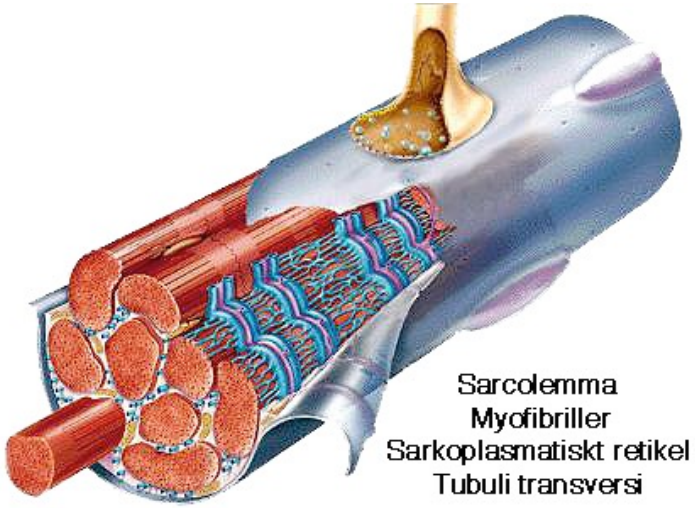
- One or several insertions/depositions?
- Dose in relation to injection volume?
- Diffusion of toxin – risk or possibility?

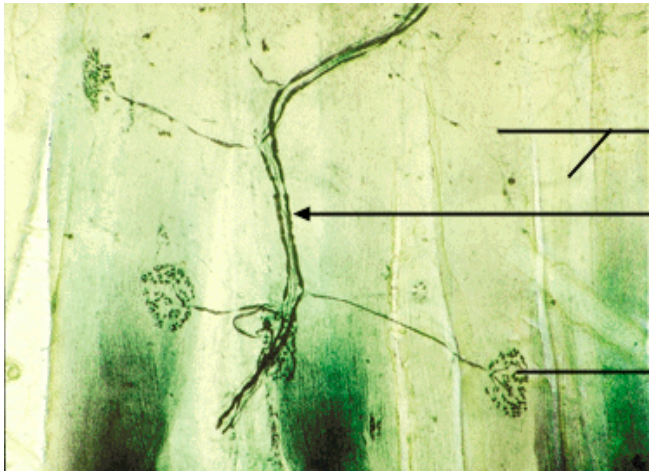












Muscle cells

Nerve fibre

End plate region

Several way to localise ‘the right position' for injection

- Ultrastund guidance
- Electrical stimulation
- EMG guidance

Choice of appropriate methods for feed-back:

- ”The right” muscles selected for treatment
  Clinical/functional findings; EMG; stimulation
- Toxin positioned close to the end plate region
  EMG
- Toxin positioned central in muscle or muscle fascicle
  Ultrasound (EMG?; stimulation?)

Assess the **biomechanical situation**

- Which movement is disturbed?
- Which muscles are synergists/antagonists to achieve the desired movement or position?
- Which muscle type is an appropriate ‘model’?
- Which intramuscular structure may prevail?
- Which is the consequence of overdosing?
- Which is the consequence of possible toxin leakage?

Asess if **’feed-back’ is needed** for optimal deposition:

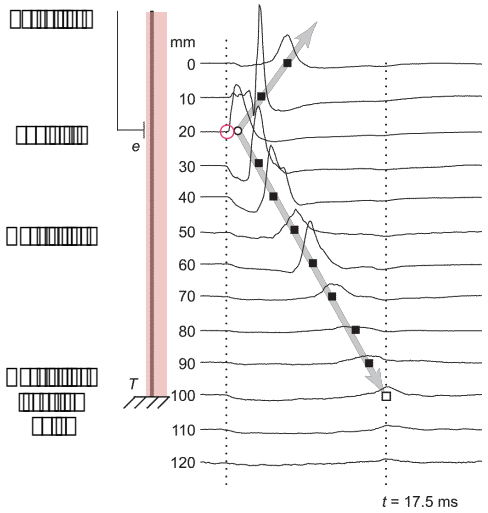
- Muscle accessibility?
- Nearness to other muscles?
- Strictly delimited muscular disturbance?
- Small or very thin muscle?
- Critical function of nearby muscles?

Use electrical stimulation to find the proper muscle

- Isolated muscular activation?
- Appropriate activation compared to a voluntary activation?

Use electrical recording for best deposition location

- Intramuscular EMG activity?
- Parallel EMG and biomechanical activation?
- ‘Focal position’ of tip of cannula close to end plates?



after: *J Appl Physiol* 2010 108:1530-41

EMG recording with the tip of the cannula in a ”focal position”, i.e. intra muscular and close to an end plate region, will produce:

”less low base and more high pitch” in the sound of the EMG signal!