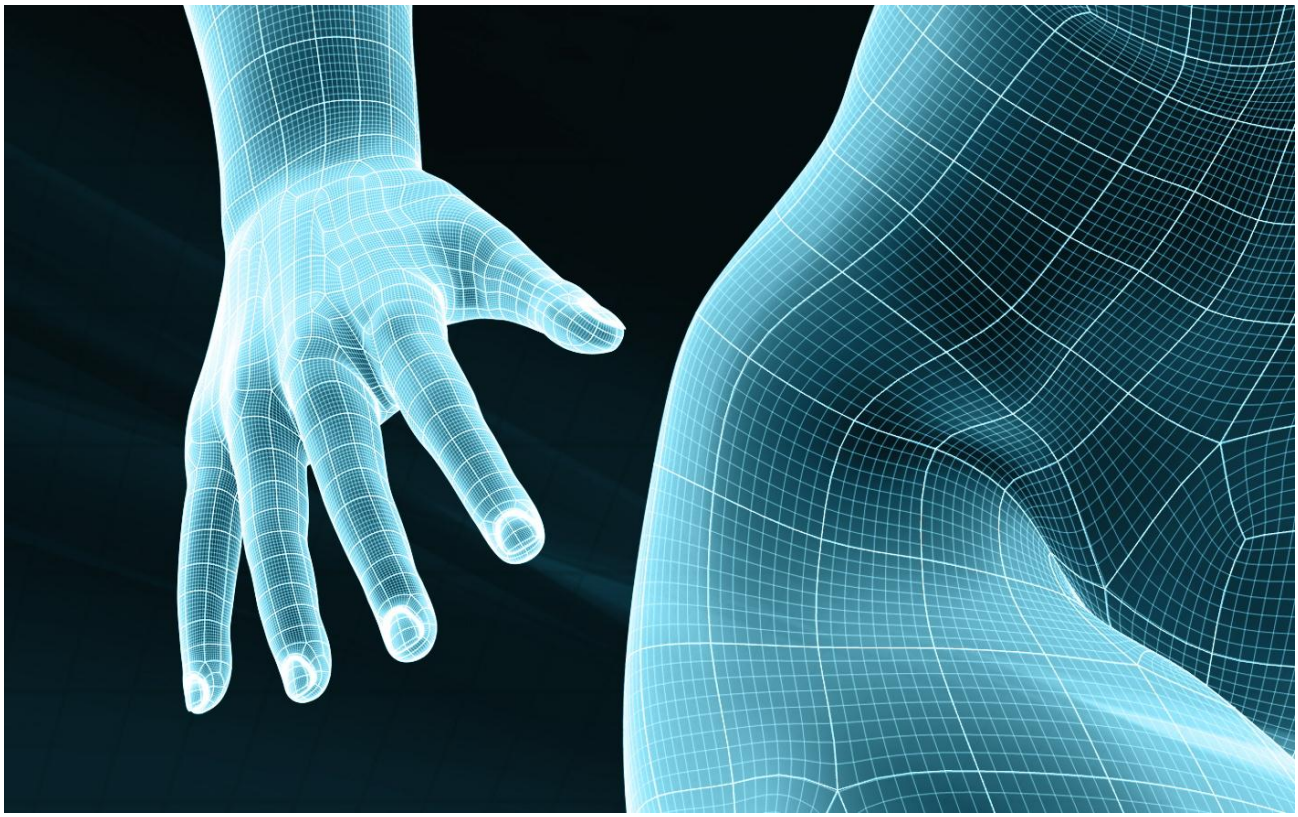
Surface EMG in Physiotherapy

~ Selected Application Examples~



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Introduction

All measurements were done in our institute in Mainz / Germany. We are working in a team of physiotherapists, osteopathic and homeostatic specialists, medical doctors and sports therapists. Our main patient groups consist of orthopedics and post surgery patients. We have to treat and rehabilitate a lot of sport injuries but also practice prevention treatments. Of course we have neurological patients as well.

Since one year we are using a 2 channel clinical DTS system from NORAXON INC USA. Because of our integrated multi-disciplinary treatment system it was part in every field we were working in.

During this period we did about 400 measurements. We used it as an assistive advice for diagnosis and biofeedback training.

On the following pages we present 6 typical patient examples.

The presentation format is mainly structured in these operational categories:

- Clinical exam
- EMG related analysis considerations
- EMG test procedure
- Test results
- Therapy decisions

1 - Low Back Pain Patient

EMG related Clinical exam - Criteria to suggest an EMG Assessment

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- Low back pain
- Sudden sharp pain transmissions in the leg
- Ventral slip of L3/4 during hip extension

EMG related analysis considerations and hypothesis

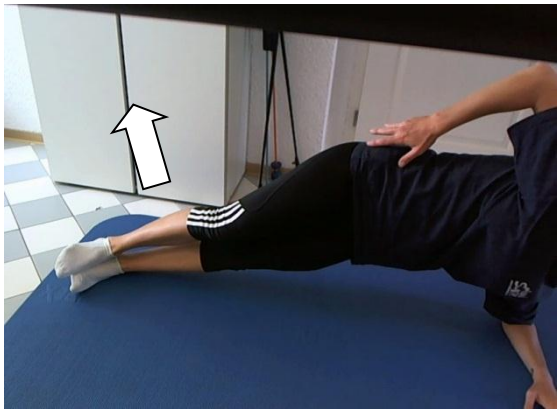
Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

- Too low firing of deep abdominal muscles
- Increase of EMG activity of internal oblique/transverses via modified/ optimized treatment exercise

EMG Test procedure

Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terms of more/less EMG, better timing, improved consistency etc.

Start exercise to be optimized:
Side extension (static)



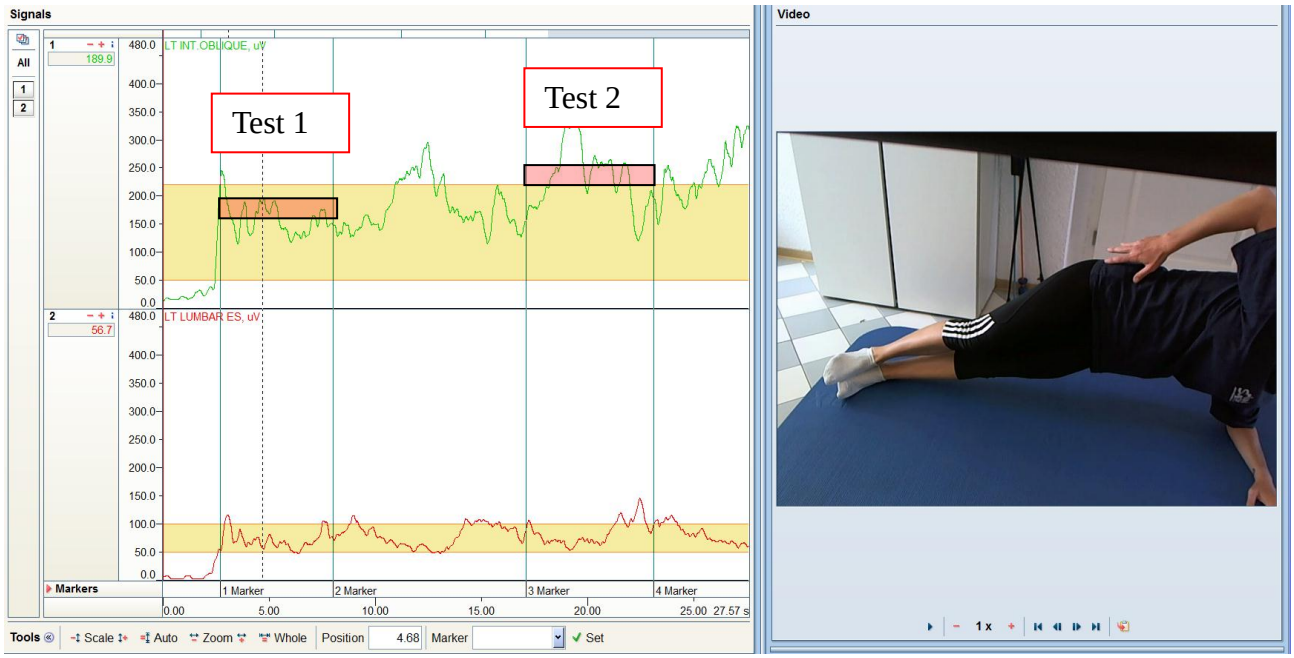
Modified exercise:
Side extension with bend knee

Explanations:

The start exercise (Test 1) may show insufficient activation of the segmental stabilizers of the trunk. An exercise modification (Test 2) including bend hip joint and minimal motion

assistance is expected to increase the EMG innervation in the target muscles “deep abdominals”

Overview of measurement recording

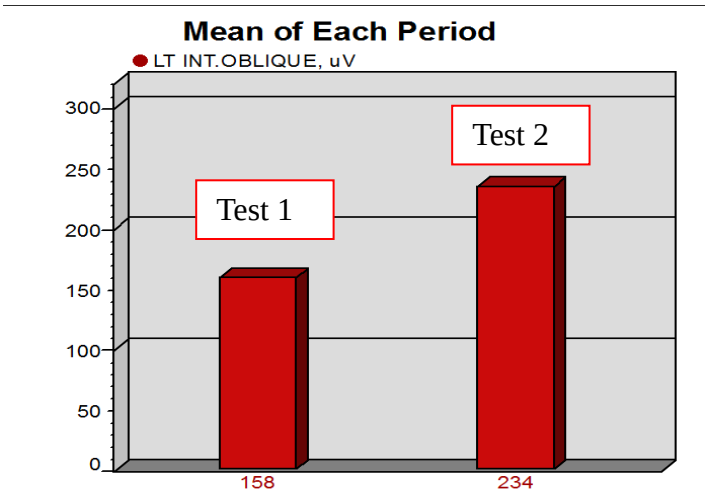


Upper channels is left internal oblique/transversus, lower channel left lumbar Erector spinae. Each test period is labeled by a marker pair.

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider to operate more evaluation exercises

Left bar shows the Mean EMG activity in the start exercise, right bar the increase of activity due to the exercise optimization :



A significant increase of EMG activation from 158 to 234 uV could be determined

Therapy decisions

Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

- Stabilization of modified exercise with EMG feedback
- Integrate new exercise in regular treatment plan

Retest or validation of EMG optimized treatment strategies

Instructions: use any of the test conditions defined above to control the effect of EMG assisted therapy and treatment regime in a retest

< not operated in this investigation >

2 - Knee Pain Patient

EMG related Clinical exam - Criteria to suggest an EMG Assessment

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- Morbus Parkinson
- Supra-patellar pain (right more than left)
- Poor control of knee, insufficient axial control in functional movement tests

EMG related analysis considerations and hypothesis

Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

- Hyper-activity of M. rectus femoris during functional knee control tasks (single leg stand)
- Muscular imbalance between knee extensors and hamstrings
- Decreased activity of target muscle via up-training and coordinative exercises for the hamstrings (eccentric-concentric)

EMG Test/treatment procedure

Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terms of more/less EMG, better timing, improved consistency etc.

Test position 1:
Stand on one leg (poor knee control)

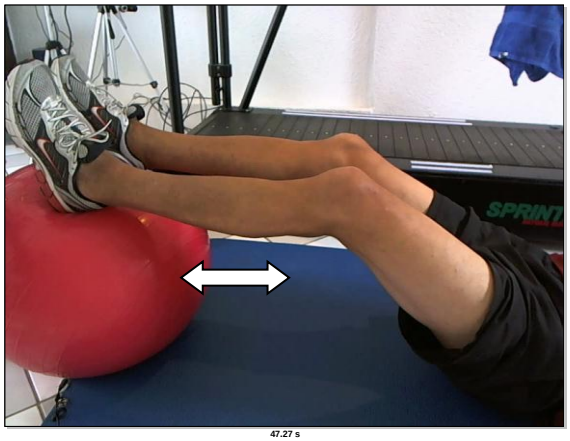
7.07 s

Test position 2 :
Stand on one leg (better knee control)

21.93 s

Biofeedback training of the hamstrings:

Flexion (5 sec.) and extension(10 sec.) of the knee on a gymnastic ball with lifted pelvis:

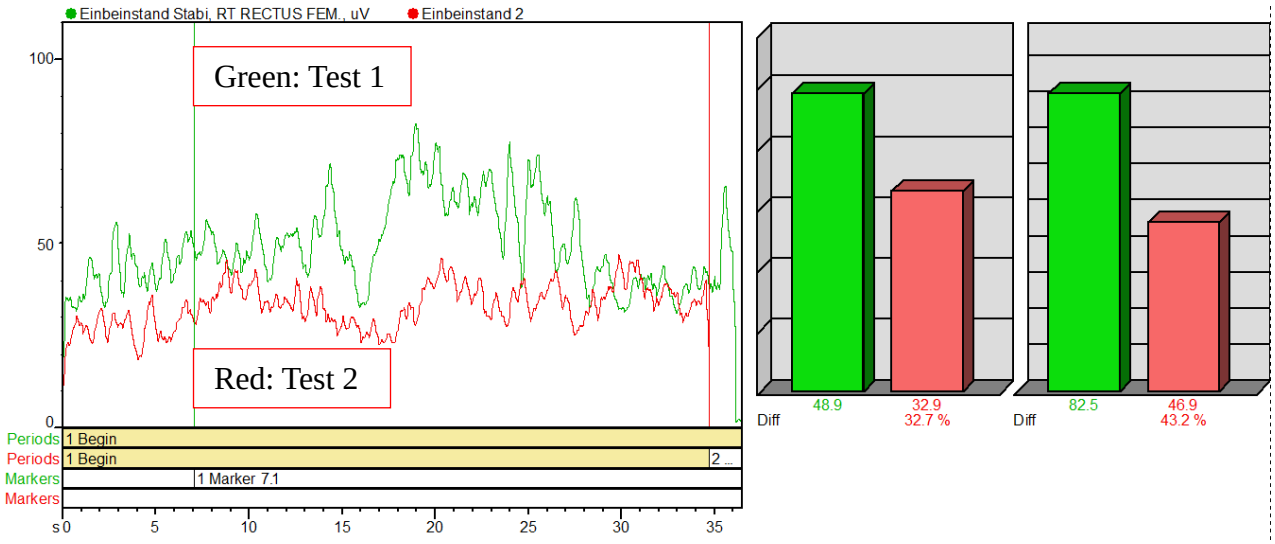


Test-Retest results

With retest operated within the same therapy session.

Explanations:

Overview of measurement recording

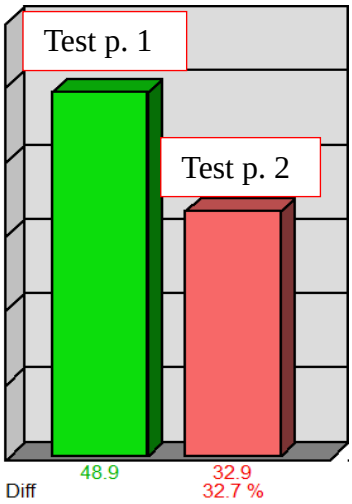


Both channels show the activity of the rectus femoris muscle. The upper (green) channel is the activities of the target muscle in test position one. The lower (red) channel is the result re test 2 right after the biofeedback training of the hamstring muscles.

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider to operate more evaluation exercises

Test position 1 (green) shows increased - activity of the rectus femoris muscle during standing on one leg. The coordinative training of the hamstrings effectively facilitated a better knee control strategy and resulted in a reduction of rectus femoris hyperactivity as shown in re-test data 2 (red) and thus an appropriate activity of the rectus femoris muscle in test position 2.



A significant decrease of EMG activation from 48.9 to 32.9 uV could be determined due to an improvement co-activation pattern of the hamstrings, indicating a direct a follow up effect to feedback controlled hamstrings up training

Therapy decisions

Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

Stabilization of the knee control with focus on up-training of the hamstrings and focus on improved intermuscular coordination

Normalization of a muscular activation balance in functional tasks like balance, gait squat and EMG Biofeedback control

3 - Back Pain Patient

EMG related Clinical exam - - Criteria to suggest an EMG Assessment

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- Insufficient core stabilization of deep trunk muscles
- low back pain
- deficits pelvis control and coordination

EMG related analysis considerations and hypothesis

Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

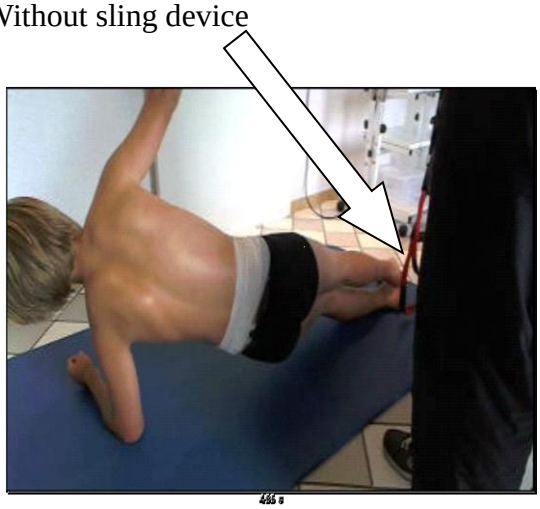
- Coordinative improvement of the target muscles (deep abdominals) while using the sling device

- significantly increased activity of the transversus abdominis muscle by giving verbal commands to hold the pelvis in the correct position

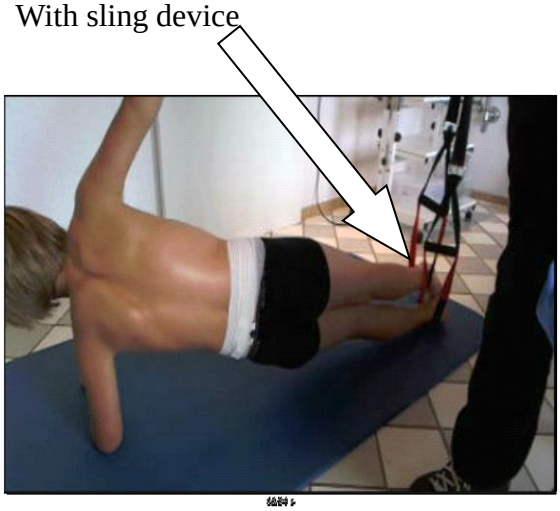
EMG Test procedure

Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terns of more/less EMG, better timing, improved consistency etc.

Test position 1:
Without sling device



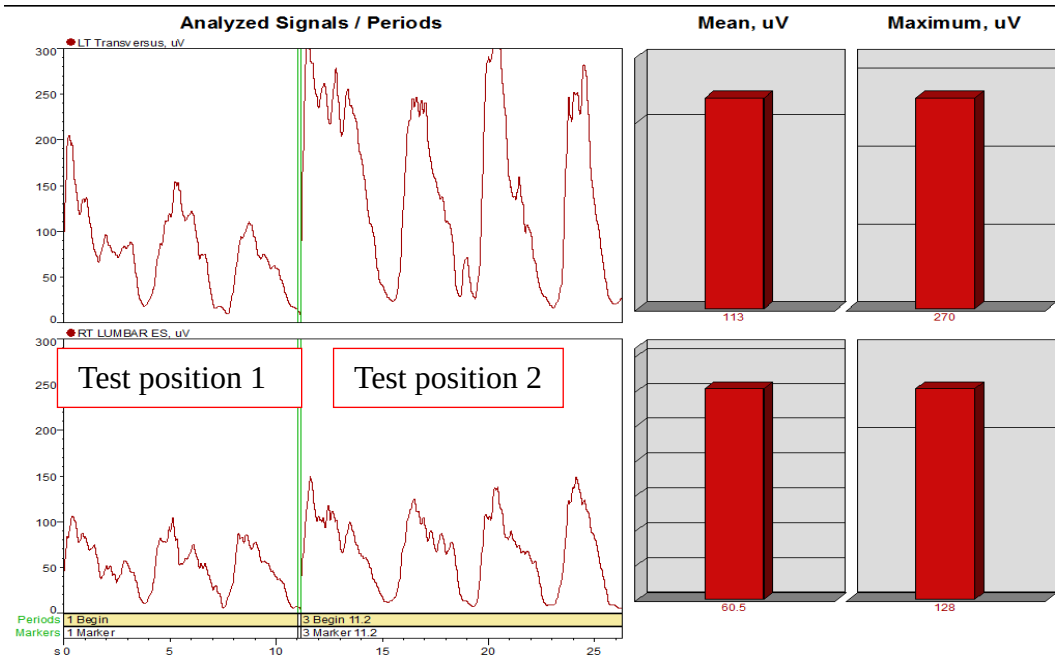
Test position 2 :
With sling device



Explanations:

The Test position 1 the patient is doing a side bending exercise as he is doing it at home. In Test position 2 the feet are placed into the sling device short above the ground, which creates a bigger instability.

Overview of measurement recording



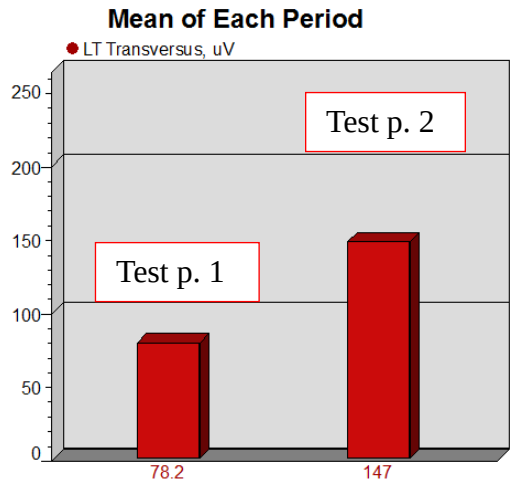
Upper channel is the EMG recording of the right internal oblique/transversus, lower channel is the EMG recording of lumbar erector spinae.

The left measurement section shows the test with grounded feet, the right one with the feet placed in the sling device.

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider to operate more evaluation exercises

Left bar shows the Mean EMG activity in the test position 1, right bar the increase of activity of the target muscle due to the test position 2 :



A significant increase of EMG activation from 78.2 to 147 uV could be determined due need to better stability core trunk muscles in instable sling training condition

Therapy decisions

Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

Data supports the conclusion that the use of sling trainers in treatment regimens leads to better coordinative stabilization of the pelvis position and higher EMG activity of deep abdominal core stabilization muscles.

Future focus of therapy is set to coordinative training of the trunk muscles with the help of devices like the sling trainer and selected EMG biofeedback.

4- Back Pain Patient (2)

EMG related Clinical exam - Criteria to suggest an EMG Assessment

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- low back pain
- ventral tilt of pelvis
- hypertension of right erector spinae muscle

EMG related analysis considerations and hypothesis

Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

- increased activity of the target muscle during gait
- improve muscular balance in left to right comparison due to EMG Biofeedback training

EMG Test procedure

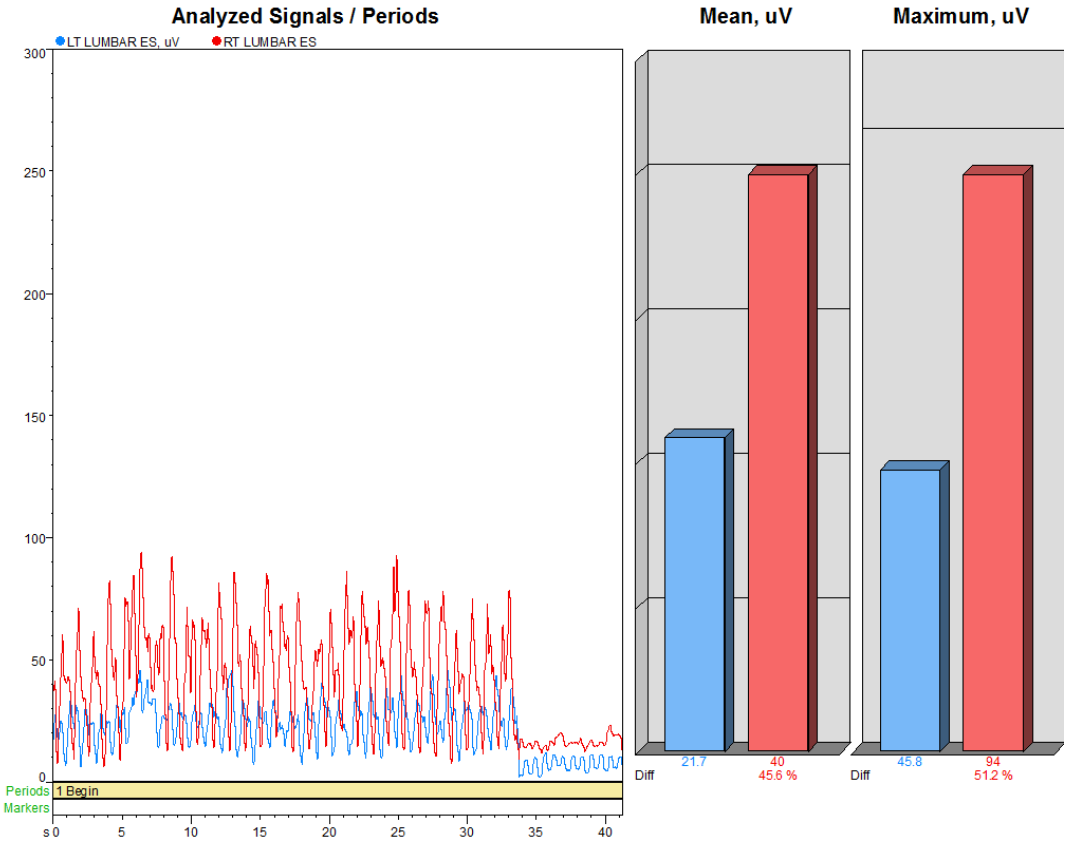
Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terns of more/less EMG, better timing, improved consistency etc.

Treadmill gait analysis at 4 kmh:

18.31 s

Explanations:

The test position shows the left (blue) and right (red) EMG innervation of lumbar erector spinae in treadmill gait at 4 km/h:



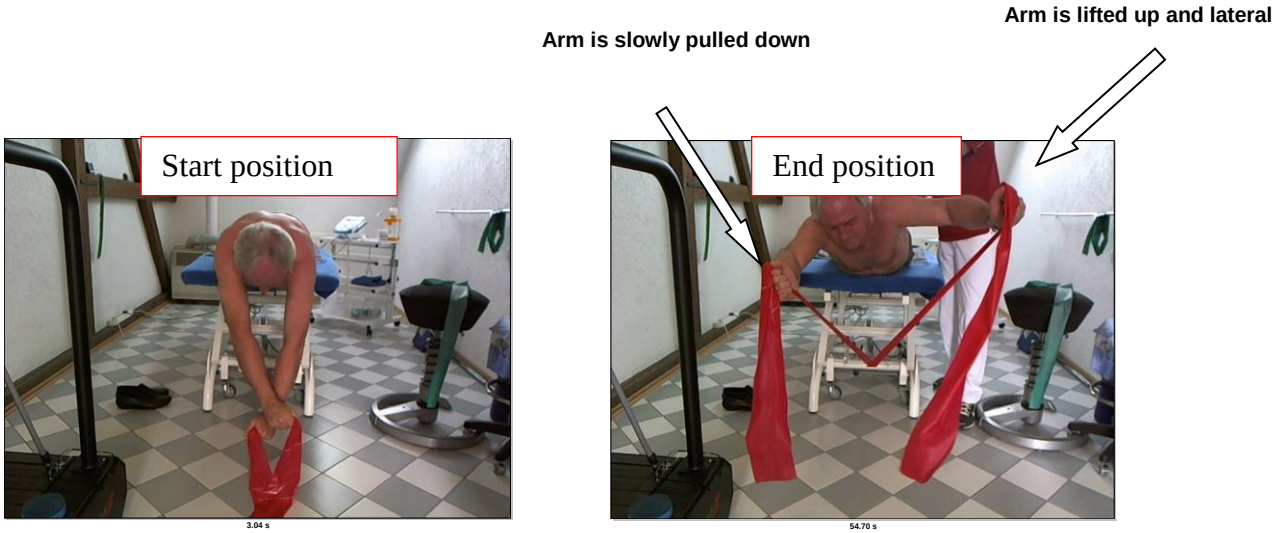
(Gait from 27.6.2012; bevor having a spacific treatment)

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider operating more evaluation exercises

- The EMG symmetry comparison shows an EMG innervation imbalance of 45.6 % between left and right muscle during the gait
- Hyperactive right erector spinae

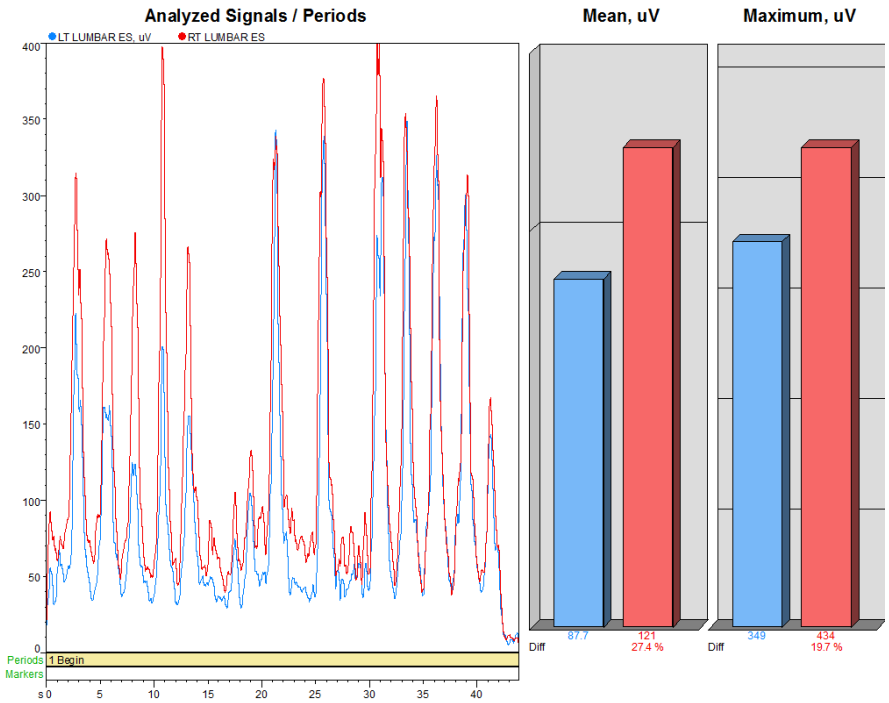
Overview of treatment recording



Treatment results

Instruction: Validate or reject your hypothesis or analytical questions and consider operating more evaluation exercises

The blue bar shows the activity of the left and the red bar of the right erector spinae muscle. The imbalance is in return to the gait less. 27.4% instead of 45.6 %.



Therapy decisions

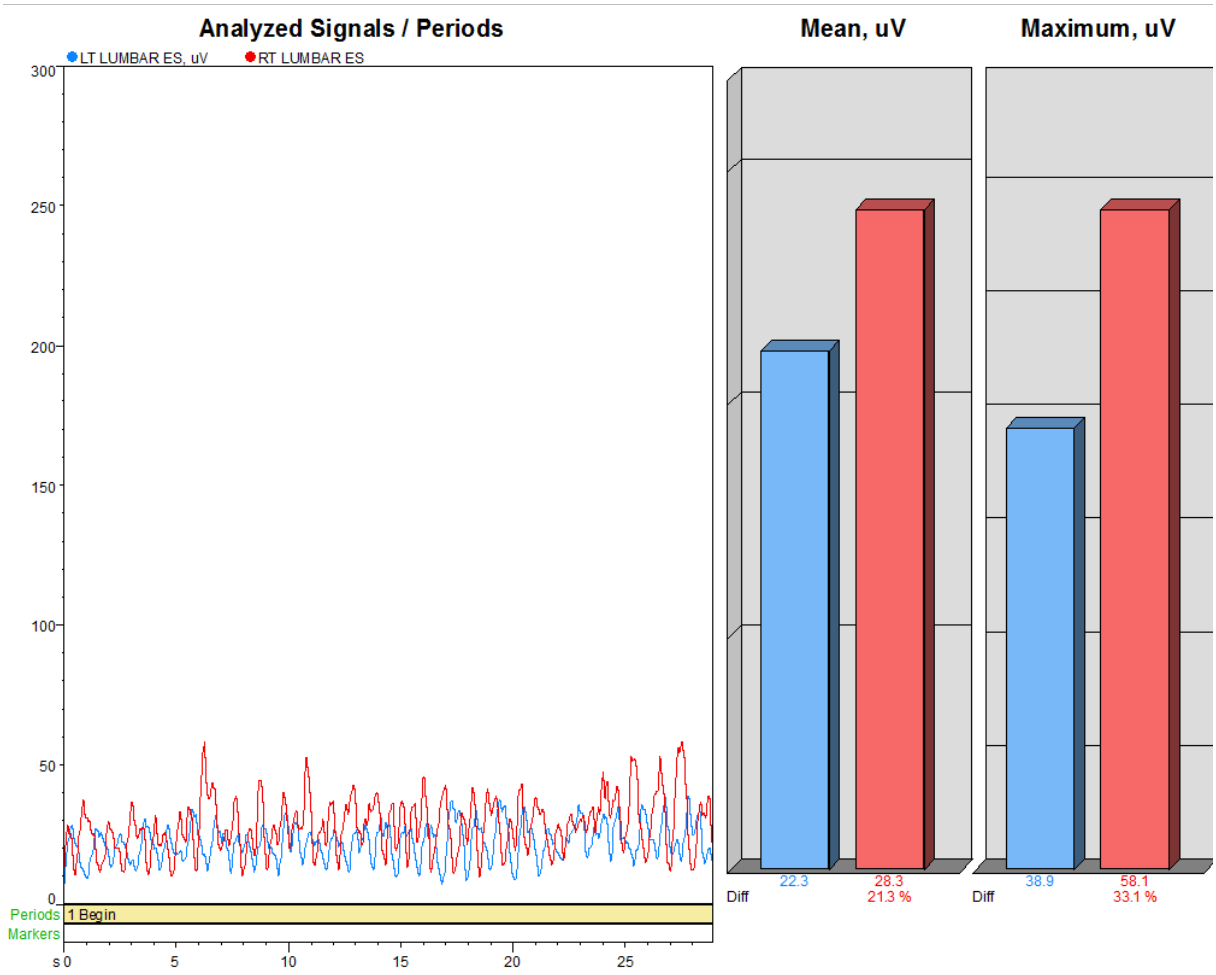
Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

Stabilization of the lower left erector spinae muscle with focus on concentric exercises: down training of the right one by using eccentric exercises. Target muscular balance.

Retest or validation of EMG optimized treatment strategies

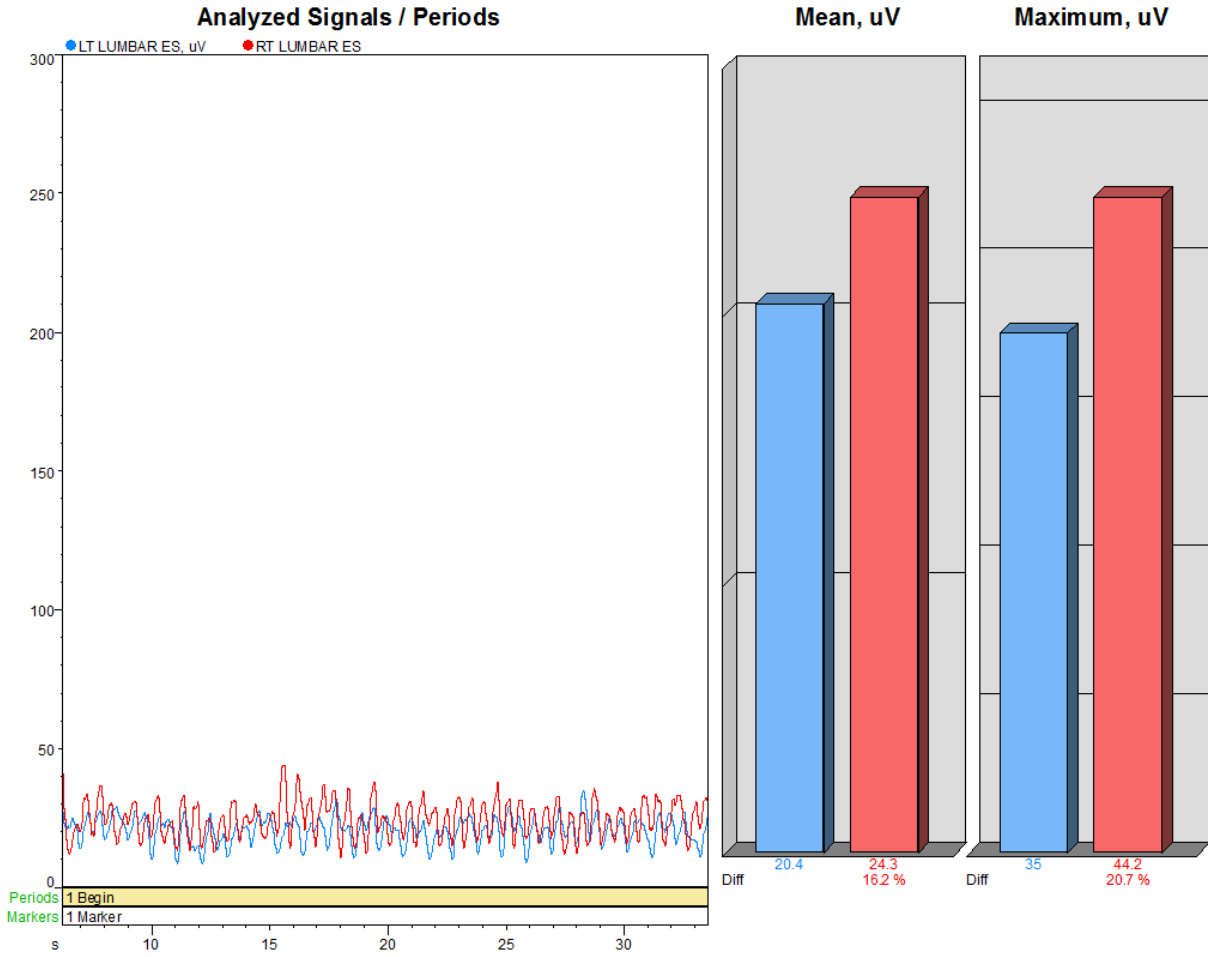
Instructions: use any of the test conditions defined above to control the effect of EMG assisted therapy and treatment regime in a retest

Re-test treadmill gait after a training period of 8 days:



Result: the muscular imbalance could be reduced to a side difference of 21,3% in regular gait activity.

Re-test treadmill gait after a training period of 12 days:

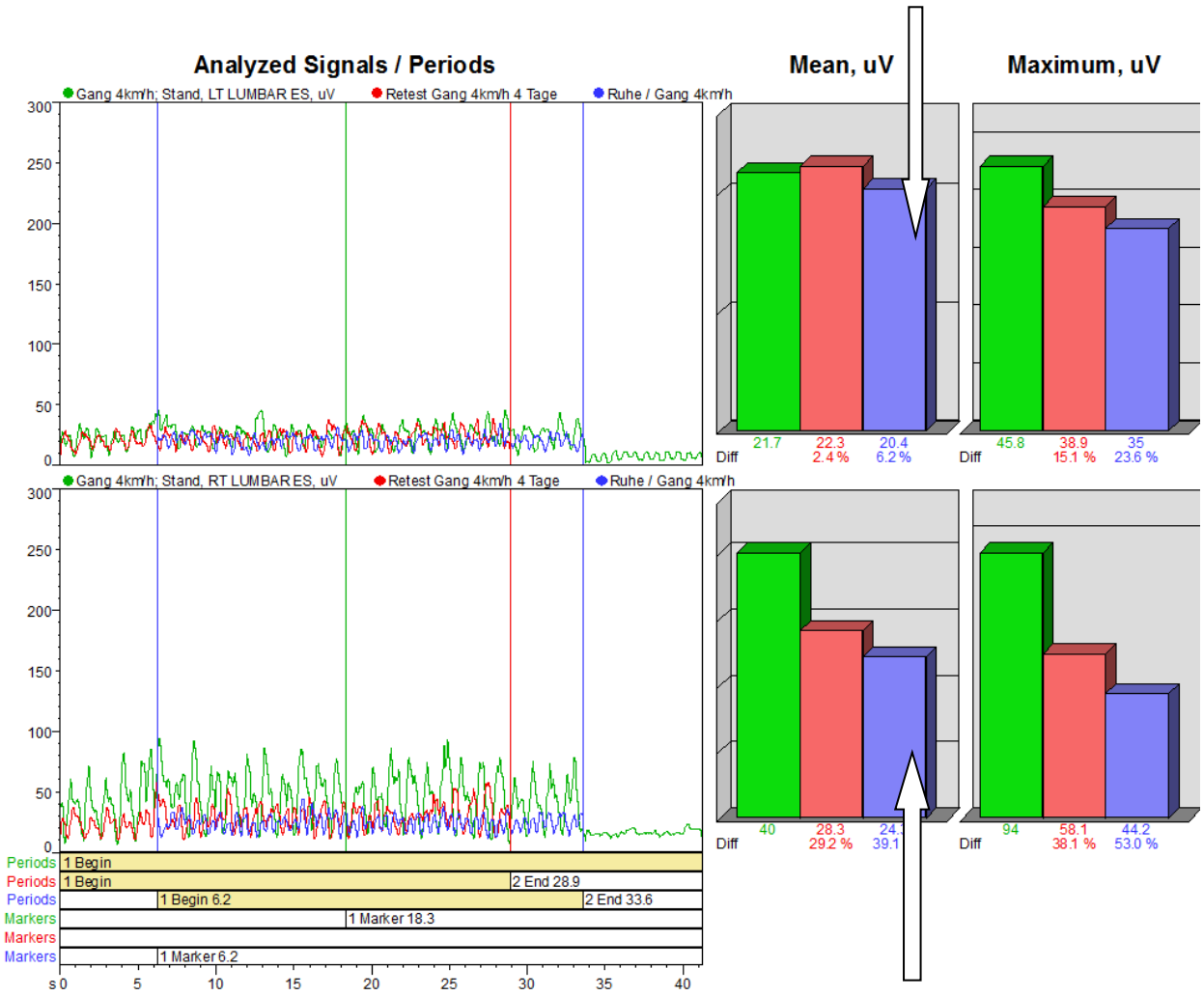


The imbalance is reduced again to 16.2% side difference.

History Diagram of Test Series

The following diagram summarizes the balancing process of left-right asymmetry imbalance of the course of 3 tests within 12 days:

Stabilization of left muscle



Downtrain of right muscle

- The upper channel section indicates the effect of the applied stabilization training which is documented by a nearly constant innervation level of the left lumbar ES (21.7uV, 22.3uV , 20,4 uV) .
- The lower channel section indicates the downtraining effect oft he applied muscle balance training , documented by a clear tendency dropped microvolt data (40 uV, 28.3 uV, 24 uV)
- EMG findings are consistent with subjective drop of pain scaling (Visual analog scale) from 8 to 2 (75% drop of pain).

5 - Neck Patient

EMG related Clinical exam

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- recurring headache
- neck pain (strained muscles)

EMG related analysis considerations and hypothesis

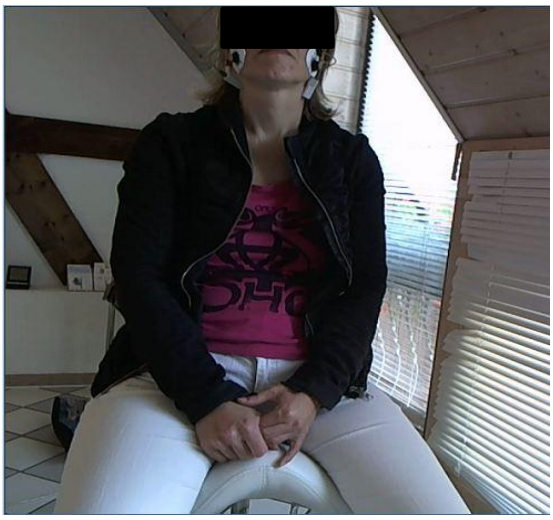
Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

- increased activity of the right trapezius pars descendens
- nocturnal grinding of the teeth

EMG Test procedure

Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terms of more/less EMG, better timing, improved consistency etc.

<u>Test position 1:</u>
Usual sitting position

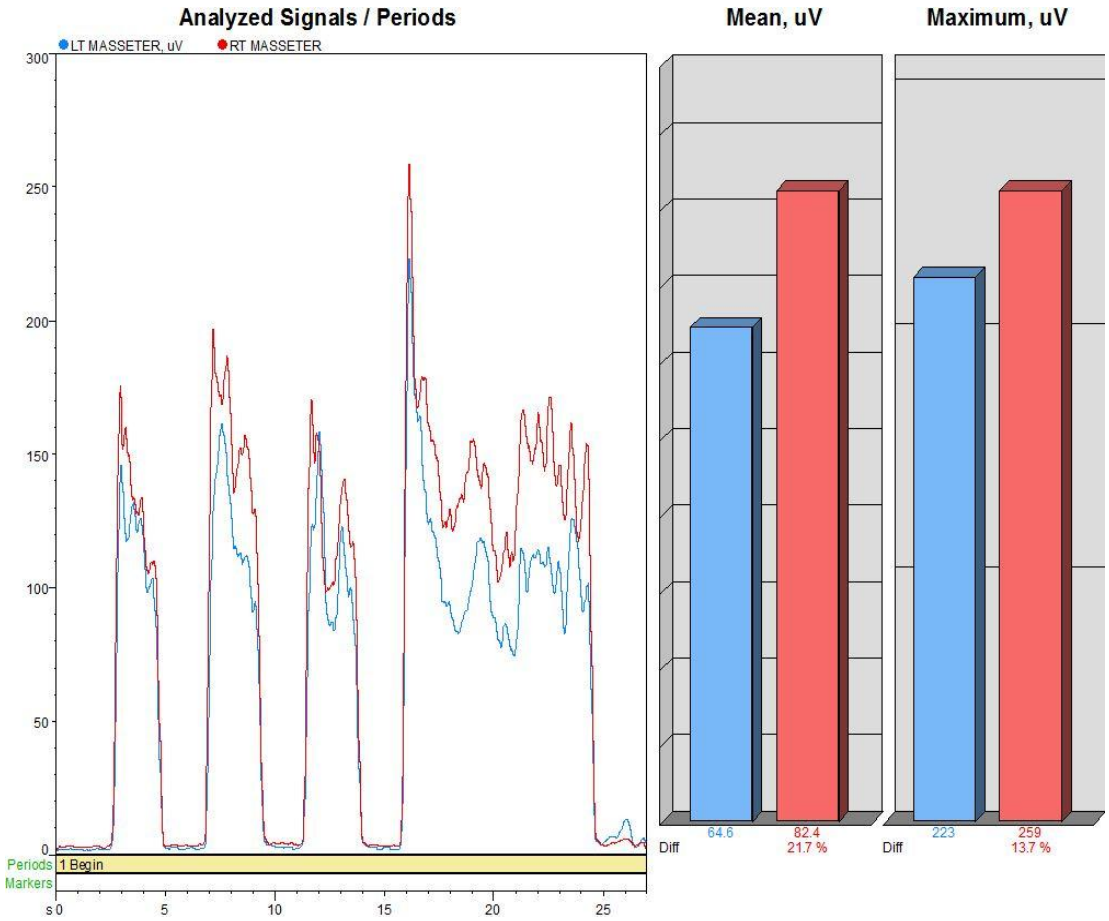


Patient is instructed to perform 3 short and one prolonged bite:

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider to operate more evaluation exercises

The patient showed an increased activity of the right masseter muscle:



Therapy decisions

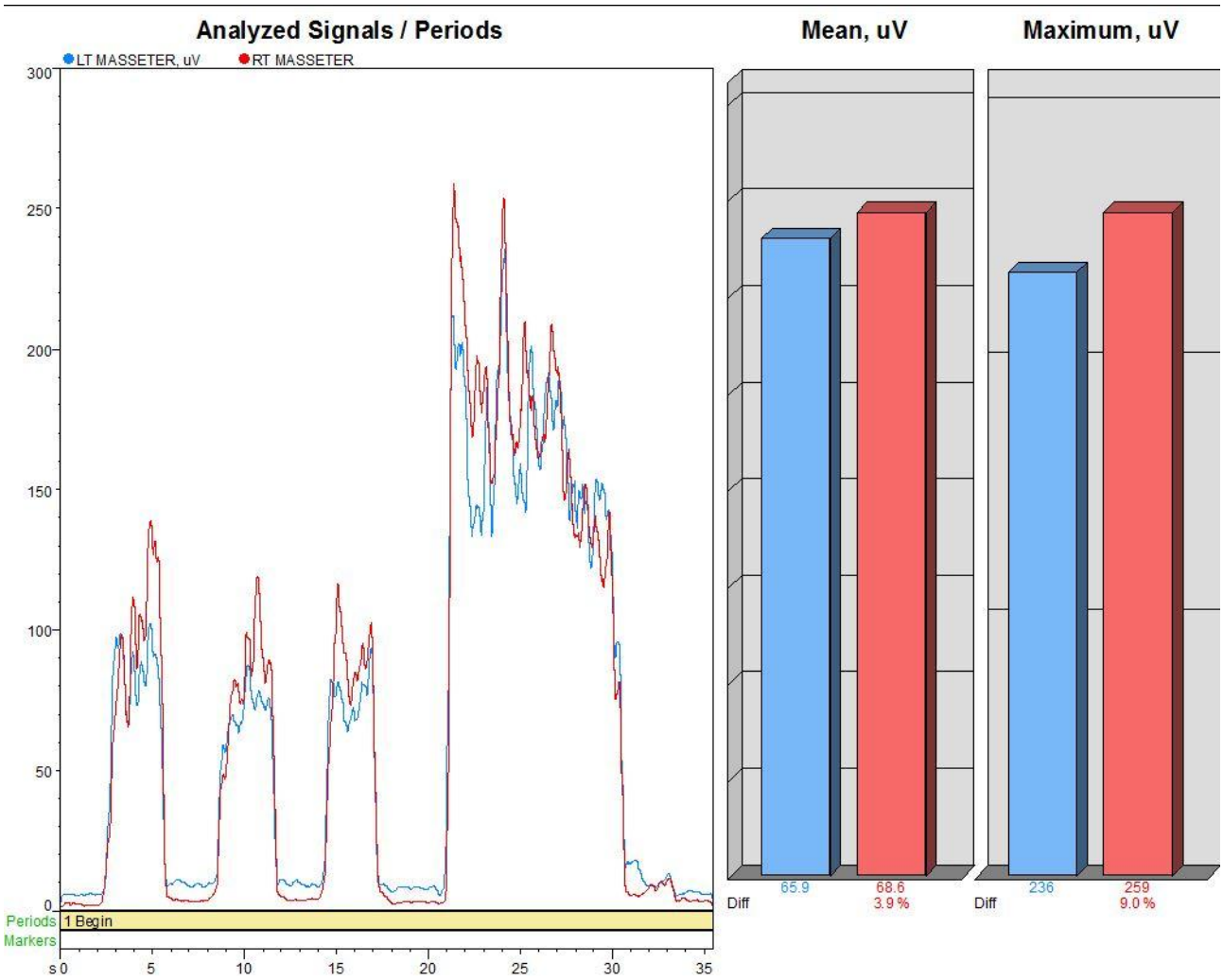
Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

manual therapy of the CMJ and cervical spine
Referral for a bite splint

Retest or validation of EMG optimized treatment strategies

Instructions: use any of the test conditions defined above to control the effect of EMG assisted therapy and treatment regime in a retest

Patient was retested after therapy and bite splint application.



- A significant decrease of the right muscle activity from 82,4 uV to 68,6 uV could be determined
- The patient has neither neck pain nor headache

6- Parkinson Patient

EMG related Clinical exam

Instruction: summarize all relevant clinical findings that indicate an EMG exam

- Back pain
- Neck pain and headache (strained muscles)
- Morbus Parkinson
- Scoliosis
- Side bending to the right during the usual sitting position

EMG related analysis considerations and hypothesis

Instruction: Formulate your expectation, assumption or observation related to neuro-muscular dysfunction or muscular compensation pattern

- Increased activity of the right trapezius muscle during the usual sitting position
- Increased activity of the left thoracic extension muscles

EMG Test procedure

Instruction: Based on your analysis considerations determine a start test and operate one or more comparison tests (treatment techniques) operating your main treatment ideas. Observe the EMG activation in terns of more/less EMG, better timing, improved consistency etc.

Starting position:
Usual sitting position
(p1)

End position: (*after treatment*)
Same sitting situation
(p2)

Eccentric training of the left thoracal extensors :
(p3)

sitting position after exercise:
(p4)

Explanations:
In (p1) the patient has a significant disposition to the right side. The general treatment strategy was to stretch and mobilize the shortened left side and stabilize the right side with a combined eccentric / concentric training of lumbar and thoracic trunk extensor muscles. Immediately after this treatment procedure the patients shows a significantly improved sitting position.

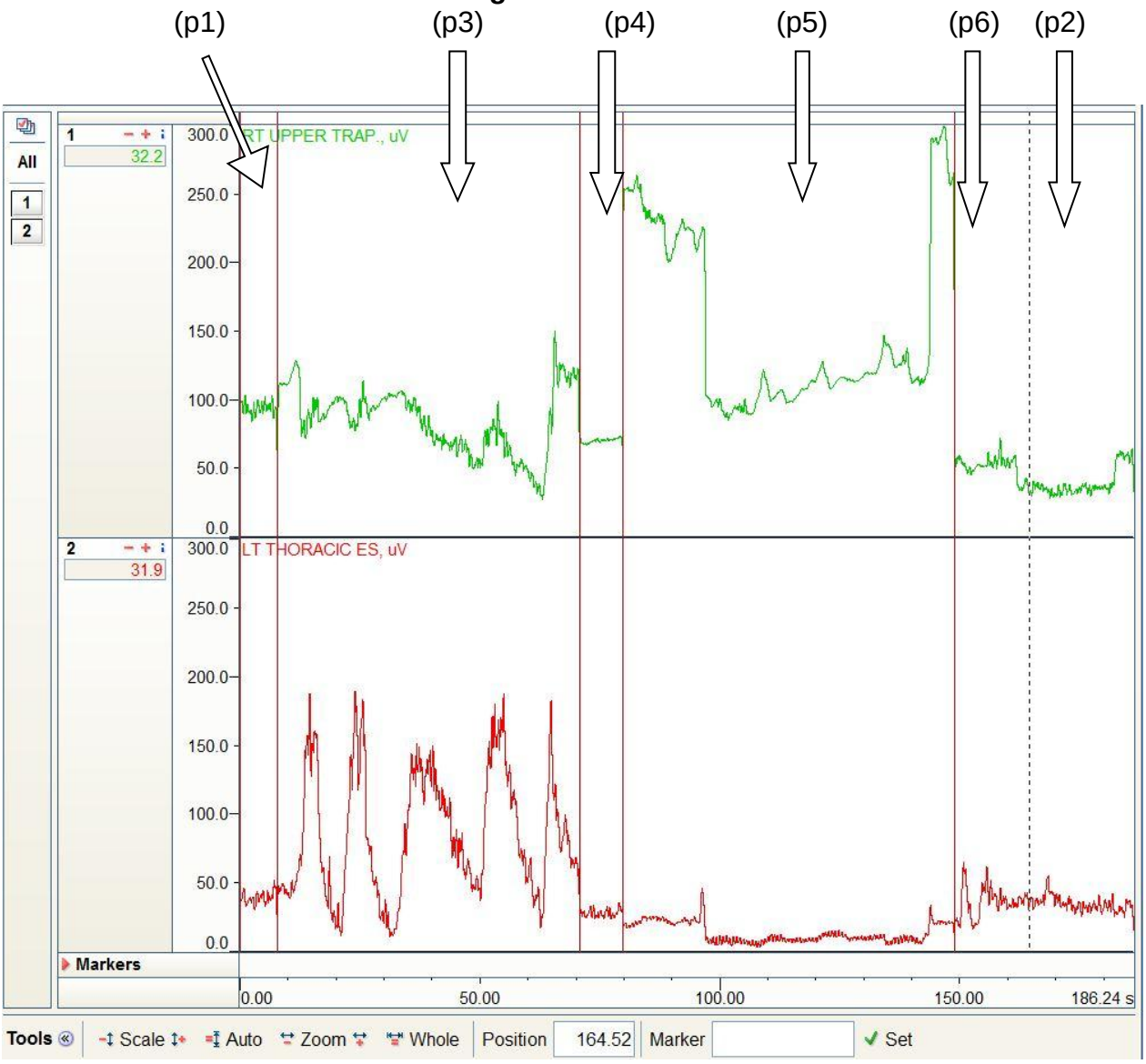
Obliquus training to stabilize
the connection between pelvis and trunk:
(p5)

Sitting position after exercise:
(p6)

Test results

Instruction: Validate or reject your hypothesis or analytical questions and consider to operate more evaluation exercises

Overview of measurement recording



As shown in position p1 and p2 - a significant decrease of muscle activation could be achieved through the treatment. These data support the strategy of strengthening the weak trunk stabilization muscle components and down train /stretch the contracted antagonists.

Therapy decisions

Instructions: Use the test results to define improvements, modifications or optimizations within therapy or biofeedback decisions

Continue to mobilize the left side bending muscles of the spine
Stabilize the global trunk-muscle-system to improve postural instability.

Conclusions

As indicated by the standardized presentation structure, we could successfully integrate the Clinical DTS sEMG system in our evaluation concept and clarify muscle activation related observations, expectations and underlying analytical questions and use the results for optimized therapy decisions.

The Clinical DTS helps us to give the patient a concret view of the activity of his muscles.
The patient was able to get an understanding of the complicated links between his problem and the muscle we are focused on. We also strengthened our cooperation work with our partners like doctors and the orthopedic mechanics, in underlining our therapy by using the EMG report.
The biofeedback tool turned into a magnificent motivator to mobilize the patients force in its best!
As a result I can say, the the Clinical DTS System from Noraxon became an undispensable tool in our practice.

Simon Roth