

## **INTEGRATING BOTULINUM THERAPY WITH MULTIMODAL STIMULATION AND INNOVATIVE APPROACHES IN HAND SPASTICITY: A LITERATURE REVIEW**

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### **Abstract**

Post-stroke spasticity limits voluntary hand movement, leading to pain and contractures. According to global research, approximately 30 percent of patients who have had a stroke develop spasticity in the upper limbs. Botulinum toxin type A (BTA) is considered the primary choice for reducing spasticity as a focal myorelaxant. In recent years, combining BTA with early neurorehabilitation, multimodal stimulation, and new local preparations is developing as an individualized and innovative approach.

### **Pathogenesis and Clinical Significance of Spasticity**

After a stroke, the motor control pathways in the brain (corticospinal system) are damaged. As a result, the "inhibitory" or "brake" signals necessary for regulating limb movement become insufficient. Normally, the brain simultaneously sends both commands for movement and signals to limit excessive excitation to the muscles. After a stroke, this balance is disrupted: the inhibitory (braking) influence decreases, while the excitatory influence intensifies. [2]

Therefore, the following changes occur:

Increased muscle tone (hypertonia) – muscles remain in a constantly contracted state, which creates resistance to passive movement.

Exaggerated reflexes (hyperreflexia) – an excessive response occurs to simple stimuli (e.g., touch to the skin or movement).

Pathological synergy – synergistic muscles contract simultaneously, meaning opposing muscle groups (e.g., flexors and extensors) involuntarily contract together.

Clinically, this condition limits voluntary hand movement: finger extension becomes difficult, and the shoulder and elbow remain in a constantly flexed position. If timely treatment is not provided:

Contractures – muscles and ligaments shorten, leading to complete loss of mobility in the arm. Pain and fibrosis – due to continuous muscle contraction, tissue pain and fibrosis develop. Reduced rehabilitation effectiveness – restricted range of motion prevents physiotherapy or exercises from achieving full results.

Therefore, early detection and targeted treatment of spasticity (for example, botulinum therapy) are crucial for preserving hand function and ensuring further recovery.

#### Key Clinical Evidence for Botulinum Therapy

Classical studies have demonstrated that botulinum toxin type A (BTA) is highly effective in reducing hand spasticity and improving passive range of motion, although it does not fully restore active function. BTA injections help relieve pain and prevent contracture formation. Meta-analyses confirm its role as a “first-line” therapy for the treatment of focal post-stroke spasticity. [4]

#### Integration with Multimodal Stimulation

In post-stroke spasticity management, combining botulinum therapy with various physiotherapeutic methods is known as multimodal stimulation.

Additional stimulation methods to retrain motor function include:

Functional electrical stimulation,

Robotic exoskeleton training,

Brain–computer interface (BCI) systems,

Specialized physiotherapy and therapeutic exercise programs (LFK). [5]

#### Synergistic Mechanism of Action

The synergistic effect of multimodal therapy enhances neuroplasticity, improves muscle tone regulation, and accelerates the restoration of voluntary motor control. Botulinum therapy reduces hypertonicity, allowing rehabilitative training to be more effective by providing a physiological basis for re-establishing coordinated movements:

Botulinum toxin therapy reduces muscle tone, thereby creating a "therapeutic window" for additional stimulations. As muscles relax, they respond more easily to electrical or mechanical stimulation, and new neural connections form faster in the brain. [6]

#### Clinical Significance:

A randomized study conducted in 2020 involving 84 patients demonstrated that multimodal rehabilitation initiated after botulinum toxin therapy significantly improved hand function (according to Ashworth and Fugl-Meyer scores) compared to conventional neurorehabilitation.

This indicates the necessity of using botulinum toxin therapy as a starting point for complex neurorehabilitation. [3]

#### Individual Injections under Ultrasound Guidance:

Performing injections under ultrasound (US) guidance increases accuracy and safety in botulinum toxin therapy. Ultrasound allows for visualization of the target muscle, the injection path, and needle depth. This reduces the risk of drug diffusion to other areas, enables individualized dosing, and enhances efficacy.

Clinical studies have shown that US-guided injections yield higher efficacy and fewer side effects compared to traditional methods based on palpation or anatomical landmarks. [3]

#### Innovative Directions and Future Prospects:

Individualized botulinum toxin therapy involves tailoring dosage and muscle selection based on the patient's clinical characteristics, spasticity pattern, and rehabilitation program. Precise injections under ultrasound guidance, multimodal stimulation (exoskeletons, robotic therapy, neurointerfaces), and the use of local medications create new possibilities for restoring hand function. At the same time, multi-stage studies are required that focus not only on passive movement but also on restoring active motor function.

#### **Conclusion**

Literature analysis confirms the high clinical efficacy and safety of botulinum toxin therapy in hand spasticity. The individualized application of BTA under ultrasound guidance, combined with multimodal stimulation and the use of local medications, elevates the rehabilitation process to a new level. At the same time, future research should be aimed at further improving individual protocols and active motor recovery.

## REFERENCES

1. Луцик В.Н. Ботулинотерапия постинсультной спастичности руки. \*Клиническая геронтология\*. 2019.
2. Королев А.А. К вопросу о ботулинотерапии постинсультного спастического пареза: механизмы действия ботулотоксина, алгоритм восстановительного лечения. Лечащий врач. 2012; 2: 78-84. Korolev A.A.
3. Луцик В.Н. ва ҳамкорлар. Ботулинотерапия постинсультной спастичности руки в сочетании с мультимодальной стимуляцией. \*Неврология, нейропсихиатрия, психосоматика\*. 2020.
4. Lance J. Spasticity: Disorders motor control. In: Feldman R.G., Young R.P., Koella W.P. editors. Symposium synopsis. Miami, FL: Year Book Medical Publishers; 1980
5. Епифанов В.А., Епифанов А.В. Реабилитация больных, перенесших инсульт. М.: МЕДпресс-информ; 2013. 243 с. Epifanov V.A., Epifanov A.V. [Rehabilitation of stroke patients.] Moscow: MEDpress-Inform; 2013. 243 p. Russian.
6. Sommerfeld D.K., Eek E.U., Svensson A.K., et al. Spasticity after stroke: Its occurrence and association with motor impairments and activity limitations. Stroke. 2004; 35: 134-139. DOI: 10.1161/01.STR.0000105386.05173.5E
7. Артемьев ДВ, Орлова ОР, Моренкова АЗ. Использование ботокса в медицинской практике. Журнал неврологии и психиатрии им. С.С. Корсакова. 2000;(4):46-51
8. Кадыков АС, Шахпаронова НВ. Спастичность как проблема двигательной реабилитации: роль миорелаксантов. Consilium Medicum.



- Неврология и ревматология. 2014;(1):56-9.
9. European Stroke Organisation (ESO) Executive Committee; ESO Writing Committee. Guidelines for management of ischemic stroke and transient ischemic attack. Cerebrovasc Dis. 2008;25(5):457- 507. doi: 10.1159/000131083. Epub 2008 May 6.
10. Urban PP, Wolf T, Uebele M. Occurrence and ceruical predictors of spasticity after ischemic stroke. Stroke. 2010 Sep;41(9):2016-20. doi: 10.1161/STROKEAHA.110.581991. Epub 2010 Aug 12
11. Хасанова ДР, Агафонова НВ. Ботулинотерапия при ранней постинсультной спастичности руки. Клиническая геронтология. 2012; 18(11-12):25-31.