Amsterdam UMC
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Dynamics of upper limb spastic paresis post stroke

Mechanisms, measurement and treatment

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Background

Upper limb motor impairments are one of the most common impairments post stroke and occur in up to 80% of all patients. Motor impairments post stroke comprise negative and positive upper motor neuron features. The negative features involve deficit symptoms, such as loss of voluntary motor function (paresis), and the positive features encompass involuntary muscle overactivity. The combination of negative and positive features leads to the typical clinical presentation of spastic paresis, which shows a considerable, still unexplained, variability between patients and changes over time post stroke. Clinically, spastic paresis is characterized by a loss of motor function, increased resistance to passive joint movement (i.e. joint hyper-resistance), reduced passive range of motion and postural change (figure A).

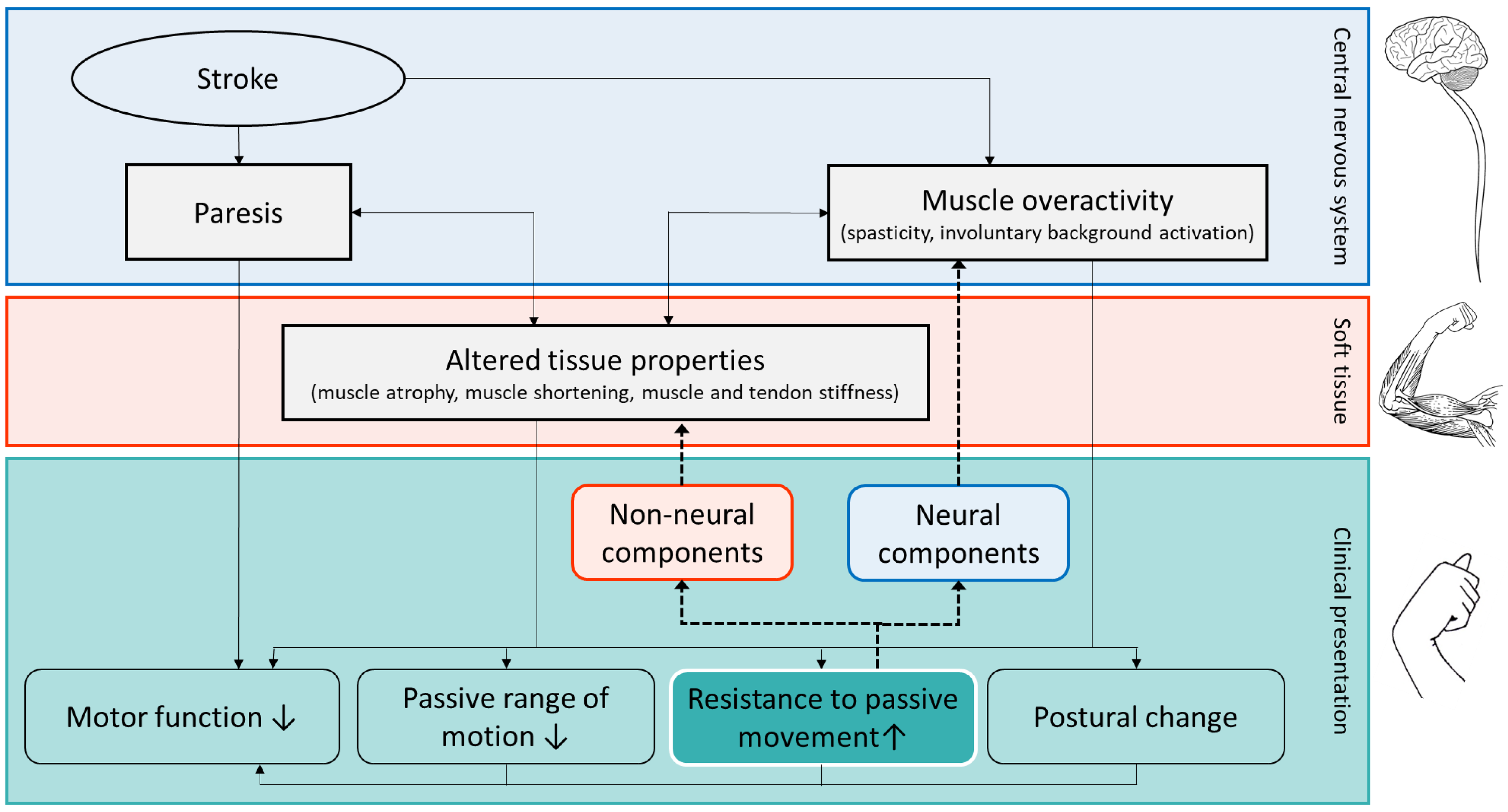

Figure A Upper limb spastic paresis post stroke

Figure B NeuroFlexor (Aggero MedTech, AB, Älta, Sweden)

Objective thesis

To investigate instrumented assessment (NeuroFlexor, figure B) to clinically quantify the underlying neural and non-neural components of wrist hyper-resistance in patients in the subacute and chronic phase post stroke and to explore its potential value for timely and patient-specific management of upper limb spastic paresis post stroke.

Main findings

- Botulinum toxin treatment in the upper limb post stroke is effective in reducing the total resistance to passive joint movement (modified Ashworth scale (MAS)) and improving self-care ability for the affected arm and hand. However, how BoNT affects the underlying components of increased resistance to passive joint movement remains unknown in the absence of a construct valid outcome measure. Botulinum toxin treatment alone has no effect on arm and hand capacity post stroke.

Andringa et al., Effectiveness of botulinum toxin treatment for upper limb spasticity poststroke over different ICF domains: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2019;100(9):1703-1725.

- Instrumented assessment using the NeuroFlexor provides a test-retest reliable, construct-valid and responsive estimate of the underlying neural and non-neural components of wrist hyper-resistance post stroke.

Andringa et al., Measurement properties of the NeuroFlexor device for quantifying neural and non-neural components of wrist hyper-resistance in chronic stroke. Front Neurol. 2019;10:730.
Andringa et al., Quantifying neural and non-neural components of wrist hyper-resistance after stroke: Comparing two instrumented assessment methods. Med Eng Phys. 2021;98:57-64.

- Patients with severe upper limb motor deficits early post stroke demonstrate a gradual increment in the neural and non-neural components of wrist hyper-resistance within the first 26 weeks post stroke. The main increase of the neural component occur within the first 5 weeks post stroke, paralleling the time window of spontaneous motor recovery, and is accompanied by a gradual increase in the non-neural elastic component after stroke.

Andringa et al., Time course of wrist hyper-resistance in relation to upper limb motor recovery early post-stroke. Neurorehabil Neural Repair. 2020;34(8):690-701.

- Botulinum toxin treatment leads to a dose-dependent reduction of the neural component of wrist hyper-resistance while the non-neural elastic and viscous components remain unaffected, suggesting a specific effect of botulinum toxin on the neural component.

Andringa et al., The effect of botulinum toxin-A on neural and non-neural components of wrist hyper-resistance in adults with stroke or cerebral palsy. PM R. 2021;1-10.

Conclusion

- Instrumented methods allow for standardized assessment and can provide objective and quantitative information of the underlying neural and non-neural components of joint hyper-resistance.
- Instrumented assessment of the underlying components of wrist hyper-resistance is of added value to current clinical assessment with the modified Ashworth scale (MAS).
- Instrumented assessment of wrist hyper-resistance gives more insight into the mechanisms underlying the clinical increased resistance to passive movement and provides a first step in further unravelling upper limb spastic paresis.

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