

# OROFACIAL RESISTIVE EXERCISES FOR ADULTS WITH SEVERE STUTTERING

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## Introduction

### Stuttering is accompanied by abnormal activity of speech related muscles

- Stutterers demonstrate involuntary spasmodic movements of the tongue, the larynx and the vocal folds at the moment of the intention of speaking (Freeman & Ushijima, 1978; Monfrais-Pfauwadel et al, 2005)
- During dysfluent speech the jaw, the lip, and laryngeal muscles of stutterers show rhythmic tremor-like oscillations of EMG activity (Kelly et al, 1995; Smith, 1989; Smith et al, 1993).
- Speech in stutterers is characterized by chaotic contractions of the diaphragm, rib cage and abdominal muscles singly or in various combinations (Zocchi et al, 1990).

### Stuttering is associated with dyscoordination of different muscle systems

- Stuttering nature is associated with dyscoordination and asynchrony of lip, tongue, and jaw muscles (McClean & Runyan, 2000; Zimmermann, 1980).
- Stuttering is accompanied by disruption of normal interaction between laryngeal, articulatory, and respiratory systems (Conture et al, 1985; Freeman & Ushijima, 1978).

In the cases of severe stuttering all above mentioned symptoms aggravate and intensify. Moreover, in some cases of severe stuttering we observed specific for every patient complexes of involuntary movements, forestalling speech initiation. It could include prolonged (2-8 sec) spasms or perseverative labial, mandibular movements and vocal ticks. As far as pathologic muscular activity appears to be one of the fundamental elements of the stuttering pathogenesis, it seems logical to employ muscle exercises to influence stuttering symptoms. Thereby the purpose of this investigation was to evaluate the therapeutic effects of 1) conventional dynamic orofacial exercises and 2) static resistive orofacial exercises in adult patients with severe developmental stuttering.

## Method

### Static exercises group

- 9 subjects (1 f, 8 m);
- Mean age 32 years;
- Mean %SS - 24 %SS;
- 3 weeks of static exercises;
- 3 clinical sessions;
- Daily training sessions (60-90 minutes);
- 9 set of exercises:
  - 3 for tongue;
  - 3 for lips;
  - 3 for neck/larynx;
- 1 set – 10 exercises;
- 1 exercise – 10-60 seconds

### Dynamic exercises group

- 9 subjects (2 f, 7 m);
- Mean age 30 years;
- Mean %SS - 21 %SS;
- 3 weeks of dynamic exercises;
- 3 clinical sessions;
- Daily training sessions (60-90 minutes);
- 9 set of exercises:
  - 3 for tongue;
  - 3 for lips;
  - 3 for neck/larynx;
- 1 set – 50 exercises;
- 1 exercise – 1-3 seconds

## Method

### Static exercises for tongue

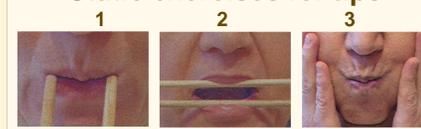


### Dynamic exercises for tongue



## Method

### Static exercises for lips



### Dynamic exercises for lips



## Method

### Static exercises for larynx

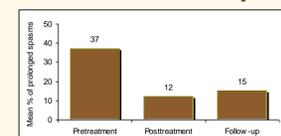


### Dynamic exercises for larynx



## Results

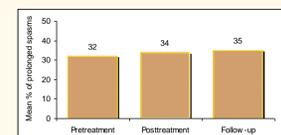
### Static resistive exercises attenuate muscle spasms



Amount of prolonged spasms and blocks, where duration of syllable repetitions, prolongations of speech sounds, or within-word pauses lasted more than 2 seconds, significantly reduced ( $p < 0.001$ , Wilcoxon matched pairs test).

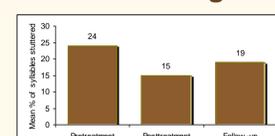
Amount and duration of complexes of involuntary movements before speech initiation significantly reduced.

### Dynamic exercises did not influence muscle spasms



## Results

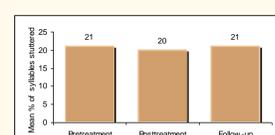
### Static resistive exercises decrease stuttering severity



Positive speech alterations in participants from static exercises group also included reduction of stuttering severity.

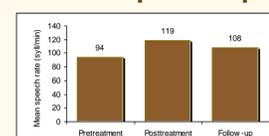
Average individual meanings in percentage of syllables stuttered significantly decreased after the course of resistive training and still remained at improved level 3 weeks later ( $p < 0.01$ , Wilcoxon matched pairs test).

### Dynamic exercises did not influence stuttering severity



## Results

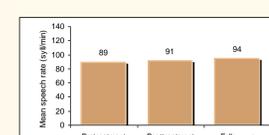
### Static resistive exercises increase speech speed



In static exercises group averaged individual speech rate before the treatment was 94 syllables/minute.

By the end of the treatment period, speech speed in all subjects significantly increased ( $p < 0.01$ , Wilcoxon matched pairs test) and remained at enhanced level (108 syllables/minute) till the last speech assessment.

### Dynamic exercises did not change speech speed



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## Discussion

According to numerous investigations, human muscles adapts differently to static resistive or to dynamic training programs (Del Balso & Cafarelli, 2007; Duchateau & Hainaut, 1984; Griffin & Cafarelli, 2005; Sale, 1988). Isometric resistance exercises induce neuromuscular activation and stimulate muscle growth and strength (Andersen et al, 2006; Pucci et al, 2006). Even after a single bout of resistance exercise, muscle protein synthesis and RNA activity was significantly elevated in the muscles 4 and 24 h postexercise (Chesley et al, 1992). Possible morphological adaptations involve activation of satellite cells, hyperplasia, changes in fiber type, muscle architecture, myofibril density and the structure of connective tissue (Folland & Williams, 2007).

It has been well documented cortical angiogenesis (Kleim et al, 2002; Swain et al, 2003), dendritic and synaptic hypertrophy and synaptogenesis within the motor cortex, cerebellum and striatum after extensive motor skill training (Adkins, 2002; Comery et al, 1995; Greenough et al, 1985; Jones et al, 1999; Kleim et al, 1996; Kleim et al, 1997a,b; Withers and Greenough, 1989). Increased voluntary activity leads to dendrite restructuring, increased protein synthesis, increased axon transport of proteins, enhanced neuromuscular transmission dynamics, and changes in electrophysiological properties at the level of the alpha-motoneurons (Gardiner et al, 2006).

It is possible that changes in sensitivity of the muscle spindles (Häkkinen & Komi, 1983) may raise thresholds of neuromuscular excitation. In this case some parts of compulsive efferent stimuli turn into subthreshold excitators and did not influence speech related muscles. As a result, amount of pathological involuntary movements decrease. Hereby static resistive exercises could induce alterations in central and peripheral mechanisms of neuromuscular transmission. It could initiate positive changes in activity of orofacial and laryngeal muscles, develop muscle control, normalize muscle tonus and decrease intensity of involuntary muscle activity.

## Conclusions

Our results indicate that static resistive exercises appear to be an effective treatment option for decreasing stuttering severity in adult patients. The most important outcome of the application of static resistive exercises is the shortening and the attenuating of prolonged muscle spasms. Changes in percentage of syllables stuttered and speech speed are not substantial enough to consider exercise training as independent therapeutic procedure for stuttering therapy. During for more than 20 years we are successfully applying suggested exercises as treatment element for preliminary period of stuttering rehabilitation. It facilitate subsequent treatment, increase its effectiveness and decrease treatment time.

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