12th European Fascia Researcher Exchange Meeting (EFREM), 18th/19th November 2022, Technical University of Munich (on-site and online)

Summary of presentations and discussions

Disclaimer

Much care has been taken to reflect the content of the presentations as accurately as possible; however, this summary has not been checked by the presenters and may, therefore, contain misinterpretations. Also, references are given as in the presentations and were not double-checked. Please consider that discussion items are opinions and not to be taken as suggested practice or scientific evidence. Drawings are adaptations of images from the presentations to aid understanding. For a realistic view, please also look at the referenced original figures.

Robert Schleip and Prof. Dr. Thomas Horstmann warmly welcome the participants to the new Sports and Health Campus at the Technical University of Munich. The campus is designed to become the biggest of its kind in Europe.

The first half of construction work is completed—with huge training halls and a big auditorium. The campus is sustainable: more than 50 % are made of wood.

As the location of the olympics in 1972, the campus is also a historical site.

Prof. Horstman is very happy to have Robert Schleip in his team. Since he joined, the department is more involved with fascia.

After the welcome, participants are led on a tour of the campus.

The princess and the pea: Comparison of different stiffness assessment tools on a multi-layered phantom tissue model

Katja Bartsch

There is a raising demand in diagnostic methods to measure soft tissue stiffness (a material's resistance to deformation).

Hand-held tissue stiffness assessment tools (SATs) are a cost-effective and easy-to-use option. However, it is unknown which tool is best suited for which tissue type and layer/depth.

Therefore, the objective was to create a multi-layered phantom tissue model (made of polyurethane, which stays relatively constant over time) that could mimic different stiffness changes in different layers and to use this model to evaluate the reliability and validity of various SATs.

The model represents the 4 layers of the human thoracolumbar region (slightly lateral to the spinous process of L3): cutis (3 mm)—subcutaneous connective tissue (6 mm)—fascia profunda (1 mm)—erector spinae muscle (10 mm).

Typical thickness and stiffness values were derived from the literature, and stiffness alterations were introduced by producing nine different phantoms for each layer and exchanging one layer at a time. This adds up to 40 variations of the phantom model.

A total of 5 SATs were tested: 3 working with indentation, 1 with myotonometry, and 1 with ultrasound (US) and an attached force gage. Measurements were taken by two blinded investigators.

SAT \ Property	Detection of stiffness changes in layers (layer thickness indicated below)				Inter rater reliability
	CUT (3mm)	SCT (6mm)	FPR (1mm)	ERS (10mm)	
Shore Durometer	✓✓✓	✓✓		✓	✓✓
Semi-electronic Tissue Compliance Meter	✓	✓✓✓		✓✓✓	✓✓
IndentoPRO	✓✓✓	✓✓✓		✓✓✓	✓✓✓
MyotonPro	✓✓✓	✓✓✓		✓✓✓	✓✓✓
Ultrasound + attached transducer		✓✓✓		✓✓✓	✓✓

✓ denotes moderate correlation (> 0.4). ✓✓ denotes strong correlation (> 0.7).
✓✓✓ denotes very strong correlation (> 0.9). Blank denotes "no reliable measurement possible".

The table shows how well the tools were able to detect the known stiffness changes in the model resulting from the introduction of variations (in relation to the default model without variations).

None of the tools was able to reliably assess stiffness changes in the very thin fascia profunda. Tools working with indentation or myotonometry were able to detect changes in three of four layers, and US with transducer was able to detect changes in two of four layers (the thicker layers).

Discussion

Stiffness changes resulting from variations in water content of tissues (during aging) can be detected; however, to evaluate water content, bioimpedance measurements would need to be included.

Fascia profunda can currently be measured with US elastography or magnetic resonance elastography. To evaluate if the multi-layered phantom tissue model works with these methods, the model would need to be modified to give an appropriate signal.

How reliable are the fingers of a manual therapist? Since we are dealing with complex structures and relatively simple tools, we should research if the therapists fingers are better than the tools. Next year, we will try that at EFREM. :-)

Possible applications:

Teaching: The phantom tissue model could be used in training for manual therapists to help them detect stiffness changes in different layers.

Clinical: Do data correlate with changes known to be involved in pathologies? (To get information on patients' diseases, we would need to combine the measurements with other observations like functional variables.)

The model needs to be further developed since right now it can only represent changes in perpendicular compression stiffness but not changes in shear strain.

Future research should consider different subgroups (age, ethnicities, gender) with different body composition to increase the validity of tools and phantom models.

Of muscles, cats, and hangovers: a tale of fascia and its role in recovery

Jan Wilke

Delayed Onset Muscle Soreness (DOMS), in German “Muskelkater“ (“Muscle Cat/Hangover“), happens 24 to 72 hours after eccentric or unaccustomed / very long exercise / large amount of loading and lasts 2 to 3 days. However, it is not in the muscle. There is no association between e.g. z-line streaming, excessive lactate accumulation or free radicals, inflammation etc. and DOMS.

A review (Wilke and Behringer 2021; https://doi.org/10.3390/ijms22179482) found no evidence for the classical muscle-oriented theories. On the contrary, there is accumulating evidence that fascia, or connective tissue in general, may play a prominent role in muscle soreness. Therefore, the term “muscle soreness“ might be a false friend.

In a randomized controlled crossover study (Tenberg et al. 2022; https://doi.org/10.1186/s40798-022-00446-7), DOMS was induced by eccentric contraction; the control condition was concentric contraction. High-resolution ultrasound (HRUS) was used to measure tissue thickness and fascial mobilty (shear strain mobility - how the different layers slide against each other). As resolutíon of HRUS is not yet sufficient to make assumptions on CHANGES for fascia only, the thickness of the whole extramuscular connective tissue layer (ECT) was measured.

Results: There was no increase in thickness of ECT after concentric exercise, whereas after eccentric exercise thickness of ECT (which includes the deep fascia) increased by about 10 %; this effect lasted a few days. There was no change in shear motion of fascia after eccentric exercise, whereas muscle movement increased after eccentric (but not after concentric) exercise.

Interpretation: There is a desynchronisation between the increasing muscle movement and the fascia/ECT, the latter not being able to follow this increase.

Another study (Wilke et al. 2022; https://doi.org/10.52082/jssm.2022.419) used US elastography to gather additional information on mechanical properties and to investigate why fascia/ECT got thicker. As can be seen from the drawing adaptation on the opposite page, stiffness in muscle and fascia was very similar before exercise. However, after exercise, there was little stiffness increase in the muscle, whereas mechanical stiffness in the fascia had increased dramatically.

The stiffness change found after 24 h can to a certain degree predict DOMS after 72 h.

What happens in DOMS? Exercise causes a tissue damage in muscle and ECT. For the muscle, this is a somewhat physiological situation leading to regeneration and supercompensation/training. However, fascia—being highly sensitive—causes more discomfort, and this might be reinforced by inflammation. So, the observed increased thickness could be due to fluid, but we do not know that.

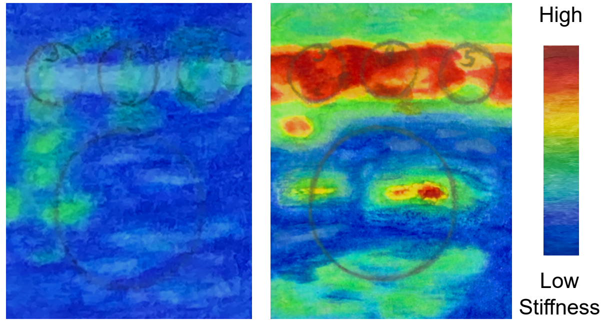


Figure: Drawing adaptation of an ultrasound elastography of the dorsal thigh before (left) and 24 h after (right) eccentric exercise. The big circle is placed in the biceps femoris muscle and the small circles in the overlying fascia. (Drawing adapted from Wilke et al. 2022; https://doi.org/10.52082/jssm.2022.419).

A meta-analysis on studies that used imaging techniques to investigate the visual substrate in clinically diagnosed muscle injuries found only in about 10 % of cases injuries exclusively in the muscle. In 90 %, injuries were found in connective tissue (in the muscle-tendinous junction or in the transition between muscle and extramuscular fascia). So, the term “muscle injury“ might need to be substituted by “myocollagenous lesion“. (Wilke J et al. 2019; https://doi.org/10.1177/2325967119888500)

Discussion

When working with athletes, making predictions based on stiffness data can be difficult because of large day-to-day baseline variations. Also, it is not clear where damage/recovery processes start and end, and if stopping the process is good or bad. Applying different modalities of recovery, possibly with a more collagenous focus, might be interesting, e.g. using collagenous supplementation and continuing with light exercise - which might be good for perfusion and pulling stimuli/signals to speed up recovery and remodeling.

What causes the increased stiffness? We need to assume fluid theories since changes in fibroblast activity leading to changes in stiffness would take longer than two or three days.

Measuring the function of the autonomic nervous system (as proxy?) could be interesting due to a known correlation between HRV and cytokine storm.

Experience shows that early movement therapy after an operation brings good range of motion, but medical doctors are hesitant. - A problem is that we have few interventional studies in fascia research. We need prospective and randomized controlled studies to be able to say how fascia reacts to treatment. This lack prevents us to advance as a field.

The body has a concept that fast mechanical healing is more important than function. Maybe, we can identify a responsible marker or cytokine in the cytokine storm and direct healing more into functional healing. - This is difficult to evaulate because factors are not region-specific. - We know how factors like cortisol and irradiation (during sun exposure) work in the skin to produce scars. Would be interesting to know what happens underneath the skin.

If you can make it to get there, you are welcome to do research in Klagenfurt :-)

CARE-TOP–study—early sCAr REmodeling therapy improves outcome in mastecTOmy Patients compared with sham laser therapy?

Stephanie Otto

Some women with BRCA1 mutations (mutations of tumor suppressor genes that will lead to cancer in 90 % of affected women) undergo prophylactic bilateral mastectomy.

In these women, the post mastectomy pain syndrome with shooting and pricking pain, tingling and numbness greatly impairs quality of life. 25 to 60 % of women suffer from chronic pain (Elzohry et al. 2018; https://doi.org/10.14302/issn.2640-690X.jfm-17-1900), which impacts social life, work, healthcare utilization and depression risk. Additionally, the breast surgery leads to functional sequelae like handgrip issues and loss of range of motion as well as sleeping troubles/fatigue.

Scarring of tissue through surgery affects the fascia, and fascia mobility has an effect on wounds (Correa-Gallegos et al. 2019; https://doi.org/10.1038/s41586-019-1794-y). The scar is the tip of a fascial iceberg.

Also, scars can be very different (hypertrophic, seroma, keloids etc.).

Together with R. Schleip, V. Fink and A. Bayat, the CARE-Top–Study was designed.

A 12-weeks phase II, interventional, prospective, randomized, controlled (right and left breast), two-arm study with 34 patients undergoing bilateral mastectomy.

The study treatment (A) consists in multimodal manual movement therapy (MMMT) including among other measures stretching and myofascial release.

The control treatment (B) is a “high-tech“ laser therapy (sham) with green light and gentle touch.

The women (who are not suffering from cancer but get prophylactic surgery) will also be treated before the surgery to soften the tissue.

Scar biopsies are taken before and after the study intervention to look at the molecular profile. A follow-up visit will take place after 6 months.

Myofascial release was included in the study treatment to reduce adhesions, restrictions, and stiffness and to increase muscle mobility, blood flow, and lymphatic flow. Myofascial release stretches the elastin and changes the viscosity of the gel substance to increase gliding of the tissue.

The purpose of MMMT is to improve scar quality and restore the affected women to the hightest level of functional movement, tissue repair, pain free range of motion, and quality of life. Psychological burden shall be lowered, too.

There is no treatment yet achieving this.

Primary efficacy endpoint
- Improvement in scar tissue quality, including pliability

Key secondary endpoint(s):
- Stiffness (MyotonPRO, sono-elastography, sham laser)
- Mechanical tissue mobility/elasticity (MyotonPRO, sono-elastography, Superb microvascular imaging, sham laser)
- Shear ability, Pressure sensation
- Tensional strength
- Range of motion (ROM): universal goniometer or smartphone inclinometer/ virtual goniometer
- Peculiarity of lymphedema: limb volume assessment, water plethysmography (water displacement method)
- Wound healing and skin scaring biomarker assessment: direct measurement of angiogenic , inflammatory, fibrotic biomarkers
- Quality of life (QoL): pain, tenderness, pliability, stiffness/softness (VAS: 1-10)
- Therapeutic Alliance Quality Scale (TAQS), Credibility/Expectancy Questionnaire (CEQ)

Discussion

Since you do not want to “cut“ the tumor, deep massage that traumatizes tissue should not be done. But soft movement therapy should be okay.

Does myofascial treatment of one breast/side influence the other side? There are experiences in the audience that range of motion only increases on the treated side. But unilateral treatment influences self-confidence and the autonomic nervous system. - Other important mechanism: Bilateral consensual reaction (if you treat one side you have a collateral effect on the other side).

There was a question around including also women who had breast reconstruction after the mastectomy and if such a reconstruction would make a difference.

Discussions around the study design:

The mechanism of the process is neurogenic inflammation by sympathetic reflex. It has been shown that sham laser therapy is very powerful to reduce stress in people. So, in this study, two treatments are compared: one directed at tissue, the other at the stress dynamic—and both will work together. Fear is that there will be nothing left to distinguish/no observable difference between sides. But how to design a better control group? - Because you do not want to whithhold treatment from women. A waiting control (or control against standard physiotherapy) could be a solution. Also, a pro of this study design is that both breasts (treatment and control group) have the same molecular profile.

With randomization into AB, BA, there might be a problem of dependency of data since groups are independent but data are dependent. - Having 4 groups (AA, AB, BA, BB) and using a mixed model would offer the possibility to perform corrections and solve the problem of dependency of data (two breasts from the same person); plus, there would also be independent data. This approach requires more participants, maybe 48 instead of 34 (with efficient mixed models). The study might take longer, but scientific data/conclusions would be more solid.

Effect of Thoracolumbar Fascia Deformation on Deadlift Velocity in Athletes and Non-Athletes: A Case-Control Study

Andreas Brandl

As presented during last year's EFREM meeting, the thoracolumbar fascia (TLF) has an influence on the erector spinae muscle (ESM).

A previous study (Brandl et al. 2022; https://doi.org/10.3390/life12111735) had shown that in patients with acute low back pain (acute LBP), the ESM activity was significantly affected by the TLF. Additionally, patients with acute LBP had a 28 % less deformable TLF than healthy controls.

The importance of the TLF is also supported by findings from Bojairami and Driscoll (Bojairami and Driscoll 2022; https://doi.org/10.1097/BRS.0000000000004223) who, from their finite element model of the spine, calculated that fascia alone contributes 75 % to spinal stability.

New research question: Does fascia deformability affect sports performance?

A study was conducted with three groups: (semi-professional) national top-level track and field athletes, untrained healthy subjects, and patients with acute LBP. In total, 45 participants were included (15 per group).

Measurements included deformation of fascia during deadlift, velocity of deadlift and ESM thickness (because of a correlation between ESM thickness and torque). Additionally, deformation of fascia during normal trunc extension was measured to see if there is a difference due to coactivation of muscles directly connected to the fascia during deadlift.

To evaluate any relationships between the measured variables, a cross-correlation analysis was performed, which allows comparison of similarity of two signals.

Results show that athletes had the most deformable fascia (change in distance between two reference points on ultrasound [US]), thickest ESM and highest deadlift velocity (see figure below; just showing trends, not precise values).

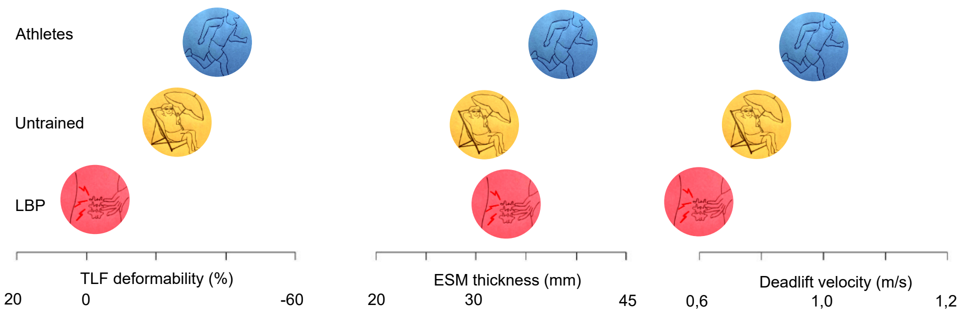


Figure: This graph does not give exact values but only a general impression. Each circle's center is located at about the median of the original graph (box-plot). Data were often skewed (not shown).

Fascia deformation did not seem to be affected by possible coactivations. Therefore, in these cases, fascia alone seemed to be responsible for the observed degree of deformation.

Acute LBP patients had hardly any deformability of fascia, and this is similar to what is seen in CHRONIC LBP patients. Usually, the hypothesis goes that pain comes first, which leads to lack of motion and then to adhesions/reduced shear motion between fascial layers. In the ACUTE LBP patients in this study, adhesions might have been there before the pain. It is an interesting question for future research why this should be the case.

In all groups, TLF deformation correlated with deadlift velocity. In athletes, TLF deformation was the strongest predictor for deadlift velocity. In contrast, ESM thickness was not convincingly correlated with deadlift velocity. Together with previous findings, this could be enough evidence to recommend a broadening in the view of performance training. There are some sports disciplines in which the focus on the TLF could be of great interest (e.g. gymnastics, swimming, sprinting, skeleton, weight lifting, wrestling).

Discussion

Comparing acute LBP patients with highly trained athletes can give deep insights into the function of fascia.

Less deformable fascia could be an important difference between LBP patients and athletes. Cause could be adhesions with underlying ESM which reduce shear motion. This could be a reason for lack of big differences when measuring prependicularly with IndentoPro/MyotonPro.

Good to have a fascia study in athletes. There are not so many.

Unfortunately, data cannot be generalized, also due to low numbers of participants. But it is difficult to find a high number of national top-level athletes able to participate.

Possible neurological mechanisms involved in changes seen in pain patients: change in motor neuron function due to lack of motion; reaction at the level of the brain stem when there is a problem (choice between pain and stiffness); disturbance of processing of information from muscle spindles in epimysium (hypothesis of Caterina Fede) due to adhesions and changes in autonomic nervous system and proprioception which could lead to changes in blood circulation.

Could skewness of data on ESM thickness in LBP patients be due to different movement patterns due to pain?

This was not controlled for in this study, but a former study had shown altered movement patterns in pain patients.

If data on movement patterns are available, a non-parametric covariance analysis might allow control for the variance introduced by altered movement patterns and show if the result changes after extracting that variance. There are software solutions which can do a non-parametric ANCOVA.

Different types of deadlift could allow different evaluations of coactivations.

Effect of Foam Rolling on Joint Range of Motion and Neurological Responses

Akane Yoshimura

Foam rolling is effective in increasing range of motion (ROM). However, the mechanism of this effect is unknown.

In several past studies (see references below), ROM in the target muscle was significantly increased, whereas none of the other variables, concerning among other things extensibility/mobility and hardness/stiffness of muscle and/or fascia, showed changes. Myofascial release using a foam roller did not seem to influence the morphology or architecture of fascia or tendons.

1) Effects of Self-Myofascial Release Using a Foam Roller on Range of Motion and Morphological changes in Muscle: A Crossover Study
(Yoshimura et al. 2021; https://doi.org/10.1519/JSC.0000000000003196)

2) Effects of Self-Massage Using a Foam Roller on Ankle Range of Motion and Gastrocnemius Fascicle Length and Muscle Hardness: A Pilot Study
(Yoshimura et al. 2020; https://doi.org/10.1123/jsr.2019-0281)

3)The acute mechanism of self-massage–induced effects of using a foam roller
(Yoshimura et al. 2021; https://doi.org/10.1016/j.jbmt.2021.02.012)

4)The effects of calf muscle self-massage on ankle joint range of motion and tendon-muscle morphology
(Yoshimura et al. 2022; https://doi.org/10.1016/j.jbmt.2022.05.009)

Further thoughts led to the conclusion that there are global changes in the central and autonomic nervous systems—mediated via stimulation of mechanoreceptors—which contribute to a palpable tissue response.

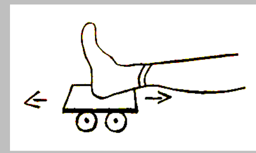
Therefore, in the most recent study, also neurological responses were investigated.

The study was conducted as a randomized controlled trial with 3 groups and 8 to 11 participants per group (27 participants in total). The targeted muscle was the calf-muscle.

A control group performed sham rolling, and one group each performed active versus passive foam rolling (see figures on the opposite page).

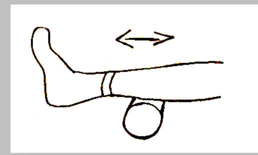
The rolling was carried out at 25 cycles per minute and an intensity of 15-25 % of body weight for 3 minutes.

Sham Rolling (Control)



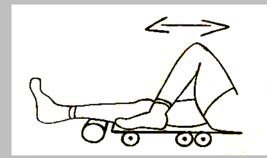
Only voluntary movement

Active Foam Rolling



Voluntary movement & pressure

Passive Foam Rolling



Only pressure

(The drawings are based on a figure from the presentation.)

Results: Passive ROM increased with active and passive foam rolling but not with sham rolling. In addition, pressure pain threshold (PPT) in the target muscle and stretch tolerance increased with active foam rolling. All other variables (pressure pain threshold in a different area, stiffness and thickness of muscle and superficial/deep fascia) did not change.

Conclusion: The mechanism of the effect of active foam rolling on ROM might be neurological; however, the mechanism of this effect in passive foam rolling is not clear.

The discussion of this study will be further deepened in the future, and another study will follow.

Discussion

It is surprising that there was an altered sensitivity in the leg but not in the hand. Usually, mechanisms of neurological pain control (modulation) are systemic. What could be an explanation for a regional change in pain sensitivity?

You have 2 to 3 minutes time to find a difference.

In this stuy, PPT was first measured in the leg and then (presumably after more than 2 minutes) in the hand.

One possible reason for having a response in the leg but not in the hand is that too much time elapsed before measuring the hand.

So, it could be conditioned pain modulation (body-wide).

Ideas for future studies:

Checking of reflexes or deep vibrations to support the neurological hypothesis

Soft Tissue Stiffness Meter

Hakan Oflaz

There are two ways to measure stiffness in tissues:

Either you press until a certain displacement happens and then try to guess the reaction force of the tissue, or you apply a certain force and try to guess the displacement.

Palpation with fingers is a very subjective method. Ultrasound and elastography are gold standards but expensive. It would be good to have hand-held devices.

A new hand-held device that measures the reaction forces in the soft tissue at a given indentation deformation was designed.

The device was tested on agarose gel samples of different molarities, which mimic the stiffness variables found in vivo, and compared to an existing durometer (Shore Type 00).

The very first version of the medical device was able to distinguish between the stiffness of agarose gel samples with a concentration of 0,25 % and 0,50 %. The type 00 durometer was not able to discern this difference in stiffness.
(Oflaz and Baran 2014; https://doi.org/10.5277/abb140115)

The second version of the device was tested on fetal membrane tissue—again compared to the type 00 durometer. The new device found a significant difference in stiffness between membranes from normal births and those from preterm births, whereas the durometer did not detect any such difference. So, the new device worked even on very thin membranes.
(Oflaz 2016; https://doi.org/10.1016/j.bbe.2015.10.007)

The device has an inner sensor that measures x/y/z coordinates and allows to record stiffness values while moving the device. In the future, it will also measure temperature.

The indentation depth can be adjusted but would then need to be calibrated for the new depth.

The device has a spherical tip to not traumatize thin tissue and to mimic palpation (finger tips are spherical). However, this prevents measuring force per surface.

The enhanced capacity of the device to measure differences in stiffness coud be used for early detection of impeding decubitus wounds or in dentistry to measure if the tissue is ready for implantation (among other applications). For the latter, a simple "yes"/"no" measurement would be sufficient.

Another device, which is in a very preliminary stage of development, is an air pressure gauge (pneumatic method from Dr. Robert Schleip).

This device can be used for measurements in tube-like structures (like the vagina). The balloon of the device is inflated with a certain amount of air/pressure and then introduced into the tube. When the balloon is squeezed, the inner pressure increases. This pressure increase is related to the inner diameter of the tube and to the stiffness of the surrounding material. By doing many experiments and getting many data, pressure changes might allow predictions of diameters/ stiffness.

The device was tested on moulds of different inner diameters and stiffness values. Non-curved samples from the same material/with the same stiffness served as controls and were measured with a normal stiffness assessment tool.

Discussion

Question on terminology: What are we measuring? Stiffness to compression? Or a more longitudinal aspect as in elastography? Now, we are introducing a more 3D concept with pressure being measured in a cylindrical shape.

We need to use different words or be very clear what we are talking about. Tissue can behave very differently in different dimensions/directions.

The industry has standardized protocols for measuring stiffness of different substances, concerning both the direction of the measurement (like indentation) and the shape of the probe (flat or round shore meters/ indentometers). / Of course, they assume homogeneity of material.

We have to do reliability studies. / Every device uses different units.

Tissue stiffness could be different in different aspects of "tube". More sensors around or turning the device plus adding more air to the balloon can give differential data.

The device measures the combined stiffness in the area. If one wall is softer and the other harder, it measures an average stiffness.

However, in real life, getting average data might not be helpful - in view of different anatomical relationships/physiological requirements at different aspects of circumference. Also, maybe elasticity is more important than stiffness in certain areas.

Since air is compressible, filling the device with fluid might be more adequate to get an idea about differences at different sites of the circumference.

Fascia and Skin Dermis

Aurélie Porcheron

Presenter is studying the effects of cosmetics and massage and the mechanisms of action on skin and emotion/wellbeing (working in a neuroscience laboratory).

Why at EFREM? Skin and fascia are physically close and share similarities. Research on massage not only concerns the skin but also the underlying fascia. The colleague developing the massage is an osteopath and has worked for several years with a fascia therapist to develop a specific massage that targets the skin and also the fascia tissue.

Past studies included the following:

- An evaluation of the effects of pincement Jacquet massage on skin wrinkles.
- An investigation into the effects of self-massage using line-field confocal optical coherence tomography (LC-OCT) to see what is going on underneath the skin. LC-OCT provides good visibility of cells and collagen fibers (up to a limited depth) and shows the orientation of collagen fibers plus the thickness of the epidermis (see also https://damae-medical.com/).
- Recently, an evaluation of the relaxing effects of skin preparation with products and massage by a therapist; in this study, a questionnaire was used to gather information on perceptional and emotional variables and heart rate variability was measured.
- In 2007, an investigation into the health benefits of the daily application of body skin care: 30 women daily applied a body cream with a defined routine of about 10 minutes. A control group of 10 women were asked to maintain their usual lifestyle and cosmetic habits. On Day 0 and day 30 the following assessments were done: lumbar and upper body flexibility, self-esteem and state-trait anxiety. Results showed measurable effects on joint mobility and positive impact on self-esteem.

Discussion/Answers

Fascial tissues and fibroblasts have sex hormone receptors. In women, after menopause, low hormone levels might lead to rearrangement in fascial architecture resulting in higher content of collagen I versus collagen III.

A group around Carla Stecco and Caterina Fede did in vitro studies on how fibroblasts and fascial tissues respond to high and low estrogen levels. They did not measure stiffness per se, but a different collagen content will very likely result in different stiffness.

A comment on the study from 2007: measuring the range of motion in the hip region might be more relevant for the type of movement the women do while applying creme on their legs (a lot of hip flexion plus elongation of the back)

Discussion/Answers to questions below

At age around 20, our elastin fibers are very thin and hydrophobic. Therefore, in the hydrophilic environment of the extracellular matrix, they can move freely and are able to stretch. As long as these fibers are thin and hydrophobic, the skin has its elasticity. But with aging/exposure to stress, mitochondria produce reactive oxygen species (ROS). Though ROS are very short living, when they leave the mitochondria and cell, they are converted into hydrogene peroxide (H_2O_2). This changes surfaces into hydrophilic surfaces. As a consequence, the elastin fibers will gradually become more hydrophilic. This means that they have 3 monolayers of water attached which have a very high viscosity (like honey). Once elastin fibers are caught in this glue, they start to collect calcium salts and become immobilized in the matrix and no longer move freely. Additionally, several fibers get together to form stiff bands. At the end of the long process, elastin fibers have the same stiffness as collagen fibers.

Self-destructive/ uncoupling/breaking down mitochondria lead to accumulation of plaques inside the cells (dark dots on skin / core material in muscle / Alzheimer plaques in the brain).

If you keep glucose levels for breaking-down mitochondria constant, you can make them live longer.

In a study using myofascial release with a focus on longitudinal stretch (low pressure), blood flow in myofascial tissue increased.

Questions to the audience

What is the impact of the physical activity brought about by the cosmetic routine (study from 2007) on fascia and how can you measure it?

What are the mechanisms when you do massage and you change the thickness and elasticity of the fascia?

What is the relationship between the skin/dermis and superficial fascia which are physically connected? What kind of actions are there between the two tissues?

What is the impact of aging on fascia, and what are similarities between aging in skin and fascia? Does aging of fascia impact skin aging and vice versa? In skin aging, the cell senescence process is very important. What about the cell senescence in fascia? We know that there are fibroblasts, for example. Do you know about senescence of fibroblasts and the impact on fascia tissue?

Are „healthy" fascia visible on the skin and vice versa?

Impact of massage on fascia nervous system?—Since fascia is richly innervated in terms of proprioception and interoception.

Can we teach individuals to „self-massage" their fascia?

What is the difference/impact on fascia between a low pressure manual therapy (e.g. Danis Bois) vs. higher pressure manual therapy [e.g. Rolfing]?

Imaging of collagenous structures by using MRI with ultrashort echotimes

Heiko Stark

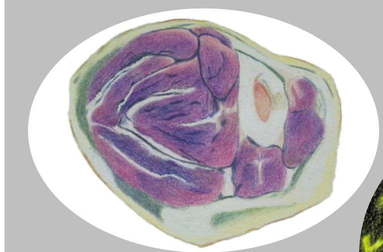
A method for 3D visualization of collagenous structures in general (not limited to fascia) by Magnetic Resonance Imaging (MRI) was developed to provide a means for diagnosis, therapy and simulation.

Collagenous fibers are important as force transmitting structures. Because of their hyperelastic (taking large deformations) and anisotropic (having different properties in different directions) behavior, 3D visualization would be of particular interest.

MRI is based on the spin orientation of the hydrogen proton, which is mainly present in water. Normal MRI cannot distinguish between muscle and connective tissue. However, muscle and connective tissue have a high content of water, and in connective tissue, this water is more bound to other structures and cannot move as well. Therefore, if we measure at different time points, we get different images and we can indirectly visualize the connective tissue in the muscle tissue.

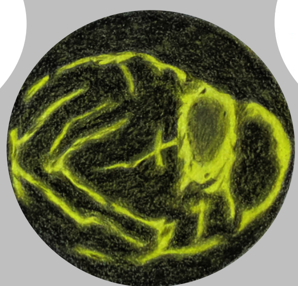
The new technique was evaluated using sheep forearms (available from another study) embedded in agar-agar. These were first scanned with MRI followed by formalin fixation and histological assessment with two different staining methods.

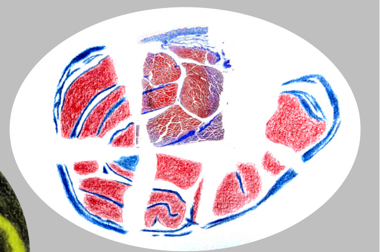
The drawing of the MRI scan below is adapted from a picture of an older scan; New images have a better resolution and show not only aponeuroses (corresponding to the blue structures inside the muscle in Azan staining) but also connective tissue inside the muscle.



Cross section

Difference image





Azan staining
(the upper middle wedge has been taken from the original image to visualize the structure inside the muscle tissue)

Please also view the original images from Stark et al.
Available under: https://www.bgn.de/?storage=3&identifier=%2F765798&eID=sixomc_filecontent&hmac=d7a1fe8922909ada2a241515d9714d1beddc9bf5 (last accessed: 6 February 2023)

The new technique can be used for diagnostic purposes and can show changes in connective tissue during therapy, thereby allowing evaluation of responses to therapy. The technique also delivers data for simulation and shows direction of connective tissue and connections between different structures.

Due to the size of the required coil, regions of the size of the head can be scanned.

Discussion

Could the technique be used for longitudinal follow-up of cancer patients, e.g. showing state of sarcopenia before an operation?

Can information on fascia be taken out of usual MRI pictures?

Answer: The technique requires an additional coil for the spectometry. Plus, in this study, a 3 Tesla MRI was used, which you do not find everywhere.

Paves the way for looking at connective tissue around the structure of interest. With back pain patients, most radiologists look at the spinal column, but with this knowledge you can open the world by looking left and right.

Connecting different structures is an important characteristic of connective tissue and if you can see connections between structures you get more insights into behavior.

The problem with ultrasound is that it is very observer dependent. By holding the probe a certain way, you can show “everything“.

This technique is more objective. It scans a bigger area and is not dependent on angle. It depends on machine and Tesla (and time delay).

Minimal voxels are 1 or 2 mm.

The technique is described under:

Krämer et al. 2019: https://doi.org/10.1016/j.mri.2019.07.015

Check out: https://starkrats.de

TRYKK - Remove emotional and physical blocks through this innovative acupressure clothing

Laura Deschl

The idea

The product idea of clothing that targets pressure points in the body was first developed as a concept for integrated psychotherapy as part of a masters degree. The general interest in the subject was also inspired by Bessel v.d. Kolk.

There is a big gap between what psychotrauma does (affecting the body) and the way symptoms like anxiety and depression are treated by cognitive approaches.

Acupressure can bring up burried emotions in the body. During a usability test with mental health patients, one patient reported emotions coming up when a certain point was pressured (to give one example).

The team of TRYKK (= Norwegian for „Druck/Pressure“) includes a Designer, a TCM Doctor and a Business Lead.

Mission: Unite what is otherwise seperated: Body and Mind—Fashion and Introspection—Clothing and Wellbeing

(Simplified drawing representation of the small balls and the elastic textile with its flexible grid. For an explanation, please see the box below. For a realistic picture, please check out: https://trykk.eu)

Product characteristics

Elastic textile with flexible grid - compression - you can stimulate multiple points - small balls stay in place, but can be moved around if wanted - openings in garment allow introduction of balls - pressure points can be individually adjusted

Merino wool together with compression yarn - easily washable, but takes time to dry - does not shrink anymore after first washing (before production)

Industrial production process - very easily adaptable - could use antibacterial yarn (however, pattern might have to be redone)

Market aspects

Market research showed that reasons to apply the product were: 1) targeting pain points in the body - 2) mind-body connection - 3) psychosomatic issues.

First adopters would be active women aged 26-41 with mental health awareness.

Starting with a set for neck and low back pain (top with pressure points in pain areas plus socks for distal TCM points on hands and feet) - other applications to come - also planning e-health platform and personalized prescription/guidance.

Targeting secondary health market; market volume of 3 Bn Euros, growth of 6 % yearly in Germany; 70 % say, they value more holistic approaches; 35 % say, we need innovation (Huber and Kirig 2015; Zakrzewski 2022; Dostal 2017)

Discussion

Question: Can you imagine that this could help cancer patients with their fatigue? Ulm University has a big center for integrative medicine. German Cancer Aid supports patient-oriented treatments.

Answer: For targeting anxiety/fatigue, you would need the whole set. We first concentrated on localized points on the back, because: 1) It might be easier to prove efficiency; 2) You can get stimulation just by lying down on the back; 3) You do not need the whole set. —But body suits exist and it would be easy to replicate them.

Zinc and Copper are antibacterial and prevent shrinking of fabric through washing - copper is not a cell poison if it is not in contact for too long.

After doing research on mechanisms of acupuncture for almost 20 years: It does not really matter by whom the point was described. You just need the small balls where the patient feels the problem.

Stimulation points in kinesiotape

But pain wanders around and we do not have to provide a customized piece

Daniel Keown “The unchartered body“ or “The spark in the machine“ (mapping western medicine with TCM and fascia) could be conceptionally interesting.

The product would give yoga practices that are talking to certain meridians another level when used for targeting the same meridian.

Laura also thought about combining acupressure and yoga. But yoga people did not seem to be more interested in the product than others. - Maybe low back pain patients who do yoga would be more interested.

Looking at possible applications and explanations of efficiency - not restricted to TCM - Looking at the best application possible

Ways to support TRYKK (e-mail: hello@trykk.de)

Case study with product (student thesis with academic supervision)

Empirical application study in exchange for company shares

Joint effort to receive funding

Models of musculoskeletal pain - Sensory findings after fascia and muscle stimulation

Andreas Schilder

Underlying question: Are there differences between fascia and muscle that—based on the quality, intensity and radiation of the patient's pain—allow to say if the problem is in the fascia or more in the muscle—and to decide what kind of therapy to start?

In a series of studies (see references on opposite page), chemical stimulation (hypertonic saline solution) and electrical stimulation (high-frequency stimulation [HFS] leading to long-term potentiation, meaning the same stimulus would then elicit more pain) of muscle, fascia, subcutaneous tissue, and skin was performed.

Results:

In terms of pain intensity and duration, the thoracolumbar fascia is more sensitive to chemical stimuli than muscle is; subcutaneous tissue is similar to fascia.

HFS of fascia led to higher pain in fascia. HFS of muscle (needle electrodes) led to less pain in fascia. There was no increase of pain in muscle after HFS of muscle. So, fascia is more sensitive to HFS. There is probably a central interaction between nociceptive afferents of fascia and muscle on the spinal level. Muscle stimulation could then attenuate fascia input driven pain plasticity.

After hypertonic saline stimulation, affective pain quality is higher in fascia tissue compared to subcutaneous tissue and muscle.

“Cutting“, “burning“, “scalding“, “stinging“ and “hot“ describe fascia pain wih a high affective component—“beating“ and “throbbing“ represent muscle pain.

After electrical stimulation, “deep pain qualities“ point towards muscle and “heat pain“ or “sharp pain“ points towards fascia.

After hypertonic saline injection, fascia stimulation has larger pain distribution patterns than muscle.

Fascia in different locations can have different sensitivity.

Conclusions:

It should be possible to distinguish muscle pain quality, intensity, and maybe radiation from fascia sensitivity - but this needs to be checked also in patients.

Also important:

From a sensory/psycho-physic perspective, our system is built in a logarithmic way (Weber-Fechner Law). Therefore, showing sensory data logtransformed might be more appropriate.

The similarity of descriptive patterns regarding fascia and skin can potentially lead to misintepretation of fascia-related pain as nociceptive pain.

References for presented results:

Schilder et al. 2014: https://doi.org/10.1016/j.pain.2013.09.025

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Vogel et al. 2022: https://doi.org/10.3390/life12030340

Magerl et al. 2022: https://doi.org/10.3390/life11050370

Research showing that the required receptors are present in fascia:

Tesarz et al. 2011: https//doi.org/10.1016/j.neuroscience.2011.07.066

Mense and Hoheisel 2016: https://doi.org/10.1016/j.jbmt.2016.01.006

Discussion

Although reaction of different tissues to a certain type of stimulation can be similar, the stimulation itself might have to be done differently (e.g. needle electrode for fascia stimulation to avoid muscle co-activation, and surface electrode on skin)

Concerning the question where to best put local anesthetics [LA], the distribution of the LA in fascia (2D structure) and muscle (3D structure) needs to be taken into account. Not easy to say what would happen if LA is injected specifically into fascia. Injecting colors to trace would be interesting.

Is there any correlation between what happens in myofascia after hypertonic saline injection compared to what happens in systemic acidosis?

There is lots to do… :-)

If you are up for collaboration on those things, happy to talk about that.

Lung Fibrosis

Resonance - an internal lung massage

Kelly Cruz Contreroz and Andrei Sommer

Andrei Sommer

One aspect of Long Covid is pulmonary fibrosis. What is lung fibrosis? In the course of an inflammatory process in the lungs, the fibers (collagen and elastin) form longlasting crosslinks and become rigid. Collagen is hydrophilic and, therefore, has three monolayers of water on the surface. These have a very high viscosity (like honey). Under the effect of reactive oxygen species (ROS) (through oxidative stress - anxiety, depression, wound, inflammation…), the three monolayers become even more glue-like. So, calcium salts and other particles stick to the surface, and the flexibility, mobility, and independence get lost.

The result is a complex system of interconnected, crosslinked fibers in the lungs. Fibers can stick together parallel or in other configurations. With time, they become rigid. The stiffer the lungs, the more difficult it is to breathe. The earlier the bonds between the crosslinked fibers are loosened, the bigger the chance to disconnect the fibrotic tissue, so that fibers are individual again.

You cannot access the lungs with external tools, but Kelly Cruz found a way to interact with the fascia in the lungs via a breathing technique and music. She uses two tools:

1) Breathing = enlarging the lungs—a slow process

2) Sound / Music = creates vibrations to dissolve the individual bonds between fibers

Through the combination of expansion plus localized vibration, the fibrosis in the tissue gradually resolves. Older and younger patients reported to be able to breathe much better after only three sessions.

This is a completely new field. We have to find out which particular frequencies and amplitudes are best to dissolve the bonds between fibers.

Kelly Cruz

Reports she did not discover this by herself, but is was given to her by her career as an opera singer. The aim is to maintain the cavity of the lungs bigger for a longer time and to put some vibration there. Like in a guitar, there are many frequencies in the lung cavities. We can feel that if we put one hand on the chest and one in the back and make sounds. Having an empty cavity is a prerequisite for resonance.

Sessions are once a week and in between patients have to train at home (three times per day). The technique needs touch.

Music brings together the logical and the abstract parts of the brain.

Discussion

There are projects working with COVID-19 patients with breathing/ singing in Europe (e.g. “Durchatmen“; a project with English opera singers).

Some of those projects work online. However, with the method presented here, touch is important to make sure the cavity stays large and vibration happens.

Some of those projects also work with explosive sounds since fascia needs elastic rebounds. However, in the method presented here, the singing is the consequence; the real focus is on training.

Possible physiological mechanisms:

Humming sounds induce nitric oxide production, which is good to soothen the tissue.

Surfactant production

Mucus in alveoli is shaken and going to go outside (one principle goal).

Other mechanisms of the technique are interoception and dealing with the mind, the “noise“ in our heads. Musical activity helps to stay focussed on the present moment; e.g., you cannot think about worries and other things when you have to keep a rhythm.

Music and vibration also help with tightness in the face and neck caused by stress/ anxiety.

Since what happens to the lungs during fibrosis is the same as what happens to the skin during aging and with stress, the technique could relieve consequences of stress (e.g. in cancer patients).

Vibration in the body goes everywhere.

In horses, vibration measurements found audible frequencies in the inner ear. There is a possible connection with tinnitus.

How it works

Part A: Enlarging the lungs

1) Breathe in deeply

Touch the ribs at the lower part of rib cage. Imagine an empty glas and fill the glas from that lower part to the top. Count to five while breathing in.

2) Make a halt (do not exhale air)

Count to five while halting.

3) Maintain the cavity using the intercostal muscles while air is flowing out

Count to five while breathing out. This protocol is a start; the aim it to make this period longer. In the third part, imagine the diaphragm like a gas pedal you are pushing down. Part A needs good training (to counteract the tendency of the thoracic cavity to besome smaller during exhalation) to be able to add part B.

Part B: Creating Resonance/Vibration

The resonance should be in the chest = low tones (high tones go into the head).

The aim is not to sing but to produce resonance to shake whatever is stuck/stiff.

Use *mmm, nnn and* later lullabies/complete sentences.

It is important to train the vocal cords slowly so that they get softer (no hard noise).

The goal is to maintain the resonance as much as possible; that is only going to happen when the cavity does not become small.

Does Stimulating the Autonomic Nervous System with Resonance Breathing have a positive effect on Vagal Tone?

Christopher Marc Gordon

This talk is on scientific background information relating to stimulation of the vagal tone and it's possible benefits.

The vagal nerve has many effects on health, among which is an influence on inflammatory mediators. One publication that demonstrated an inverse relationship between vagal activity and inflammatory competence is

Marsland et al. 2007: Stimulated production of proinflammatory cytokines covaries inversely with heart rate variability (https://doi.org/10.1097/PSY.0b013e3181576118).

In animals, it was shown that parasympathetic signalling inhibits the production of proinflammatory cytokines by activated macrophages and this leads to a reduction in local and systemic inflammation *[information taken from the abstract of the above mentioned reference].*

There is currently a huge worldwide interest in stimulating vagal tone—invasively and non-invasively. Vagal tone is often measured by heart rate variability (HRV), which increases with increasing vagal tone. One technique to increase vagal tone is paced breathing, which is discussed in the following publication.

Tsai et al. 2015: Efficacy of paced breathing for insomnia enhances vagal activity and improves sleep quality (https://doi.org//10.1111/psyp.12333)

Paced breathing enhanced vagal stimulation. Practicing paced breathing for 20 minutes before going to sleep benefited sleep quality and regeneration.

A special type of paced breathing is resonance breathing. In resonance breathing, the breath and the heart rate correlate/are synchronized.

Lin et al. 2014: Breathing at a rate of 5.5 breaths per minute with equal inhalation-to-exhalation ratio increases heart rate variability (https://doi.org/10.1016/j.ijpsycho.2013.12.006)

How can this stimulate the vagal tone?

Slow breathing slows the heart rate down. Fast breathing increases the heart rate. Only breathing with a rhythm of breathing 5 to 6 seconds in and out (equal proportion) leads to a real coordination with heart rate; this can be called the "Golden Mean of Breathing" (for the greatest part of society, with exceptions).

Based on this study, self treatment tools like the Fascia ReleaZer® and the Stress ReleaZer® were developed, which have gone through different pilot studies and a randomized study. The goal was to find something that works for as many people as possible with the aim to standardize research and therapy and to reach out to the many, not the few.

For therapists involved in treating patients with pain, strategies to reduce sympathetic tone are interesting.—Because if we are always caught in sympathetic tone, we create a vicious cycle that causes not only a greater pain cycle, but affects the brain, the endocrine organs, how much cortisol/adrenaline is in the blood.

Nazarewicz et al 2015: Sympathetic pain? A role in poor parasympathetic nervous system engagement in vicarious pain states (https://doi.org/10.1111/psyp.12516)

It is very important to include the autonomic nervous system (ANS) in fascia research, and to include breathing therapy and vibrational therapy in clinical work of bodywork therapists.

At last year's EFREM meeting, the talk "Self-Myofascial Release for Chronic Low Back Pain and Stress: A Controlled Clinical Trial" (available under: https://www.center-gordon.de/Abstract-Gordon-Self-Myofascial-Release.pdf) was presented. It showed clinical evidence on self-myofascial release and vibratory breathing work using the Fascia ReleaZer®, applying a special setting to induce vibratory breathing training.

It has not yet been investigated whether vibratory breathing training is significantly more interesting than just breath pacemaking with music or once inner rhythm. But the presenter would love to know more about this and build more relationships and bring this out as a research question: "Does vibratory induced breathing have a greater effect or not?"

Discussion

Is it possible to control the ANS with breathing exercises? One always hears it is autonomic and you cannot control it.

The ANS should not be called autonomic; this is not quite the right name because it is partly autonomous and partly not.

Being able to control the ANS has huge advantages. This is what the yogis have been teaching for thousands of years; it is nothing new.

We are just making it accessible to modern people having fallen out of their rhythm and perceiving and receiving more stress than ever before.

Paced breathing works best with 2 times 15 minutes per day.

"Being interested in fascia, it is more and more important that we look and involve ourselves in the parameters and the variables that can allow us to understand how to put our research questions in a more evidence-based framework so that we understand how fascia is relating to the autonomic nervous system."—Christopher Marc Gordon.

Reseach question: "Does vibratory induced breathing have a greater effect or not?"

Myofascial Syndrome and Low Back Pain: Focused Shockwaves as Diagnostic Tool for Myofascial Trigger Points

Hannes Müller-Ehrenberg

[Unfortunately, there were repeatedly technical issues during this talk. A few minutes are lacking completely on the recording and for the rest of the talk often visibility of the slides and/or intelligibility of spoken language were not good enough for unambiguous understanding.]

Myofascial tissue is an important source of pain and discomfort. Myofascial Trigger Points (MTrP) can mimic articular dysfunction and neurological and orthopedic diseases. Myofascial pain can imitate a nerval root lesion (e.g. "Pseudo S1 Syndrome").

Diagnostic critera for myofascial TrPs are: (from: Tough et al. 2007: https://doi.org/10.1097/AJP.0b013e31802fda7c)
1.+2. A taut band with a tender nodule/spot (MTrP) in it
3. Recognition of the pain by the patient (meaning that after a proper stimulus on a TrP, the patient will say that this is their typical pain, this is something they recognize; this is also important for the aspect of reffered pain, when not the local pain but the referred pain is the leading pain)
4. Predicted pain referral pattern
5. Local twitch response.

Focused shock waves can be used not only to treat but also to diagnose MTrPs. In a pilot study in 2005, a recognition of pain while stimulating an MTrP was found in 29 out of 30 patients.
(Müller-Ehrenberg and Licht 2005; available under: https://www.semanticscholar.org/paper/DIAGNOSIS-AND-THERAPY-OF-MYOFASCIAL-PAIN-SYNDROME-M%C3%BCller-Ehrenberg-Licht/08451eafac308b1a2d1c9f249d97eb70a3393988)

Together with the University Hospital of Münster, Germany, a recent study on low back pain was set up.
Aim: To demonstrate that myofascial tissue plays an important role in chronic low back pain and that, with focused shock waves, we have a good tool for diagnosing this and for generating reproducible data.
Shock wave device used: Wolf piezo100plus from Wolf/Elvation

Fascia and muscle are a functional unit.
There are different systems to classify and name tender „spots". MTrPs according to Travell/Simons is seen form a muscle perspective. However, the Stecco system sees spots in fascia. Could be the same spots.
(As an aside: „tender points" from fibromyalgia are not trigger points; trigger points are not a rheumatoid disease or fibromyalgia.)

Advantages of using focused shock waves also as a diagnostic tool are:

- The technique is non-invasive, but it can reach deep and targeted into the soft tissue through control of energy/penetration depth. The technique is different from shock waves used for destruction of renal stones etc. There are guidelines and protocols for using it for MTrPs.

- When a patient presents with pain and an abnormal finding like a disk hernia on MRI, stimulating an MTrP with focused shockwaves can illustrate to the patient that their pain might not come from the nerve but from other structures (as a reminder: 30 to 80 % of asymptomatic people have abnormal radiological findings at the spine, and 80 % of people with LBP have unspecific LBP, where we do not know the cause).

- The technique delivers reproducible data, which for myofascial tissue/pain treatment is relatively lacking. We have difficulties to get reproducible data and present these. Focused shock waves are also more reliable than manual palpation.

Conclusion

- Myofascial tissue seems to be a specific reason for chronic LBP
- fESWT is a good diagnostic tool to diagnose myofascial tissue to be an important source of LBP

(using diagnostic criteria of myofascial triggerpoints according to Travell/Simons)

- Outcome of the specific diagnosis of myofascial pain is related to a manuel examination
- There is a need of a consensus in myofascial ESWT for the diagnosis and the treatment

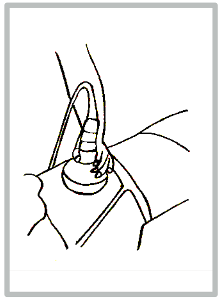

Figure: Drawing of a shock wave device based on an image from Müller-Ehrenberg and Licht 2005

Discussion

Anybody working in the field has an idea of a palpation of a TrP, but so far we have no imaging pictures from MRI in vivo. (Apart from a group in Munich that visualized something which could be called an MrTP in the trapezius muscle.) For electron microscopy, we would need biopsies.

[Somebody from the audience had an idea, but this was not intelligible in the recording.]

Question:
Can you prove that focused shock waves are more reliable than palpation?

Answer: Hands are not able to so often elicit recognition and referral of the pain. They are great tools, but focused shock waves use a different stimulus and hands are limited if you go deeper.

One aspect for future research might be to visualize myofascial trigger points in vivo.

About different passions and how they may work together: Printing with intelligent ink

Maria Neugschwender

Also for this presentation, there were technical issues: sound is good, but slides are nearly all not decipherable.

First passion: Printing

With printing, you can manage a lot of knowledge.

Today, you can print a lot of things. There are also printed electronics. For this, you modify printing ink by using nanodispersions to make the ink intelligent.

With intelligent ink, you can do a lot of things. You can print sensors and wires and even displays.

Video out of research lab shows wires and sensors printed on foil—can be stretched by more than 200 percent and also crumpled up.

Second passion: Chronic Back Pain

As a patient, this feels like a darkness you do not understand and do not know. But with the help of medical experts and asking the right questions, you can gain more and more knowledge and show interrelationships (e.g. with diet or movement).

With research it is the same: We can show interrelationships between different areas where we would not even expect them.

Motivaton for the product: Generating knowledge with printing.

The current project is based at the Technical University of Munich, the Karlsruhe Institut of Technology and the University of Life Sciences in Munich; it is also getting funding from the government.

Bring a measurement system from medicine (surface EMG) into daily life

To get to the current state, a lot of problems had to be solved. Does printing surface EMG work?—Yes, it does. The next problem was the characterization of the sensors, then the mechanical stability (the first prototype was not stretchable). Is it washable?—Yes, up to 60 cycles. Nex were software problems; also those were solved.

Right now measurements are done in a bipolar fashion (with two electrodes), but in the future an array system shall be used to eliminate problems with the placement of the electrodes.

Currently, there is a project together with Werner Klingler and Robert Schleip. This is what the belt shown around during the meeting is for.

Measuring the low back with printed electrodes.

Right now, the project is in the development phase. It is due to start the pilot phase in three weeks. Also, an app is currently being designed.

Looking for feedback from the audience.

The electrodes are covering the lower back.

The belt can be connected to a mobile device. The app shows on a color scale how active muscles are. (In the future, more detailed data are planned.) The right and left side are shown seperatedly. This can be used for biofeedback training, e.g. by doing the pingpong game.

There is also life data - you can download raw EMG data.

Discussion

As with any surface EMG, it is difficult to differentiate between muscles. However, it is hoped that the array system will solve some of the usual problems with surface EMG.

Calibration on an individual level is possible for generating data on specific muscle groups. However, for using the device to train muscles and compare a before/ after (e.g. an injury) situation, very individual data/different sort of calibration would be needed.

Electrodes can also be printed on other material, which can be applied on almost everything, including leggings.

System will make research with EMG easier, when no longer having to deal with a lot of cables.

Looking for feedback from the audience. Would like to discuss applications and problems.

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Aurélie Porcheron

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Heiko Stark

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More possibilities for collaborations

Andreas Brandl:

On guest editorship of Robert Schleip in MDPI Journal of Clinical Medicine (see info e-mail sent on this topic on 30 November - key decisions had to be taken in the past weeks - so please contact Andreas Brandl for current status ot the project - Timeline? Exact subject?)

Patrick Weber:

Studying effects of vibration therapy on myofascial tissue.

Does anyone have information, studies, literature on this? (Please share)

What effects it has on myofascial tissues (muscle and fascia) - from cellular level to clinical research (release, stiffness changes, proliferation)

It is about which different frequencies we can use.

Exclusions: It is NOT about whole body vibration. Only local vibration. And NOT on massage-guns/tools causing a deformation of tissue.

Katja Bartsch:

Has a research interest in female physiology and fascial tissue - changing levels of female sex hormones throughout month and lifetime - and structural and functional parameters of fascial tissue. Focussing on interventional studies. Little research so far, getting more.

If anyone is interested in this or also has that focus, or potentially would like to think about future studies or cooperations, would be delighted to get into contact. Together with Robert Schleip and Jan Wilke curently setting up a first study. Wanting to announce this, in case anybody else is passionate about this.