Technically Assisted Rehabilitation of the Hand after Stroke by Means of the HFD 200 Hand and Finger Dynamometer

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Goal:

The re-establishment of the functionality of patients' hands after suffering a stroke often poses a difficult task to patients and doctors alike. Our aim was to restore or significantly enhance the functionality of their hands when prior treatment had been unsuccessful, i. e. difficult to treat or even resistant to therapy. In particular, the goals were:

- Reconstruction of voluntary motoric ability of the hand
- Reduction and minimalization of spasms
- Reconstruction of mobility and capability to perform common tasks and work activities

Pursuing these goals the effectiveness of our technically assisted rehabilitation method was put to the test.

Method:

12 male patients (58.6 ± 6 years) and 7 female patients (59.3 ±11.5 years) were treated. In the past these patients had undergone extensive rehabilitation programs like:

- Physiotherapy - (Bobath-Concept, PNF-Techniques) (Davies 2002, Renata 2005),
- Remedial gymnastics (active and passive mobility exercises, electrical stimulation currents)
- Occupational therapy (using weaving and braiding techniques, exercises aiming at improving mobility and strength by working with clay and plasticine)

In our practice, the patients received training amd exercise treatment with the HFD 200 Hand and Finger Dynamometer (image 1), (Weber 2003, Weber 2011).

image. 1: Hand and Finger Dynamometer HFD 200 with screen and PC (base model)

Senso-motoric training treatments were conducted with 14 patients to increase the strength of the hand and the individual fingers. These were eight male and five female patients suffering from functional incomplete flaccid or spastic paresis plus one female patient with functional complete spastic paresis due to spasms of the flexor and extensor muscles of the finger (spastic claw hand), (image 2)

	
Image 2: spastic paresis of the left hand – claw hand after three years of treatment with electrical currents condition before beginning our exercise (seven years after a stroke)	**Image 3: decrease of the spastic patterns in posture and movement (claw hand), control over arm after seven years of paresis, ability to open and close door, front limbs of the fingers are in neutral position**

Five patients received exercise treatments, four male and one female patient suffered from functional complete paresis with flaccid paresis of the finger flexors and spastic paresis of the finger extensors.

The exercise treatments consisted of two parts. In the first part the patient tried to develop the maximum voluntary gripping strength on the Hand and Finger Dynamometer in order to reduce the spasms of the muscles in the hand. In the second part the patients tried to open the spastic hand. This way the paralyzed hand was activated at the same time by the healthy hand, by applying less gripping strength on the Hand and Finger Dynamometer (contra-lateral activation).

Results:

The number of exercises and sessions until obvious success could be registered was 47 om average in the case of male patients and 27 on average for female patients. The maximum number of senso-motoric treatments on the hand and finger dynamometer was 150.

A statistically proven increase in the maximum voluntary hand gripping strength MPHB and hand opening strength MPHS was monitored during the first 21 training and exercise sessions of male patients. As for the female patients this was observed during the first 16 training and exercise sessions. The maximum hand gripping strength and hand opening strength was measured, trained and exercised at the middle of the fingers' middle limbs under isometric conditions.

The maximum gripping strength (bending strength finger II – V) increased for the whole group of 12 men on average from 15.7 ± 7.5 kp to 33.3 ± 18.3 kp. For the eight men with incomplete flaccid or spastic paresis the gripping strength increased considerably from 18.1± 6.0 kp to 41.9 ±15.7 kp on average. The maximum voluntary hand opening strength (flexing strength finger II –V) of those men

increased significantly from 4.0 ± 3.1 kp to 8.6 ± 6.3 kp. The maximum gripping strength of all seven women increased on average from 20.8 ± 8.1 kp tp 26.4 ± 8.4 kp.

The dramatic rise in maximum gripping strength MPHB and hand opening strength MPHS of the eight male and five female patients with incomplete paresis proves restoration or improvement of their condition with regard to the following

basic functions and capabilities:

- coordinated bending and flexing of all fingers individually and simultaneously
- tweezers grip of fingers I to fingers II to V
- gripping function of the hand
- ability to carry loads of 5 to 10 kp (improved function of the arm)

Ability for activities of daily life, for example:

- opening a door (image 3)
- eating with fork and knife, drinking from a cup
- writing and tying a knot
- sewing with a needle (image 4)
- opening and closing a zipper
- ironing with an iron

Craftsmanship:

- manual work like working with a hacksaw, hammer, chisel and trowel
- fine detailed work such as: sewing and knitting

Image 4: Considerable decrease of finger spasm (claw hand before senso-motoric exercises), putting a thread through the eye of a needle and releasing it after 30 training sessions, active bending and flexing of all limbs of all fingers, carrying out nearly all household chores without extra help (visual control of activities, however, of the right hand due to lack of sensibility of proprioceptors)

For the four male patients and the one female patient with complete paresis due to flaccid paresis of the extensor muscles and spastic paresis of the flexor muscles the flexing spasm of the fingers was reduced (only through exercises). The fingers were mainly relaxed and slightly bent. A female patient with complete paresis succeeded to gain partial re-establishment of the function of the hand after 56 treatments, having suffered of her condition for five years (image 5). She was then able to complete simple tasks (e. g. drinking from a cup, cutting bread with a bread cutting machine, doing the dishes, vacuum-clean, ironing).

All patients' pathological innervation patterns such as spastic positions and movements as well as acroataxia improved significantly and permanently. Additional targeted and intensive treatments of individual functions and abilities were not pursued. The senso-motoric training and exercise sessions also had other positive effects such as improved speech, concentration and attention span, endurance performance of the lower extremity and the whole body.

Image 5: Distinct stretching of finger III to V after approx. 50 training sessions, (visual control of the right hand necessary due to lack of sensibility of proprioceptors)

Conclusions:

- For most patients the technically assisted rehabilitation with the Hand and Finger Dynamometer HFD 200 lead to re-establishment of mobility and ability for actvities of daily life of their hands so that gross and fine motor skills were re-established, they were again self-sufficient and able to carry out simple craftmanship.

- With increased opening and closing strength and with increased voluntary influence the pathological innervation patterns decreased and former mobility and action programs restarted even without targeted extra exercise.

- The results of the technically assisted rehabilitation proved considerable potential for rehabilitation even for therapy resistant or difficult to treat patients and even years after a stroke.

- The senso-motoric training and exercise sessions had a high rehabilitation effect.

Literature:

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