

HASOMED

# RehaMove®

Functional electrical stimulation



FES applications

## For all therapeutic areas

The functional electrical stimulation (FES) is highly important for the therapy and rehabilitation of paralytic illnesses. If correctly used, FES is an effective method for the prevention or retardation of disuse atrophies. Whether it is used to increase local blood circulation, to relax muscle spasms or to maintain or increase the range of motion – FES with RehaStim2 opens up new possibilities!

## Extended opportunities with sequence training

With the help of sequence training, FES applications from 1-channel hand extension to 8-channel gait training are possible. Standard templates allow an easy and quick setup of the motion sequence to be stimulated. Any sequence training template can be customized by individually adjustable stimulation and resting periods.

## Flexibility in usage

- Automatic timing of simulation sequences
- Manual initiation of single sequences with one touch
- External hand switch for several stimulation sequences



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## Application examples

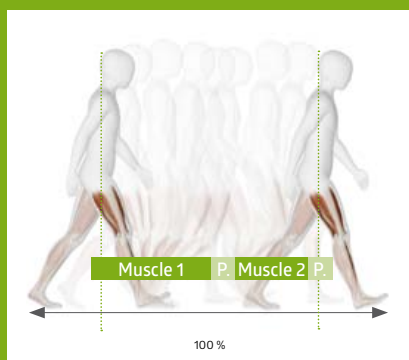
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# Percentage or seconds?

The stimulation sequences can be programmed in an absolute manner (in seconds) or relative to the complete movement cycle (in percent). The interval setting determines the resting interval after each movement cycle.

## Percentage

One complete movement (e.g. one double step) corresponds to 100%. The duration of the period indicates the movement duration. The user defines the relative proportions of the individual sequences of the complete movement in percent. The resting intervals are generated automatically.



### Example:

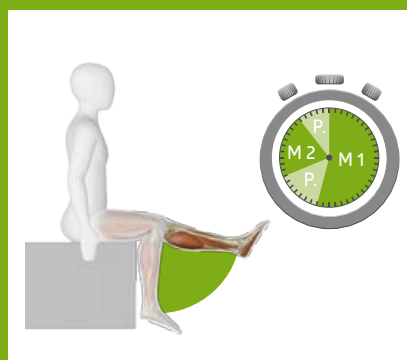
Muscle 1: 0-50%  
Muscle 2: 60-90%  
Period: 10 s

Stimulation M1 5s → 1 s break  
Stimulation M2 3s → 1 s break

## Seconds

The duration of each individual sequence is indicated by the start and end time in seconds.

The resting times between the individual sequences result from the end and starting points of two consecutive sequences.



### Example:

Muscle 1: 0-3 s  
Muscle 2: 4-6 s  
Interval: 2 s

Automatic break of 1 s between muscle 1 and muscle 2, 2 s break after muscle 2

# Using stimulation templates

There are a number of pre-made templates for a variety of sequence training applications. The muscles to be stimulated are assigned fixed channels and stimulation times.

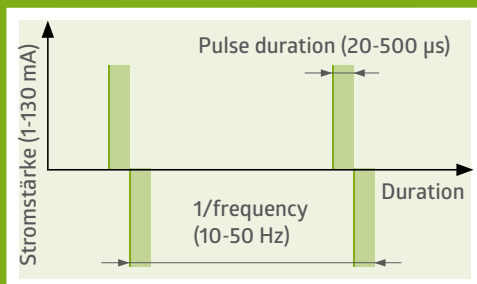


The templates are sorted according to the application area: upper extremities, lower extremities and trunk. Templates can be individually customized and modified. Assignment of muscles and stimulation channels as well as defining the stimulation periods / percentages can be done individually at any time.

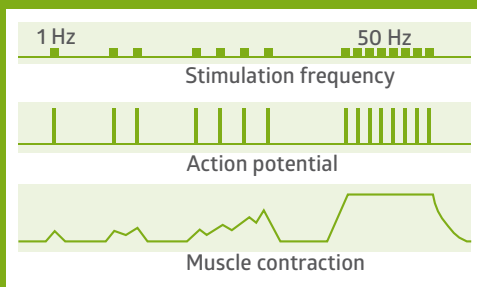
# Correct stimulation parameters

People are different in terms of their muscular constitution, physical nature and their individual stimulus thresholds. Therefore, parameters for electrical stimulation must always be individually adjusted.

- **Frequency:** Number of single pulses per second; crucial for the contraction intensity and muscle fatigue
- **Pulse width / pulse duration:** Duration of the impulse, which is crucial for fiber recruitment (long pulses recruit more motor and sensitive nerve fibers)
- **Current / amplitude:** Pulse height, which is relevant to threshold crossing (sensitive, motor or painful supra-threshold)



Stimulation duration depends on the desired therapeutic goals. Lower intensities allow longer stimulation periods, high intensities should only be applied for a short period.



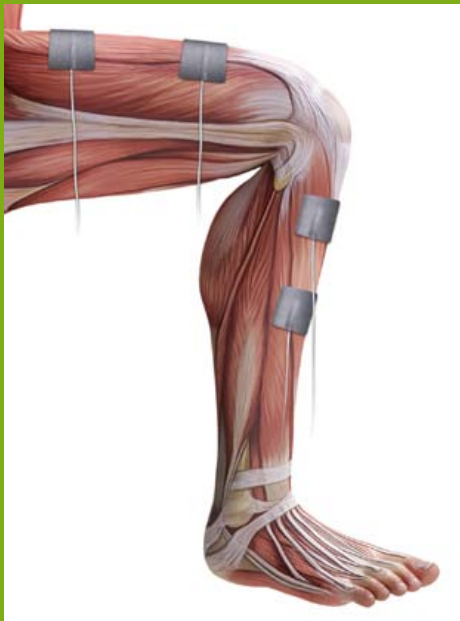
For exact details on duration and frequency of the particular application should be settled in consultation with the patient, therapist, and doctor.

# Positioning of the electrodes

With the help of FES, the motor nerve of a muscle gets stimulated. The action potential is directly generated within the efference. A 100% exact and reproducible positioning of the electrodes is almost impossible due to the different location of the motor nerves.

If required, or in case of an unsatisfactory stimulation result, the electrode position can be adjusted at any time.

The electrodes should be placed to ensure stimulation over the belly of the muscle along the muscle fiber, with a distance of at least one electrode between them.



Please note that different muscles require different electrode positionings appropriate to their muscle fiber direction and other muscles close-by with antagonistic functions.

For instance a wrong electrode application for muscle Tibialis Anterior could affect an unwanted stimulation of the antagonistic Soleus muscle.



without Stimulation



with Stimulation



# Hand extension

The hand extension is essential to carry out simple tasks in daily routines and having adequate strength is fundamental to these movements. Disuse atrophies in case of apoplexy or tetraplegia in particular can be treated supportively with FES.



## Template:

· wrist\_extension\_1Ch (unilateral/bilateral), PERCENT/SECONDS

## Stimulated muscles:

M. extensor radialis, M. brachioradialis

## Stimulation duration:

5-20 minutes (depending on constitution)

## Stimulation parameters:

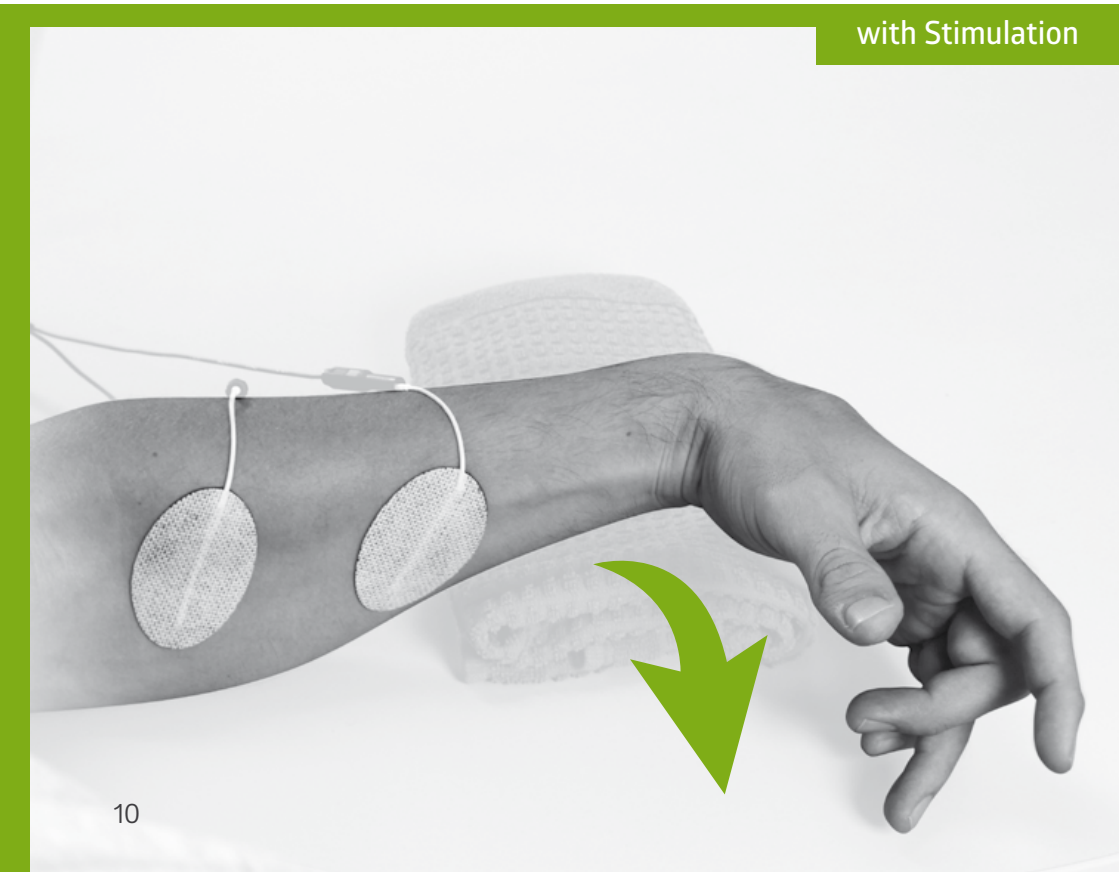
- Pulse duration: 100-400  $\mu$ s (depending on degree of muscle innervation)
- Amplitude: individually approx. 10% above the motor threshold  
(Example: motor threshold at 20 mA, then adjust amplitude value to 22 mA)
- Frequency: 35-50 Hz for atrophy prevention, 10 Hz for relaxation

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape)



without Stimulation



with Stimulation

# Hand flexion

Due to spasms, there is often a hypertonic fixation of the hand flexion. In order to strengthen the antagonistic extensor muscles, it is vital to fatigue the spastic flexor muscles. A low stimulation frequency is used to reduce hypertension.



## Template:

- thumb\_radial abduction (unilateral/bilateral), PERCENT/SECONDS

## Stimulated muscles:

M. flexor radialis, M. flexor ulnaris

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

- Pulse duration: 100-200  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 10 Hz relaxation, 35-50 Hz for atrophy prevention

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape)



# Elbow extension

Especially with tetraplegic patients, the elbow extensor muscles are often only partially innervated. Movements like the simple support step are only possible with difficulty. When flexion spasticity is also present, there is the danger of elbow contracture. Stimulation of the M. triceps brachii can maintain muscular atrophy and improve the range of motion.

## Stimulated muscles:

M. triceps brachii

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

- Pulse duration: 100-400  $\mu$ s (depending on degree of muscle innervation)  
Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape);  
for sensible patients: 5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Elbow flexion

A basic tone and/or corresponding strengthening of the elbow flexor is important for co-ordinated hand-eye-movements or for grabbing. To calm existing spasms, the flexor muscles must be relaxed, similar to relaxing hand flexion.

## Stimulated muscles:

M. biceps brachii

## Stimulation duration:

depending on constitution, 5-20 minutes

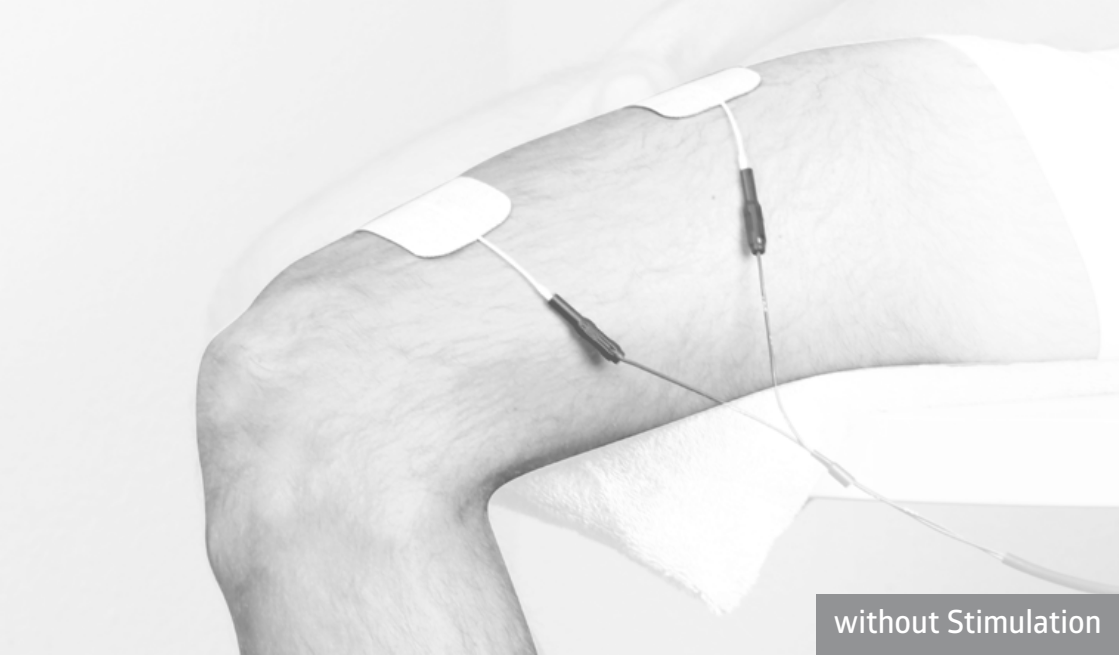
## Stimulation parameters:

- Pulse duration: 100-200  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention, 10 Hz for relaxation

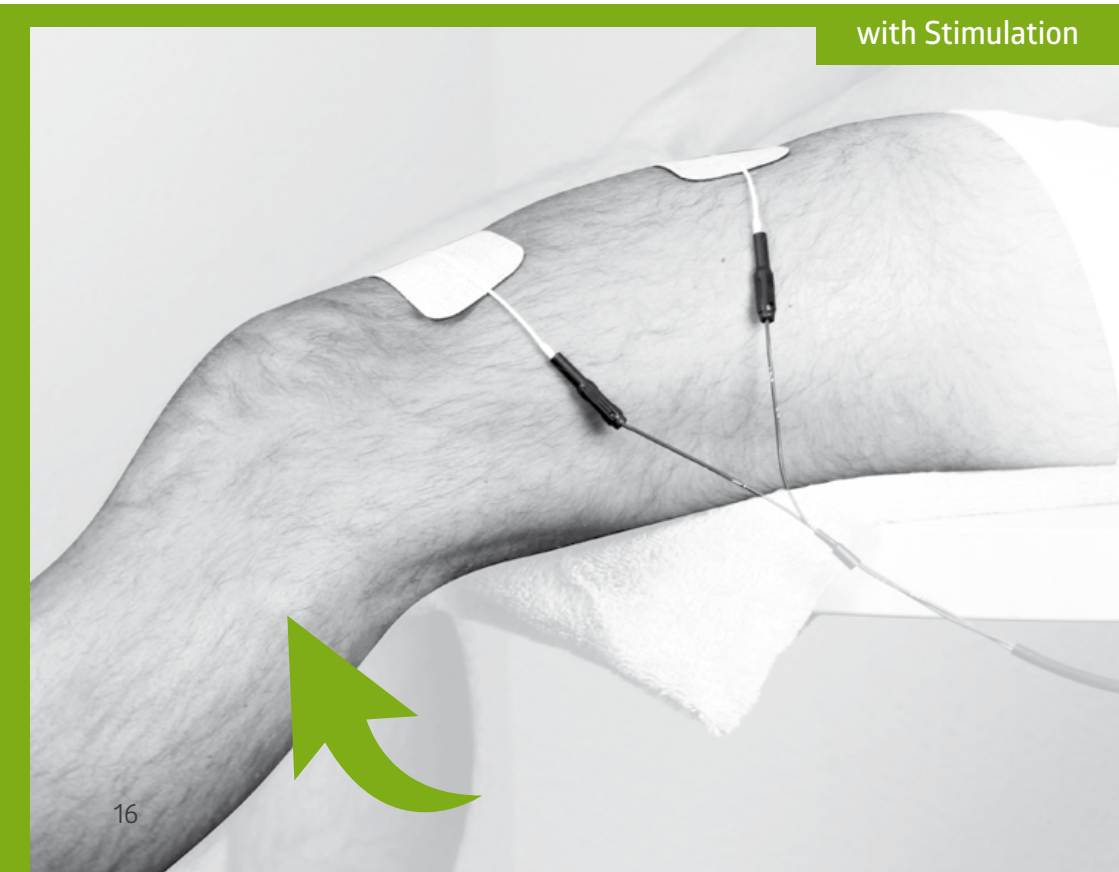
## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape);

for sensible patients: 5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation



# Knee extension

Knee extension is the prerequisite for standing or gait movements. If the M. quadriceps is partially innervated FES can prevent or retard disuse atrophy. Maintaining muscle structure and tone plays another important metabolic role.



## Template:

· knee\_extension (unilateral/bilateral), PERCENT/SECONDS

## Stimulated muscles:

M. quadriceps (M. vastus medialis, M. rectus femoris)

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

- Pulse duration: 200-500  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention, 10 Hz for relaxation

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Knee flexion

As antagonist of the M. quadriceps, the knee flexion muscles are an important counter of extension spasms. By stimulating the flexors, you can achieve an indirect stretch of the extensors. Additionally, stimulating in the sense of increasing tone and metabolic rate is helpful.

## Stimulated muscles:

M. biceps femoris

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

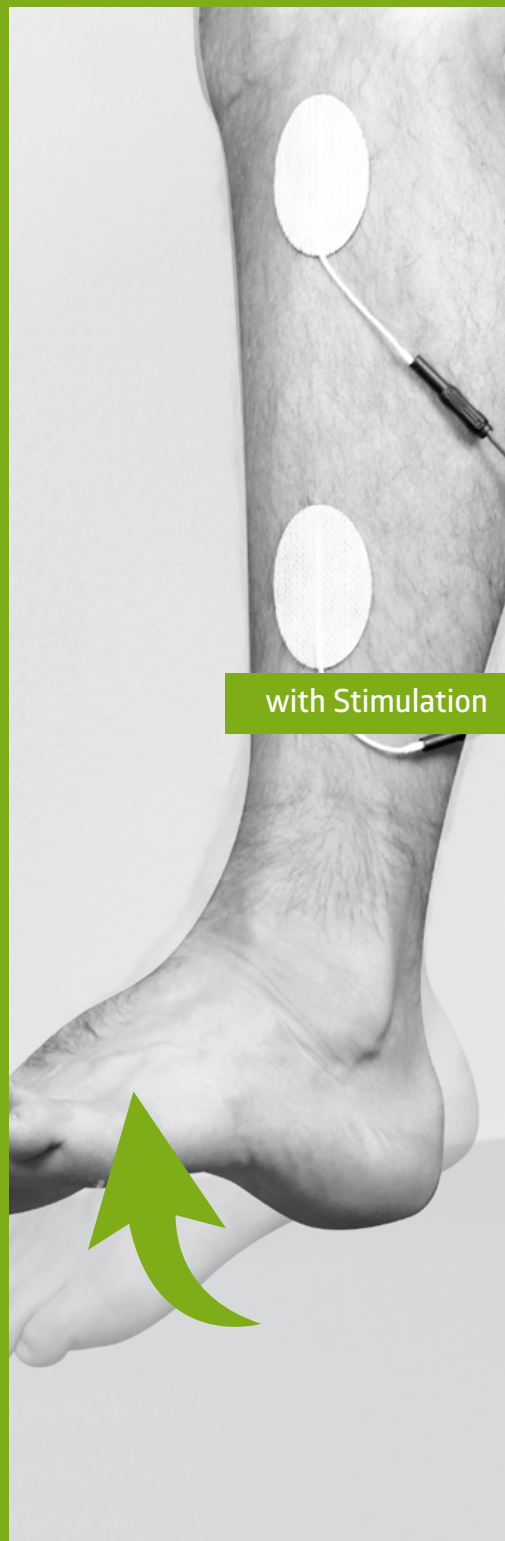
- Pulse duration: 200-500  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention, 10 Hz for relaxation

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Foot raise

To prevent drop foot symptoms in case of a hemi or paraparesis, it is helpful to stimulate the muscles for dorsiflexion of the foot. An achieved atrophy prevention can support further therapies.



## Template:

· foot\_dorsal extension (unilateral/bilateral), PERCENT/SECONDS

## Stimulated muscles:

M. tibialis anterior, M. peronäus

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

- Pulse duration: 250-500  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape)



# Foot extension

The calf musculature is important to a stable cardiovascular system. In case of long lasting inactivity and high spasticity, its function as venous pump is strongly affected. FES allows an effective blood circulation and atrophy prevention of the calf muscles.



## Template:

· foot\_dorsal ext./plantar flex.\_2Ch (unilateral), PERCENT/SECONDS

## Stimulated muscles:

M. gastrocnemius

## Stimulation duration:

depending on constitution, 5-20 minutes

## Stimulation parameters:

- Pulse duration: 200-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention, 10 Hz for relaxation

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape)



without Stimulation



with Stimulation



# Shoulder stabilization

Particularly with hemi and tetraplegia there is a great danger of shoulder subluxation due to the atrophy of the rotator cuff muscles. FES of the affected musculature helps to retard of disuse atrophy.



## Template:

· shoulder stabilization (unilateral/bilateral), PERCENT/SECONDS

## Stimulated muscles:

M. deltoideus, M. supraspinatus

## Stimulation duration:

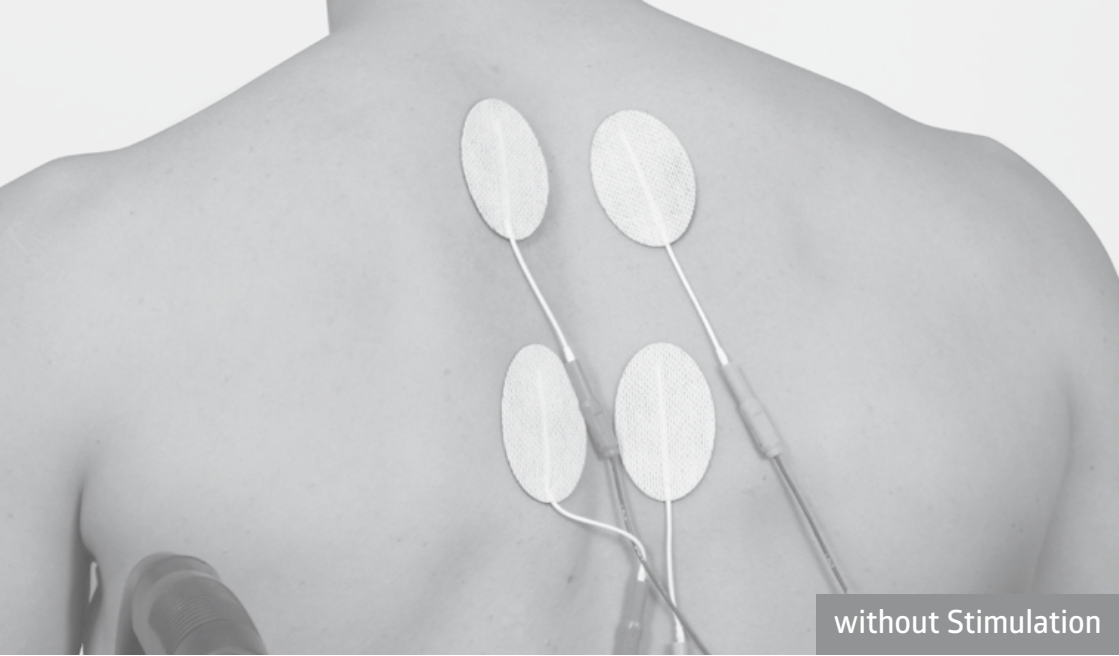
depending on constitution, 5-20 minutes

## Stimulation parameters:

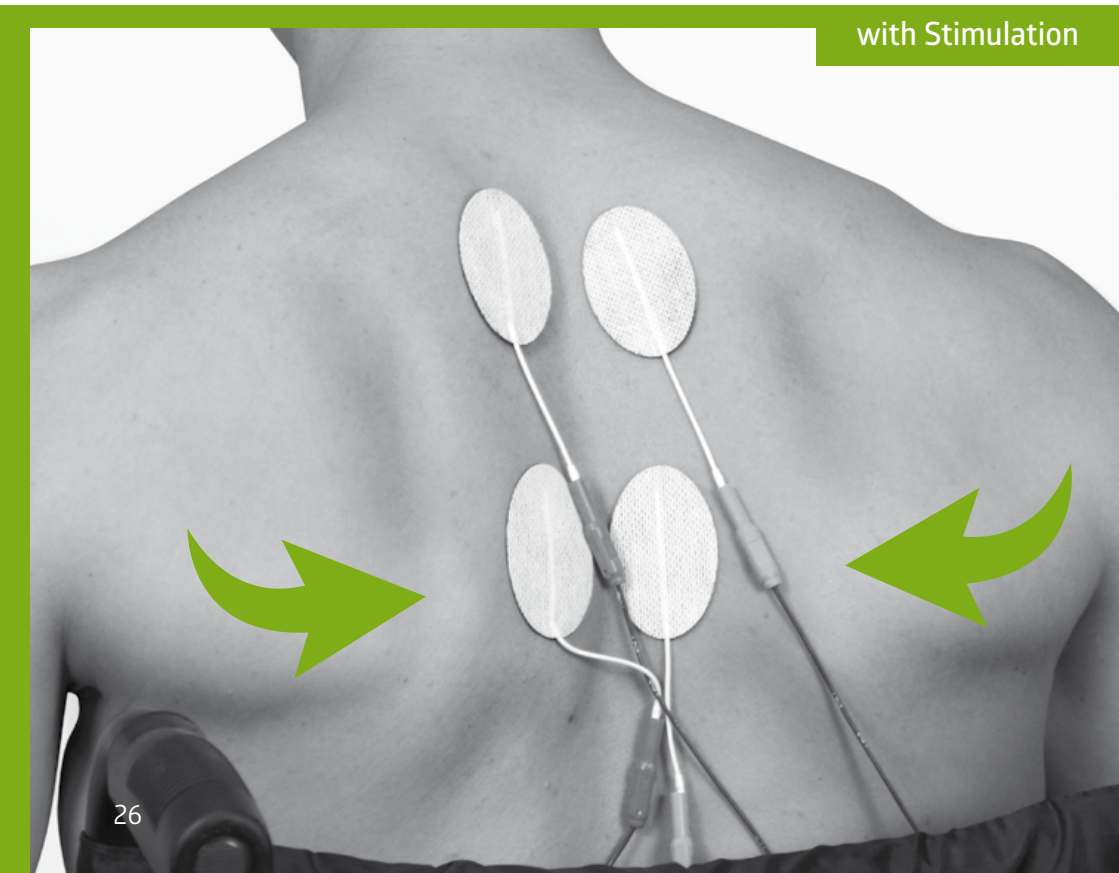
- Pulse duration: 100-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape)



without Stimulation



with Stimulation

# Shoulder straightening

Stimulation of the rhomboidei is a proven method to improve posture in terms of prevent atrophy of disused back muscles, in particular of wheelchair users. Straightening/ stretching of the thoracic spine can be an effective prophylaxis against hunchback symptoms and supports the respiratory muscles.



## Template:

· lumbar\_spine\_extension\_2Ch (bilateral); PERCENT/SECONDS

## Stimulated muscles:

M. rhomboideus

## Stimulation duration:

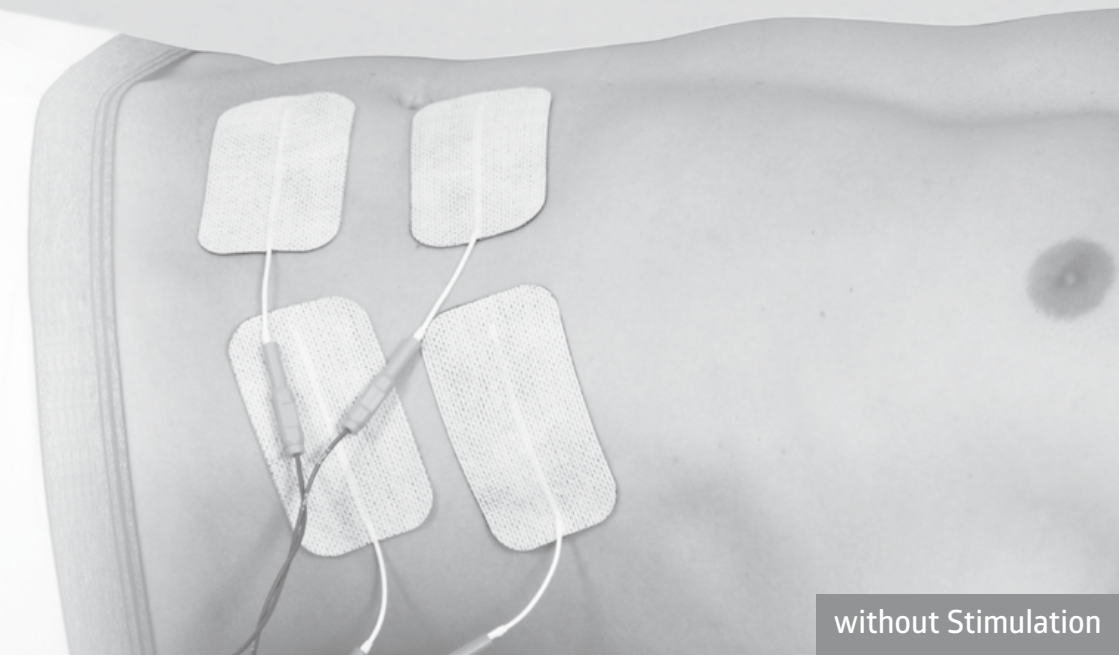
depending on constitution, 5-20 minutes

## Stimulation parameters:

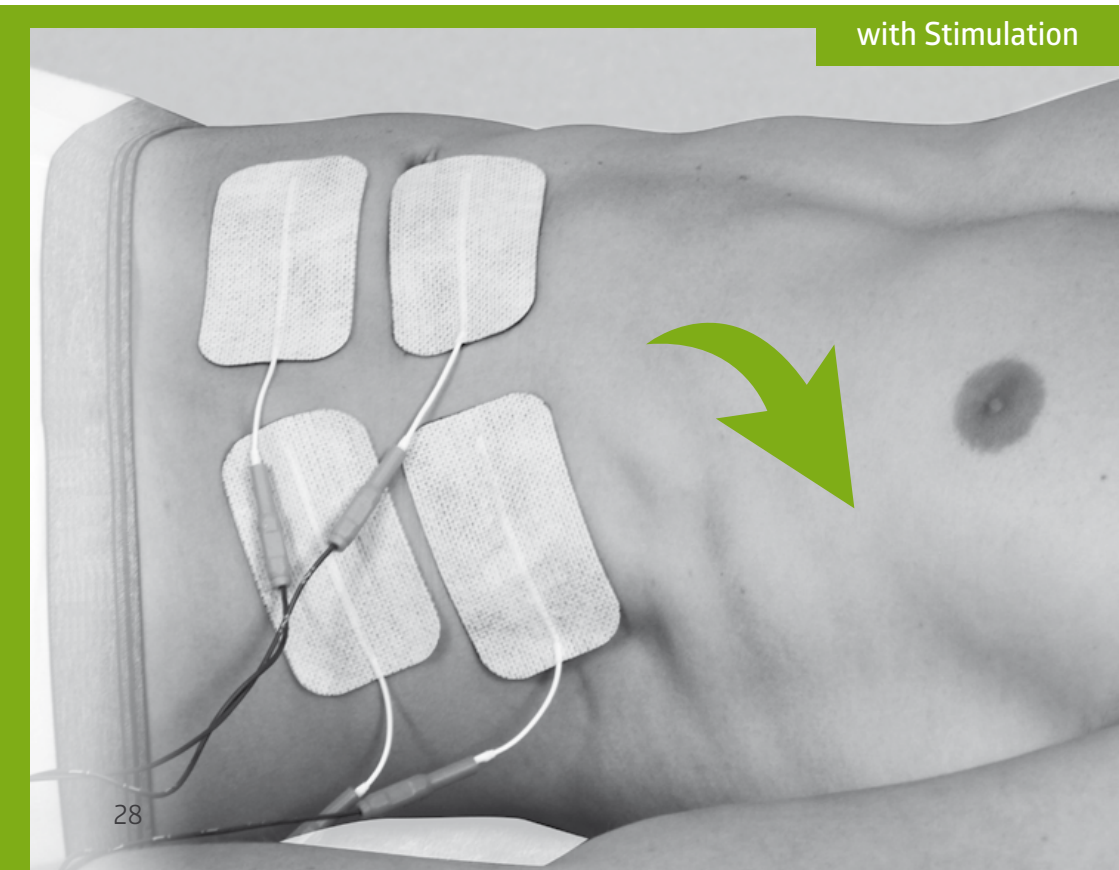
- Pulse duration: 150-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Torso stabilization, unilateral

A muscular imbalance of the torso stabilizing muscles can result in malpositions of the spinal column, e.g. scoliosis. Stimulation of the atrophic muscles can have a preventative, as well as an improving effect.

## Stimulated muscles:

M. rectus abdominis, M. obliquus abdominis

## Stimulation duration:

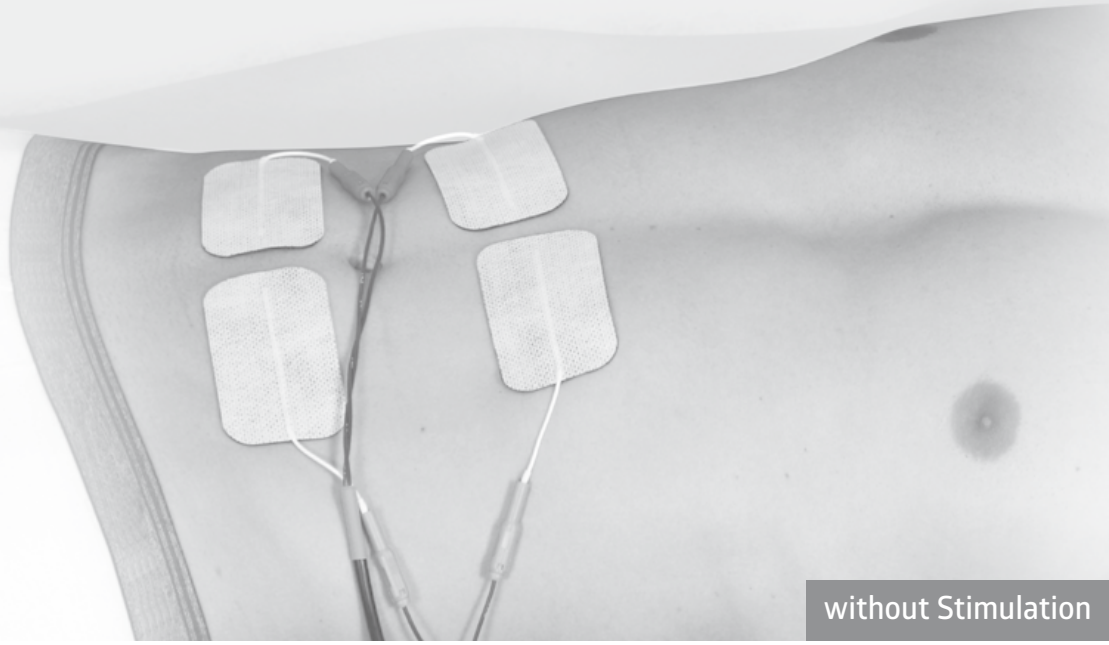
depending on constitution, 5-20 minutes

## Stimulation parameters:

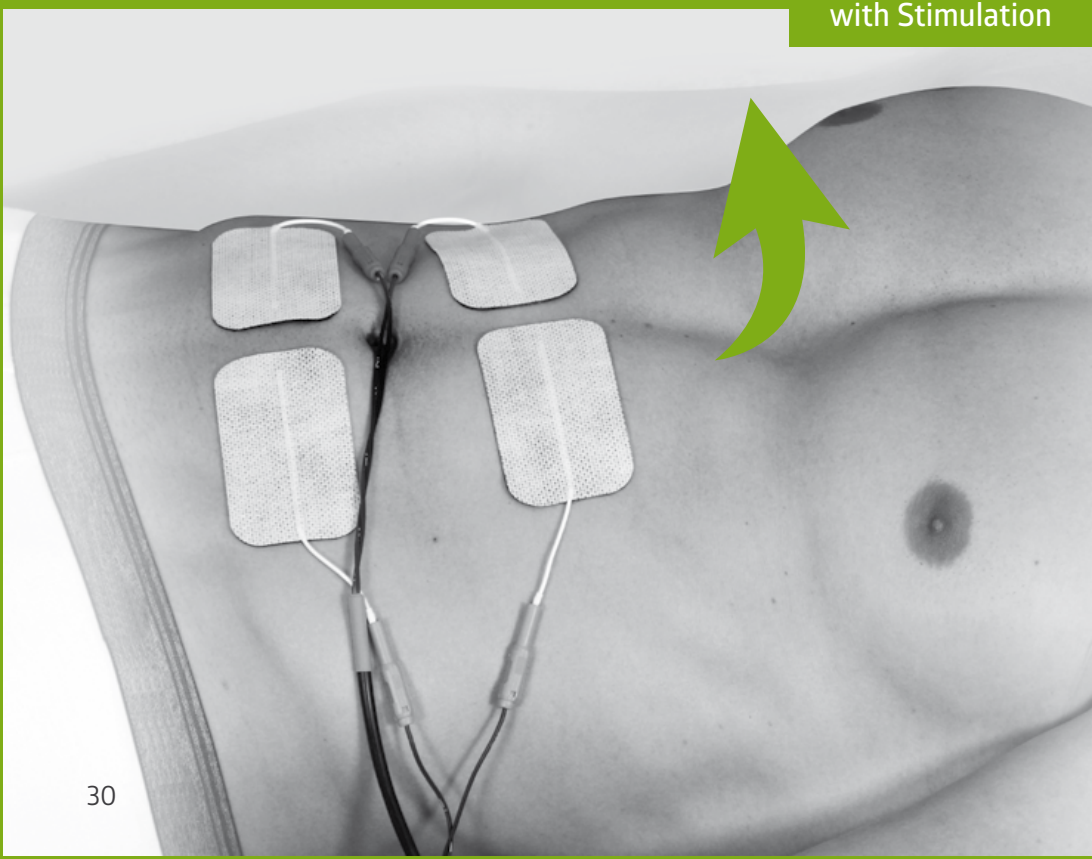
- Pulse duration: 150-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Abdominal training

For torso stabilization in terms of retardation of atrophied abdominal muscles, FES is often applied - especially for tetraplegic patients.



## Template:

· lumbar\_spine\_flexion\_2Ch (bilateral), SECONDS

## Stimulated muscles:

M. rectus abdominis

## Stimulation duration:

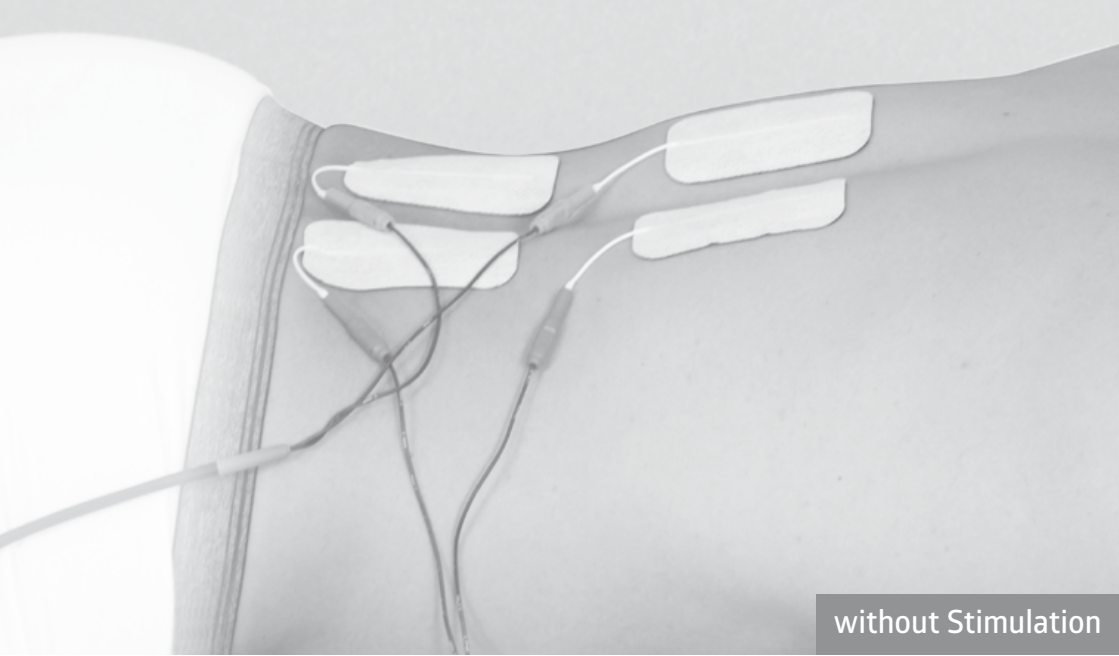
depending on constitution, 10-45 minutes

## Stimulation parameters:

- Pulse duration: 150-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation



# Back strengthening

The back extensor muscle group is elementary for posture and torso stabilization in case of quadriplegia or high paraplegia. FES of this area can retard a fast muscle atrophy.



## Template:

· lumbar\_spine\_flexion\_2Ch (bilateral), SECONDS

## Stimulated muscles:

M. erector spinae

## Stimulation duration:

depending on constitution, 10-45 minutes

## Stimulation parameters:

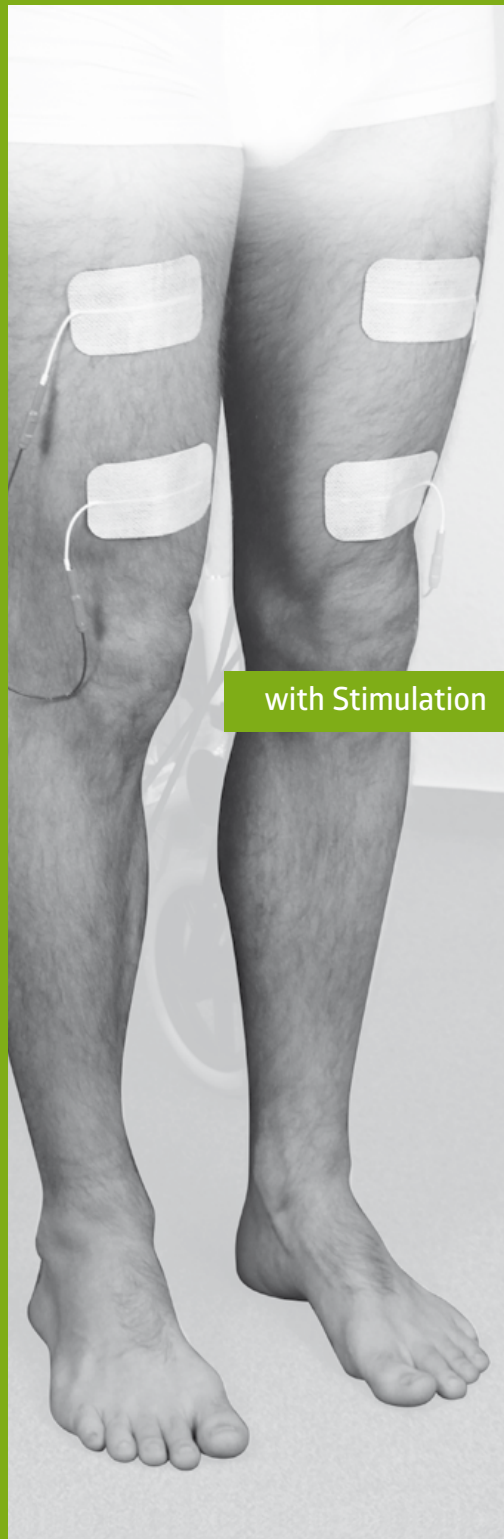
- Pulse duration: 150-350  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)



without Stimulation



with Stimulation

# Standing (up) training

Transfer from the wheelchair to free standing, up to walking, is one of the most important goals in the treatment of incomplete paraplegia. Stimulation of required muscles can increase the range of motion and support transfers effectively.



## Template:

- knee\_flexion/extension\_4Ch (bilateral), PERCENT
- Step\_Leg\_6K (bilateral), PERCENT
- Step Leg-4K to be individually adjusted to:  
QU\_L + QU\_R: 0-100%, BF\_L + BF\_R: 50-100%
- Step Leg\_6K to be individually adjusted to:  
QU\_L + QU\_R: 0-100%, GL\_L+GL\_R: 40-100%, BF\_L + BF\_R: 50-100%

## Stimulated muscles:

M. quadriceps, M. gluteus maximus, M. biceps femoris

## Stimulation duration:

as required and after possible stand up attempts

## Stimulation parameters:

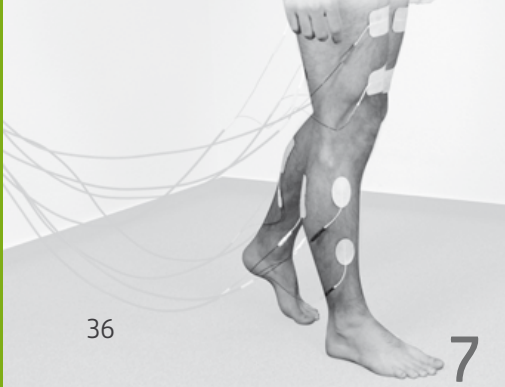
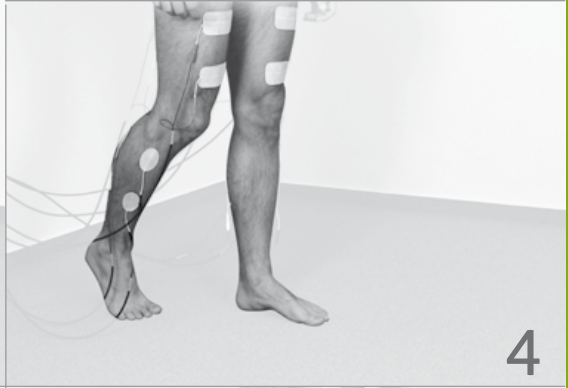
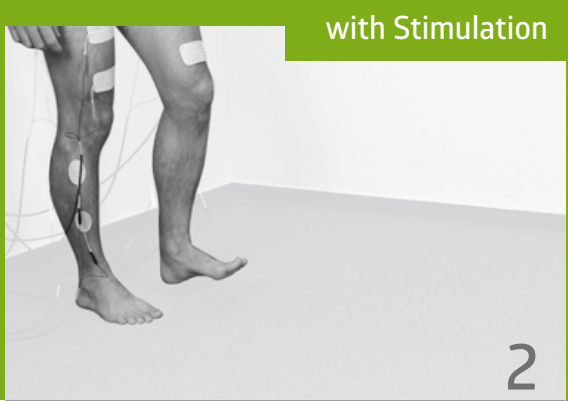
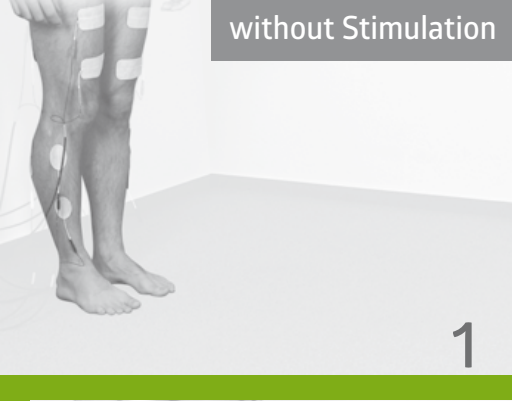
- Pulse duration: 250-450  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 40-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)

without Stimulation

with Stimulation



# Gait training

A high rate of repetitions of complex movements can increase proprioceptive input effectively. Simultaneous FES can support paralyzed muscles evidently in terms of spasm relaxation, increasing of blood circulation and retardation of atrophy.



## Template:

- Step\_Leg\_4Ch (bilateral), PERCENT
- Step\_Leg\_6Ch (bilateral), PERCENT
- Step\_Shank\_8Ch(bilateral), PERCENT

## Stimulated muscles:

M. quadriceps, M. biceps femoris, M. gluteus maximus, M. tibialis anterior, M. gastrocnemius

## Stimulation duration:

depending on the number of possible gait cycles

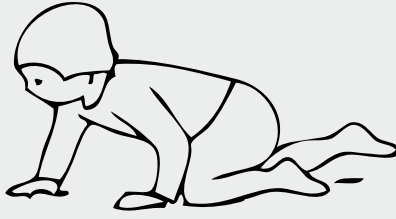
## Stimulation parameters:

- Pulse duration: 250-450  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz

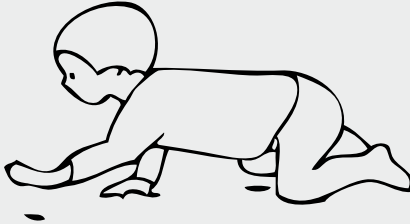
## Electrode size:

4 × 6.4 cm / 1.5 × 2.51 inch (oval shape) for lower legs;  
otherwise 5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)

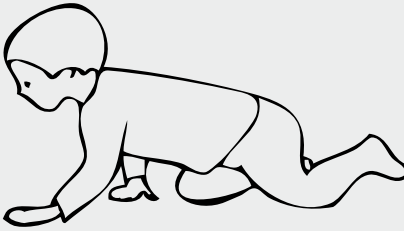
1



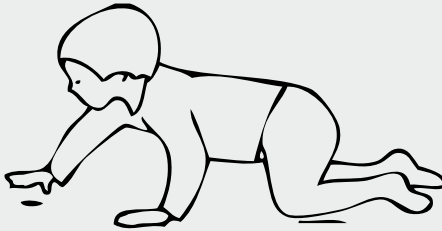
2



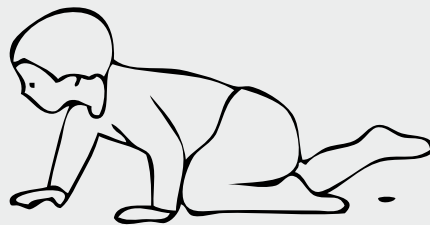
3



4



5



References:  
Susan K. Patrick, J. Adam Noah, Jaynie F. Yang  
Journal of Neurophysiology Published 1 June 2012 Vol. 107 no. 11, 3050-3061

# Crawling

Crawling is the first neuronal movement pattern which is obtained in early childhood. With plegic patients, the basic position is favorably used together with a POSTUROMED® to stabilize the static postural muscles. FES can help to increase the range of motion of simultaneously stimulated muscles.



## Template:

· Crawling\_8Ch (bilateral), PERCENT

## Stimulated muscles:

M. quadriceps, M. biceps femoris, M. gluteus maximus, M. iliopsoas

## Stimulation duration:

depending on the number of possible gait cycles

## Stimulation parameters:

- Pulse duration: 250-450  $\mu$ s
- Amplitude: individually approx. 10% above the motor threshold
- Frequency: 35-50 Hz for atrophy prevention

## Electrode size:

5 × 9 cm / 1.9 × 3.5 inch (rectangular shape)

STANDING (UP) TRAINING



HAND EXTENSION



ELBOW FLEXION



FOOT RAISE



FOOT EXTENSION



SHOULDER STABILIZATION



ABDOMINAL TRAINING

