13th European Fascia Researcher Exchange Meeting (EFREM), 17th/18th November 2023, 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 original figures, where available and referenced.

The meeting started with a guided tour of the training facilities and research laboratories of the beautiful and impressive Sports and Health Campus of the Technical University of Munich. Made to more than 50 % from wood, it is designed to become the biggest campus of its kind in Europe, and, as the location of the Olympics in 1972, it is also a historical site.

Pain quality patterns in delayed onset muscle soreness of the lower back suggest sensitization of fascia rather than muscle afferents. A secondary analysis study

Andreas Brandl

(Note: The data for the first analysis were previously collected by Andreas Schilder. A big thank you to him.)

The presentation included two studies around Delayed Onset Muscle Soreness (DOMS) and acute Low Back Pain (aLBP). A connection between the two is that DOMS is sometimes used as a model for aLBP [e.g. Bishop et al. 2011; https://doi.org/10.1186/1471-2474-12-35).

First Study

Background: Work by Schilder et al. 2018 (https://dx.doi.org/10.1097/PR9.0000000000000662) showed that pain perception in fascia differs from that in muscle, with fascia pain having a higher affective component and a different pattern of sensory pain descriptors. Recent studies indicate that extramuscular connective tissue is likely involved in DOMS (Tenberg et al. 2022; https://doi.org/10.1186/s40798-022-00446-7 / Wilke et al. 2022; https://doi.org/10.52082/jssm.2022.419), whereas there is no proof for the common belief that DOMS is in the muscle.

Hypothesis: If DOMS is related to extramuscular connective tissue, this should be seen in the pain perception scale.

Method: Induction of DOMS through an eccentric exercise protocol. Collection of data on pressure pain threshold (PPT, by algometry) and self-reported DOMS (by palpation) before and 1 hour, 24 hours and 48 hours after exercise plus data from pain perception scale 24 hours after exercise. Factor analysis of pain perception data, testing the resulting factors for significant differences between the different pain types (muscle pain, fascia pain, DOMS).

Results: PPT measured by algometry did not significantly change at the different time points, whereas self reported DOMS measured by palpation was strongest after 24 and 48 hours. The factor analysis showed a significant similarity between fascia pain and DOMS concerning pain quality. This differed from the pattern in muscle pain shown in a previous study.

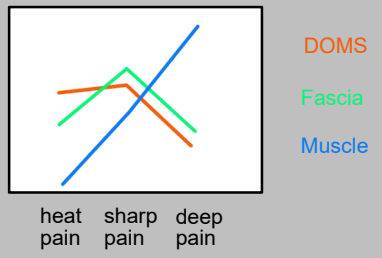


Figure adapted after Brandl et al. 2023; https://doi.org/10.1007/s00424-023-02896-8) The line graph was chosen to best visualize (non-)similarity of patterns.

Conclusion: The similarity in pain quality between fascia pain and DOMS suggests that DOMS could occur in the fascia.

Second Study

As former work showed similarity of pain patterns in skin and fascia, the question of how skin and fascia are involved came up.

Therefore, a second study evaluated whether skin and the thoracolumbar fascia (TLF) can move against each other and if that is different in patients with aLBP.

Ultrasound measurement of TLF displacement relative to skin during trunk/hip flexion in healthy subjects and patients with aLBP.

The results led to the hypothesis that in aLBP fascia and skin might move together.

Wilke and Tenberg (https://doi.org/10.1111/joa.13283) showed force transmission between muscle and superficial fascia. Other researchers (Helen Langevin) found force transmission from muscle to deep fascia, from deep fascia to superficial fascia and to skin.

In previous research, Wilke showed swelling of extramuscular connective tissue during DOMS. This could be due to higher muscle movement during eccentric exercise and might have provoked pain due to overuse of tissues.

Question: Could overload of the richly innervated extramuscular connective tissues in the presence of densifications or adhesions be a mechanism in aLBP?

Discussion

It is intriguing that not only the dense layer of fascia but also the subcutaneous connective tissue might be involved (acknowledging that we just started to look at this and these are only hints that need to be further investigated). With eccentric contraction, normally no changes in the skin would be expected, but rather in the endomysium, perimysium, intramuscular connective tissue - what we are not able to see on ultrasound.

Previous work suggested that after eccentric exercise the muscle moved more and the deep fascia less and it was hypothesized that this higher movement of the muscle leads to overuse of the deep fascia. There was also swelling shown after DOMS and the question is, where does the swelling come from.

Tenberg showed that after 3 days the palpation pain and the swelling of the extramuscular connective tissue was correlated.

When measuring pain with an algometer or by palpation, the difference between vertical pressure and the more shearing palpatory pressure and between blunt and hemispherical algometers and different tip sizes produces different results, and it can be hypothesized that palpation involves more the fascia. These aspects need to be more systematically investigated.

Are there numbers on the force transmission between fasciae during movement? Perhaps, a way to measure this could be stepwise evaluation of changes in shear-wave elastography in different positions (but might not work).

See also the presentation by Jan Wilke in the EFREM Protocol 2022
https://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf

Comparison of induced pain in various deep fascia reveals distinct differences in its intensity and characteristics

Andreas Schilder

The underlying question to the research is

Are there pain descriptors that can be used as a kind of biomarker to identify whether the pain a patient describes originates from fascia or muscle?

As already shown in the presentation during EFREM 2022 (https://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf), there are differences in pain quality, intensity, and descriptors between fascia and muscle.

Fascia is more prone to chemical stimuli than muscle, and the fascia pain after chemical stimulation has a high affective component.

“Heat pain” or “sharp pain” qualities and descriptors like “cutting”, “burning”, “stinging”, and “hot” point to fascia pain.

“Deep pain” qualities and descriptors like ”beating” and “throbbing” point to muscle pain.

Another observation is that fascia pain patterns match skin pain patterns.

For this presentation, the question was:

Do fasciae of different anatomical origins show different pain characteristics?

The studied fasciae were: temporal fascia, fascia of the trapezius muscle, thoraco-lumbar fascia (TLF) and iliotibial band (ITB).

Results:

The temporal fascia is more prone to chemical stimuli (hypertonic saline injection). The trapezius muscle is the least sensitive.

The temporal fascia also has a higher affective pain component.

When comparing affective and sensory pain components after hypertonic saline injection, all fasciae studied except the temporal fascia had a significantly higher sensory component.

The pain distribution was in all the fasciae similar.

Looking deeper into the results:

Affective pain seems to point to fascia. However, patients are more likely to use sensory pain descriptors when describing their pain.

A closer look at the sensory pain descriptors in the different fasciae suggested that “stinging” pain might be a marker for a contribution of fascia to the pain.

Up to know, studies were done with healthy volunteers. The plan is to do also studies with patients.

Discussion

The more superficial layers of fascia come increasingly into focus and are very interesting because of their rich innervation and relation to the lymphatic system.

When further investigating the contribution of different types of “pain receptors” to e.g. the stinging pain (which, as shown, might suggest a contribution of fascia to the pain), it would be interesting to see if there are pathologies that do not have that specific receptor (as in the case of the PIEZO 2 receptor in a certain type of scoliosis).

When we talk about innervation, we have to keep in mind, that there are different types of nociceptive nerve fibers, differing in terms of receptors, transmission and connection into the CNS.

Whereas the behavior of cells under certain stimuli can be observed in isolation, investigating pain needs a nervous system.

Due to differences in average pain thresholds, subgroup analyses by gender and age groups would be interesting. However, this would require much higher numbers of subjects.

See also the presentation by Andreas Schilder in the EFREM Protocol 2022
https://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf

Effect of foam rolling on conditioned pain modulation

Renée Feldbinder

Previous research showed that foam rolling leads to a temporary increase in range of motion (ROM) (e.g. Wilke et al. 2019; https://doi.org/10.1123/jsr.2018-0041 / Yoshimura et al. 2021; https://doi.org/10.1519/JSC.0000000000003196) and pressure pain threshold (PPT) (e.g. Hendricks et al. 2020; https://doi.org/10.1016/j.jbmt.2019.10.019). One study showed an effect on the contralateral limb, and the authors of the study mentioned that Conditioned Pain Modulation ("pain inhibits pain") might be a possible explanation (Aboodarda et al. 2015; https://doi.org/10.1186/s12891-015-0729-5).

Therefore, this study explored if foam rolling has a CPM effect.

Method

Application of different conditioning stimuli (foam rolling of the back of the thigh or introducing a hand in a cold-water bath) and subsequent evaluation of PPT at the thenar of the contralateral hand (the one not introduced in the cold-water bath) and Straight Leg Raise (SLR) measured with a goniometer.

To eliminate the effect of age on CPM, younger subjects were selected (mean age of 26 years).

To eliminate the effect of cognitive processes on CPM, the subjects were blinded to the study purpose (they were told that hip ROM was the main parameter of interest).

Sequence of interventions

Measurements (PPT + SLR)

Foam rolling (1 of 2 foam rolls with different hardness)

Measurements (PPT + SLR)

Cold-water bath (contralateral hand)

Measurements (PPT + SLR)

Walking break (3 minutes)

Change to other foam roll (harder vs. softer) and other side of the body

Measurements (PPT + SLR)

Foam rolling (1 of 2 foam rolls with different hardness)

Measurements (PPT + SLR)

Cold-water bath (contralateral hand)

Measurements (PPT + SLR)

Results

PPT was only significantly increased after the first cold-water bath. Therefore, it was concluded that foam rolling did not induce CPM in this study.

ROM was increased after each conditioning stimulus. Therefore, foam rolling can be used to increase ROM in practice, which is in line with the literature.

A correlation between roller hardness and increasing PPT was seen - but not for ROM, which is also in line with the literature.

Limitations of the study

Some authors report a ceiling effect for CPM. This would mean that any conditioning stimuli after the first cold-water bath might not have been effective anymore.

There is no protocol for the test and it is not clear from the literature how painful the conditioning stimulus needs to be. As the foam rolling was perceived by subjects as unpleasant but not painful, the stimulus might not have been intense enough.

Discussion

Possible further limitation of study: the ice water test measures a pain intensity of up to 100 percent acting on a large area.

Foam rolling has a lesser intensity than ice water and also acts on a large area.

Subsequently, PPT is measured with the algometer on a small area.

Pain perception is very variable and there might be "respoonders" and "non-responders". Therefore, subgroup analyses might be helpful.

Interesting question: Is CPM triggered differently by mechanical forces versus temperature?

The next study will use a harder foam roll to ensure an intense enough stimulus. Also, to avoid a ceiling effect on CPM, there will be no cold-water bath before measuring the effect of foam rolling.

What is the Core Concept of the German „Atem-, Sprech- und Stimmlehre“, it’s Relationship to the Fascia Research from the Perspective of a Cat

Andrei Sommer, Kelly Cruz Contreras

Pulmonary fibrosis is a very important factor in POST-COVID (Duong-Quy et al. 2023; https://doi.org/10.1007/s41030-023-00226-y).

As pulmonary fibrosis is inside the lungs, manual therapists do not have direct access to it with their usual tools.

The group discovered a vasodilatation technique by music (see below). Also, some time ago reported on how to counteract the aging effects on elastin with red light (which has a wavelength similar to the dimension of elastin). Whatever resonates will help remove all kinds of hydrophilic deposits and help rejuvenate the tissue.

A simple model to improve breathing

1) Mechanical dilatation of the thorax (so that the lungs can occupy the space)

2) Vibroacoustic resonant frequency in the lungs (a vibration that produces resonance in the thorax and presumably removes deposits)

3) Vasodilatation via humming and/or production of deep tones (NO) (see Manisalco et al. 2003; https://doi.org/10.1183/09031936.03.00017903)

4) Oxygenation

To generate paranasal NO, frequencies as low as 130 Hz were found to be effective. Low humming frequencies (25 to 50 Hz) are instrumental in accelerating the healing of muscular wounds and consolidation of bone density in cats (https://www.scienceworld.ca/stories/secret-power-cats-purr/).

Cats heal themselves while purring. (Scientific American: Why do cats purr?; https://www.scientificamerican.com/article/why-do-cats-purr/). The frequency of „healing purring“ in the cat is similar to the NO-producing frequency in humans. Question: Might the cat be producing NO while purring? Purring/humming is calming down, and the NO produced has also antiviral, antibacterial and vasodilatatory properties.

Humming together with exhalation produces significant amounts of intranasal NO (Manisalco et al. 2003; https://doi.org/10.1183/09031936.03.00017903). Also, when breathing in after humming, NO produced intranasally is carried into the lungs. Neutralisation of NO by oxygen (O2) in the lungs is a higly improbable process due to the relatively low concentration of the generated reaction partner NO. This means that the fraction of NO released by inducing low frequencies into the thorax cavity will not be significantly reduced during the exhalation process.

A calculation shows that the resonance frequency in the lungs is between 41 Hz and 117 Hz.

If we create by singing something between 40 and 100 Hz in the lungs, we have a frequency which is generating massive amounts of NO, and together with mechanical dilatation, we have a tool to work with stiff material in the lungs.

Other possible applications

Also, the blood-brain barrier can be opened by music.

Another question: Can the frequency also reach the liver (cave: liver fibrosis) or does the diaphragm has too strong a dampening effect?

Discussion

Would the harmonics of the base frequency (40 Hz as base, 80 Hz as first harmonic, then 160 Hz) work? In that case one could go up beyond the hearing.

Another option to work with lung fibrosis is hypoxia-hyperoxia therapy. In the hypoxic phase, the lung opens in order to get more oxygen, and in the hyperoxic phase, the oxygen goes in.

One participant has a treatment table with a frequency generator, with which he can apply frequency to the client.

It would be interesting to check the vagal response (e.g. HRV) while humming or after humming.

Vasodilatation can happen through stress (e.g. production of reactive oxygen species, CO2 build-up)) and through relaxation (NO production). But the “side effects” are different.

Since NO is a neurotransmitter and frequencies also resonate in the skull, NO released through humming can have a direct effect on the brain.

With vagus stimulation plus hyperoxia we create NO.

See also the presentation on the breathing technique in the EFREM protocol 2022:
https://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf

Functional Elastography of the Back Fascia and Muscles

Wolfgang Bauermeister

Uses Functional Elastography for diagnostics in patients with back pain or pain of the entire body who have not responded to anything over many years.

He is interested in the functional aspect. How stiff is the fascia and the (back) muscle in sitting, standing and lying? Some people get pain when sitting, others when lying or standing.

By now, he has a huge amount of data, and he has questions to the group (see opposite page).

The physics of shear-wave elastography

(including parts of the discussion from the presentation summarized on pages 24/25)

You put a push beam into the tissue, which acts like a shock wave that creates a vibration with a certain speed. The higher the speed in the tissue, the stiffer the material is.

For practical reasons, the speed is converted into kilopascal (kPa), which is then converted into colors for the ultrasound picture.

The higher the push beam is, the stronger the vibration and the velocity of the shear wave are. You need different push beams for different tissues, and usually the equipment has three different push beams.

Figure: typical color scale of shear-wave elastography. In real use, the colors are assigned kPa values.

As he has been looking for Trigger Points manually, now he looks for areas with the highest degree of stiffness in the elastography.

With elastography, one can measure the stiffness values at every level of the spine.

Using the elastography together with the Oswestry Disability Index gives a functional idea of the problems in standing, sitting etc.

A small exploratory investigation

Has selected a group of 21 patients showing very different patterns of stiffness in fascia and/or muscle at L1-4 in different positions.

Doing a principal component analysis, he tried to figure out what contributes most to the picture.

The result was that left and right muscle means in prone position are the two factors contributing most.

The question for the discussion:

Are measurements in all positions necessary or would a series in standing, sitting or lying provide enough information?

What is the easiest and fastest way to find out which is the stiffest area along the back, either in the fascia or the muscle?

Suggestions

Different fascia stiffness values in different positions could result from different pre-stretches of the fascia when there are adhesions at different levels.

Reply: The investigations on patients with chronic low back pain showed high stiffness values in regions that would normally not be pre-stretched in the given position (sitting, standing or prone).

It might be an idea to first focus on an individual group, like those having pain in sitting versus standing or lying. With a more homogenous group, one might be able to identify if there is commonness among patients with the particular pain pattern.

The existing data could be used to train an artificial intelligence model. You tell the model what those patients have and then later, the model can tell you that with that particular pattern there is a high likelihood for (something else).

There has been a recent TV report on the work of Prof. Bauermeister:
https://www.br.de/br-fernsehen/programmkalender/ausstrahlung-3352608.html

Use of Artificial Intelligence (AI) in sonographic diagnosis of fascia low back pain

Franziska Wittleder

The idea is to build a 3 D model of the human body with fascia, muscle, and pain spots to be better able to locate the origin of pain, which might be distant from the region where the pain is.

The aim is to find precise measurements/biomarkers around fascia and stiffness and muscle health that are standardized and effective enough to point to effective treatment (an analogue to a glucose meter for blood sugar/diabetes).

First step: Quantifying back pain with ultrasound (US) diagnosis of fascia low back pain (LBP), for example through ultrasound videos that could show gliding properties or stiffness or other things that might cause pain. The idea is to take the data and look for patterns that make most sense to cause pain and then recommend treatment on the basis of that.

Training an AI model

So far, there are 20 US videos available, but normally, to train an artificial intelligence (AI) model, around 10.000 videos would be needed.

The trick - Transfer learning

In transfer learning, more readily available data from another organ are used to help the system learn some characteristics. Subsequently, only fewer US videos of the fascia of the lower back wil be needed. Just 500 might be enough. It is like learning to ride a motorcycle when you know to ride a bike. You can concentrate on the differences.

Once well trained, AI can provide deeper insights by revealing its reasoning

But even if we have a model that is able to distinguish “LBP” / “No LBP”, that is not enough. We want to know the reason for LBP. What happened in the back that caused the LBP?

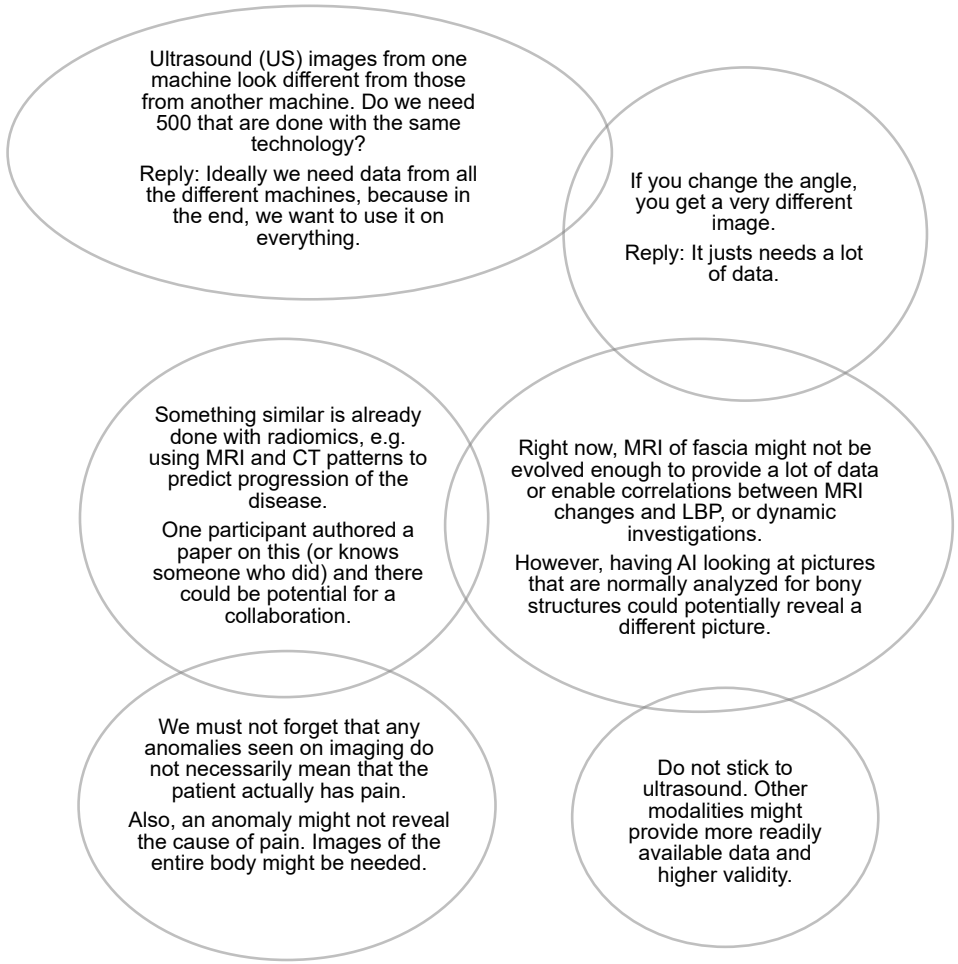
You can ask the machine, what it looked for to distinguish between “LBP” / “No LBP”. For example, the system could tell you that this fascia looks like this or the movement is odd or something else is different from what it looks like in a normal heathy person.

[To explain the rationale: If you train the machine how dogs and cats look like and then show it a foto of a front view of a dog and a side view of a cat, it might tell you it recognized the dog by the face (pattern) and the cat by the tail (pattern).]

Risks

You need a very broad and inclusive data base to make it applicable to a broad population with different characteristics, e.g. in terms of gender, size, BMI etc.

Discussion



Franziska Wittleder is looking for data.

See also presentation on MRI of collagenous structures from EFREM 2022: https://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf

Interorgan fascia-single-cell atlas – an international cooperation project to investigate visceral fascia

Stephanie Otto

Fascia is a whole-body endocrine organ. There are many different types of visceral fascia.

Organs consist of different types and layers of connective tissue:

the parenchyma

the subserosal fascial layer

the serosa

The subserosal fascial layer varies in structure from organ to organ. It can be soft, irregular, and areolar or tight and collagenous. It can be thin, elastic and well innervated, attaching directly into the organ and shaping it (investing fascia), or thick, less elastic, and less innervated, creating a pocket or compartment for the organ (insertional fascia), the latter seeming to be connected to the musculoskeletal system.

The Interorgan Fascia-Single-Cell Atlas aims to catalog all types and even subtypes of interorgan cells in the body, and thereby create a comprehensive reference map of all visceral connective tissue cells.

Identifying the molecular and morphological profile of visceral fascia/serosa in healthy and sick subjects will increase understanding of human health and support diagnosis, monitoring, and treatment of diseases by identifying markers and signatures for diseases and new targets for therapeutic interventions.

For the project, tissue at the interface of the organ surface and the fascia connective tissue is taken and analyzed by molecular diagnostics including spatial transcriptomics.

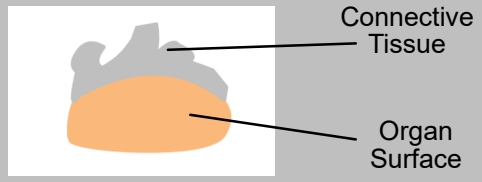


Figure adapted from the presentation

This will provide a direct view of human biology in vivo, removing the distorting aspects of cell culture, and will help understand the communication of cells in the transition from the microenvironment to the organ, where cells move in and out.

Working Group consisting of Ulm University, Helmholtz Center Munich, TUM, and Lab Lavia

Investigated organs (so far):
Stomach, liver, colon, gall bladder
Pleura (esophageal surgery)
Peritoneum (gall bladder surgery)
Appendix

Additional information to be provided:
Is the tissue from a healthy or “sick” subject
Exact information about where the connective tissue was taken from
Photographic documentation
Occasionally mouse tissue counterparts

Discussion

There is a recent publication by Yuval Rinkevich in *Nature* about the cell type CD201+, which he recognized in the subcutaneous connective tissue und which is responsible for fibrotic scarring and healing.

Is also found a lot in cancer tissues.

Explains why there is more fibrotic healing on the back than on the abdomen.

With the CD (Cluster of Differentiation) analyzing and naming system, many more different cell types in fascia than fibroblasts, myofibroblasts, fasciacytes and telocytes are identified.

As to the fusion between sports and medicine: movement teachers are actually therapists, because we do not need to do hands-on to treat fascia, but we treat fascia when we move in a moderate way.

It would be interesting to see what happens in the sicker organ and what happens in the healthier organ and how one can prepare the microenvironment of the organ to let the good cells go into the organ and the bad cells out. How can we provide for a good - not fibrotic situation - in the microenvironment using soft mechanical treatments - that do not induce spreading of tumors and do not harm the body in other ways - and thereby aid the overall health? This needs of course a lot of investigation in animal models first.

Additionally, possible options for collaborations with other departments of TUM in terms of using local biobanks (easier to handle than distant ones) or collaborations in other projects like exercise oncology were discussed.

Some tissues are difficult to get in a healthy state.

The role of Fasciae in Low Back Pain: Implications of Fascia Tissue Manipulations

Robbert van Amstel

Hypothesis: In a healthy subject, it is expected that, when transitioning from a standing position to maximum trunk flexion, the skin, superficial fascia and thoracolumbar fascia (TLF) will slide over the erector spinae muscle. In contrast, in a condition where tissues are strained, the muscles contract to protect against further straining. This contraction limits fascia sliding mobility and joint range of motion (ROM). Trunk motion with ongoing skin displacement (SKD) in the correct direction might unload these strained tissues, thereby normalizing muscle contraction and increasing joint ROM. (If SKD is done in the "wrong" direction, it increases the stress and decreases ROM.)

There is a test involving active joint motion with or without ongoing SKD, followed by evaluating the specific (in terms of location and direction) effect SKD has on ROM and pain. This test is part of the 4xT-method, where the 4 Ts represent the algorithm of "Test-Trigger-Tape-Train". (See also the Dynamic Arthromyofascial Translation Test, short DAMT® test; https://osf.io/d85k3/; Noten K 2021; link provides access to a publication and a video explaining the test and SKD procedures.)

From clinical experience, the test seems valuable. However, the significance of the results is unknown. Therefore, two studies were performed.

1) A systematic review of the effect of lumbar elastic tape application on trunk ROM (elastic tape is expected to have a similar effect as SKD) (van Amstel et al. 2021; https://pubmed.ncbi.nlm.nih.gov/34589682/)

Result: The mobility improvements seen with elastic tape application in situ were within the margin of the measurement error.

2) A comparison of SKD with a sham procedure (placement of hands without SKD) in healthy individuals (van Amstel et al. 2022; https://pubmed.ncbi.nlm.nih.gov/36505071/)

Results: The data showed a significant mean difference between the groups that was beyond the measurement error: there were changes in the SKD group versus no changes in sham group.

Substantial changes were observed in all joints (hip, lumbar spine, thoracic spine). The variations in ROM were dependent on both the SKD location and direction, aligning with and supporting the hypothesized expectations.

Upcoming projects

Project A: Examining the impact of SKD on flexion mobility and muscle activity in non-specific chronic low back pain (LBP) measuring flexion mobility, flexion-relaxation ratio (muscle activity of erector spinae muscles in flexion and extension) via EMG + motion capture - clinical focus

Project B: Examining skin-to-fascia- and muscle shear strain ratios during SKD using ultrasound (prior investigations on two subjects suggested that the skin, superficial fascia, and TLF were equally displaced in the same direction with SKD, with the greatest displacement superficially and gradually decreasíng with depth)

Project C: Measuring the effect of epimuscular fatty connective tissue on clinical outcomes (via MRI, AI)

In the meantime published:
van Amstel et al. 2024; https://pubmed.ncbi.nlm.nih.gov/38276256/

A New Bioreactor for In-Vitro Mechanical Stimulation of Fascial Cells

Muhammed Tarik Çöpoğlu

Most current systems for applying mechanical stress on fascial cells only allow to apply one or two types of mechanical stimulation (like compression, hydrostatic pressure, shear stress, tensile stress, shaking forces) or chemical stimulation.

Therefore, a modular device was developed that is able to apply different kinds of stimulation: the „McSteam“.

The device is fully transparent to enable real-time observation of changes under an inverted microscope.

Additional features are: easy to assemble, dissemble and sterilize (with different sterilization techniques). Easy to connect to other types of machinery.

Production

The device is produced by editing manufacturing techniques. The material was selected to provide air and water tightness and durability.

Flow characteristics

The flow through the device was simulated by Computational Fluid Dynamics (CFD) analysis, which allows to define different parameters for fluid and gas inlets and outlets and to see the expected results of the system. This was verified by observations of the device in action and is planned to be further verified by cell culturing results.

Design and options for stimulation

The central part of the device includes a membrane. Applying a vacuum will stretch the membrane radially (maximum amount: 13 % - what is used mostly in other stretching studies). This enables to apply radial stretch to cells.

Using inlets and outlets at the sides will result in laminar flow (aided by segmentations/guiding structures on the inside). Adding high-pressure flow from side inlets will create turbulent flow at the central part (where the cells are).

CFD simulation informs about volumes and pressures needed at different inlets to create a specific pressure on the cells.

In addition to the option to apply different kinds of flow or stretch, it is planned to produce further modules, so that the central part, which carries the membrane for radial stretch, can be exchanged with a module that is able to apply axial stretch or compression (e.g. using a gel).

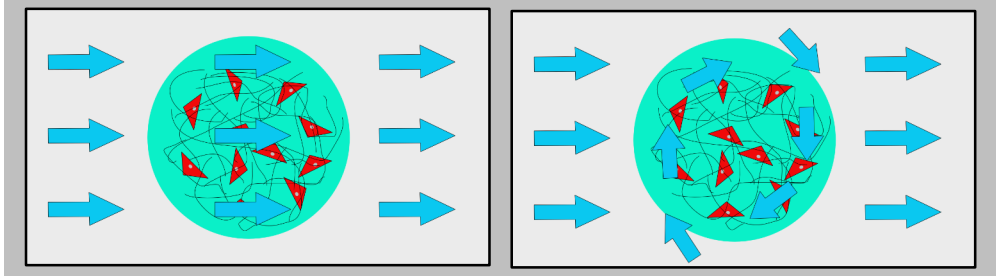


Figure: (Very) Simplified graphical representation of the device adapted from figures from the presentation. On the left laminar flow and on the right turbulent flow generated by enabled side inlets. The central membrane can be stretched by applying a vacuum. In addition, the central module carrying the membrane can be exchanged by modules allowing axial stretch or compression (some not yet available).

Discussion

The device is a historical contribution and will enable what Leon Chaitow had been waiting for: that we examine the direct mechanical stimulation on a tissue through a given method (not what name you give to the method).

The design is still in the prototype phase. If others want to try, the data can be compared, and the design might even be fitted to the other protocols.

The cells do not need to be removed but can stay on the membrane. Also use with microscopes with biological chambers possible. Makes even recording of videos possible.

Should also include membranes with paradoxical characteristics like the auxetic behavior of the Achilles tendon (spreading laterally when elongated longitudinally).

For the future, options like chemical stimulation (agonists or antagonists) and maybe even magnetic stimulation are planned.

Or photo/light stimulation, wave/sound stimulation.

Also involved in the project and discussion:

Hakan Oflaz and Alberto Zulla

Everybody can give ideas and the design can be improved according to those ideas. Also open to sharing of the device and new collaboration.

Fascia stimulation via a new type of (orthopedic) insole

Norbert Becker

The insole is meant as a foot enclosure to stimulate the fascia for safe standing and dynamic walking and running.

At the foot and ankle, several lines of fascial force transmission (superficial back line, superficial front line, deep front line and lateral and spiral line according to Anatomy Trains) meet in a very small space.

The tissue at the ankle and sole of the foot has a high density of sensory cells, which perceive a high range of qualities like pressure, tension, vibration etc. This is important for controlling gait and weight-bearing, and maintaining the dynamics of the physical activity. [Stecco - Atlas des menschlichen Fasziensystems, ISBN: 978-3-437-55905-1) (Functional Atlas of the Human Fascial System)]

Shoes prevent the feet from coming into direct contact with the ground. This influences the body's sensations.

Shoes are molded over a last, and lasts are often fashionably slim and do not respect the (over the day changing) anatomical and biomechanical properties of the foot.

Foot and shoe build a functional unit, and this connection can become dysfunctional and lead to diseases of the musculoskeletal system.

Repeated incorrect loading of the foot in the shoe can lead to overload syndromes and negatively influence the myofascial system, disturbing the alignment.

Results of Carla Steccos anatomical preparations and Tom Myers anatomy trains led to the idea to specifically address the sensory elements of the foot area. Therefore, an insole was developed that runs flat over the entire sole of the foot, covering the plantar fascia (superficial back line, partly deep front line), and ends medially and laterally in front of and behind the inner and outer ankle in so called "ankle tongues".

The pads are intended to exert pressure stimuli on sensory structures of the foot that are generally not covered by the shoe. This is hoped to activate the myofascial system and straighten the body.

The primary aim of the insole is not to treat an illness but to increase the feeling of safety, improve comfort and performance, and optimize the functional foot-shoe unit.

Figure: Graphical representation of the ankle tongue (adapted from a picture of the presentation). The tongue passes underneath the foot to the other side, where it is fitted in a similar manner. Under the foot, the inlay is completed by a longitudinal sole.

Based on positive feedback of the wearer trials, the application profile was expanded:

Integration of the principle of the foot wings into the concept of orthopedic insoles.

The fascia inlay can also be produced with a 3D printer, based on an individual footprint or orthopedic measurement (especially if the scanner also captures the ankle region).

Ankle wings incorporated into socks with anti-slip properties can help the foot recover from a tight shoe and move more freely, while the muscular system remains activated.

The insole has been tested in different application scenarios

Badminton players: Felt more intense contact with ground and better control over movement of the lower extremities and feet.

Possible interpretation: Better feedback from foot and ankle - activation of motor memory/reference values acquired through training - adjustment of sensorimotor movement strategy.

Elderly people (>75 years): described better sense of stability in walking and safer gait.

Possible interpretation: Compensation of sensory decline in old age - improvement of balance and joy of movement.

Proposed mechanisms of action

Influencing myofascial trains to activate and support proprioceptive and sensorimotor processes

Proprioceptive activation of the intrinsic and extrinsic muscles of the foot

Proprioceptive activation of the entire musculoskeletal system by influencing all the main fascial lines that run through the entire body

Discussion

Important aspect: the design of the insole is based on 30 years of practical experience as a medical doctor

Difficult to prove scientifically - but the different wearer groups gave positive feedback, reporting e.g. a feeling of increased security.

Comfort is a very important factor for sports performance.

Unfortunately, further discussion was disrupted by technical problems.
Please email any feedback or suggestions to:
Norbert.becker@fair2feet.com

What is the mechanism of foam rolling-induced improvements in range of motion?

Akane Yoshimura

Foam rolling (FR) increases range of motion (ROM), and this effect is equal to that of stretching (Konrad et al 2022; http://doi.org/10.1007/s00421-022-04927-1).

The mechanism of the ROM effect is not yet fully understood.

Previous studies showed no significant changes in extensibility of tissue, tissue stiffness, skin temperature, and blood flow.
Yoshimura et al. 2020; https://doi.org/10.1123/jsr.2019-0281
Yoshimura et al. 2021; https://doi.org/10.1519/JSC.0000000000003196
Yoshimura et al. 2021; https://doi.org/10.1016/j.jbmt.2021.02.012
Yoshimura et al. 2022; https://doi.org/10.1016/j.jbmt.2022.05.009

So far, these studies did not consider neurological parameters.

Since recent research suggested that voluntary movement could influence the ROM effect, the following two research questions were investigated:

Is the effect of ROM increase affected by

1) voluntary movement or pressure stimulation?
2) morphological parameters or neurological parameters?

Three different interventions: (see opposite page)

Outcomes

Main outcome:	Active and passive ROM
Neurological:	Pressure Pain Threshold (PPT, also in non-target area)
	Stretch Tolerance (by Visual Analogue Scale)
	Heart Rate Variability
Morphological:	Muscle and Fascia Thickness
	Muscle and Fascia Stiffness

Results

Passive ROM increased in both active FR and passive FR - Active ROM increased only in active FR.

Neurological but not morphological outcomes improved (PPT and stretch tolerance increased with active FR). This points to neurological mechanisms for the increase in ROM (improved pain/stretch).

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

The intervention was performed for 3 minutes with 15-25 % of body weight and 25 cycles per minute. The foam roll used had a shore value that would be medium in sports, but hard for a yoga group.

Discussion

Whereas in this study the outcomes were measured immediately after the FR intervention, in a former trial outcome measurements had been done after 1 hour, and it had been shown that the effect continued until 20 minutes.

From neuroathletics we know that an increased awareness of the joint or tissue leads to a higher effect of mobility training in terms of mobility and stretching. With active foam rolling, people might move the ankle a bit and this could have an effect.

So, having a group which really moves the ankle to the end of ROM and comparing this to people doing foam rolling with a stiff ankle could be interesting.

As to the future project (see below) there might be a problem with applying the cold-water bath pre and post, because of:

-Pain experience that might lead to avoidance (stopping earlier)

- Possible ceiling effect/adaptation process

Also important for ROM measurements: Considering parallax and the measurement error of the system

Future plans: Answer the question if the FR intervention improves pain tolerance only in targeted area or also systemic pain tolerance. To evaluate this, the idea is to measure

Time from putting hand in cold water until perceiving first pain (pain threshold)

Time from putting hand in cold water until pain becomes unbearable (pain endurance)

Crossover trial with intervention /non-intervention

(See also discussion above.)

Tissue-Specific Quantification of Radiation Induced Cervical Fibrosis in Head and Neck Cancer Patients (QUAFI)

Wolfgang Bauermeister

The present study used shear-wave elastography to measure the effects of radiation in terms of tissue stiffness and thickness in a group of head and neck cancer patients having received radiation to the neck and in healthy controls.

A similar study on the same subject was performed in 2015 (Liu et al. 2015; https://doi.org/10.1055/S-0034-1366364).

The present study methodologically differs from the previous study in the following aspects:

In the present study, large area elastography was used, whereas in the previous study, for technical reasons, only very small regions of interest (ROI) (5 millimeter for the muscle and 2 mm for the subcutaneous tissue) could be used. Since tissue stiffness can be very heterogenous in a given region, choosing a small ROI can bias results. The risk to incidentally pick a stiffer or less stiff ROI is higher.

In the present study, a smaller scale for the elastography was used (0 to 40 kPa), which allows for better visual (color) differentiation than using the same colors to differentiate values in the range of 0 to 180 kPa (which means that everything from 0 to 40 kPa stays in the "blue range" - see figure).

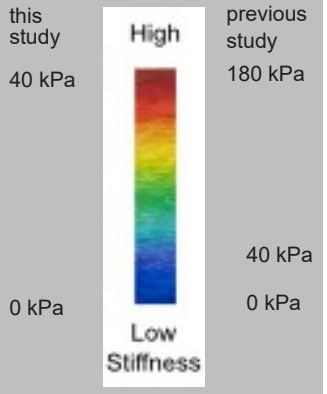


Figure: color scale of shear wave elastography with different assignment of colors to kPa values.

In the present study, the ultrasound probe was placed parallel to the sternocleidomastoid muscle (3 positions to get the entire muscle) and - in addition to muscle and subcutaneous tissue - also fascia was measured.

Absolute values from different studies are generally difficult to compare because ultrasound devices form different manufacturers will deliver different values. Also, values depend on the probe used and the intensity of the push beam (which moves the tissue and creates the shear wave). This problem can be avoided by using relative (pre/post) values.

Results

Stiffness

Both studies come to the same conclusion: The tissue gets significantly stiffer. That is also what we feel with palpation. (However, with palpation, we cannot distinguish which tissue contributes most to the increased stiffness and where we should aim with our treatment approach.)

Thickness (can be measured with regular ultrasound)

The former study also found reduced thickness of muscle and subcutaneous tissue. The current study saw that only in muscle (and in skin), not in subcutaneous tissue. This might be due to the fact that margins are difficult to identify (the previous study did not measure fascia as a further tissue layer and therefore did not need to make such fine distinctions).

More analyses to come.

Drawbacks of elastography

Equipment is expensive (125.000 Euros). However, at a recent fair trade, there were laptop devices from China in the price range of 25.000 Euros.

Export of data is a time-consuming thing. The new device might solve that problem, too.

Discussion

Sometimes, stiffness in the area of a trigger point does not change in elastography even when the patient has improved clinically after treatment. Then, there might be stiffness changes identifiable in other areas.

Recent technological improvements are: high-speed acquisition, meaning you do not have to hold the probe for two to three seconds to get a stable image anymore.

A new collaboration aims at getting more reliable kPa results from elastography. With elastography the kPa results can change depending on different factors, even when it is known that the stiffness of the material has not changed.

An alternative technology, often used in the past, is strain elastography = qualitative technique providing information about the stiffness of one tissue in relation to another.

Other interesting aspects might be neuroinflammatory signs on the cellular level in the area of trigger points. Studies showed cytokines and other inflammatory substances to be significantly increased in the stiffer trigger point areas and their surroundings.

Is thinking about an epigenetic study looking at the methylation pattern, which provides information about the activity of genes.

Part of the discussion is included in the description of the method on page 10.

Nutrition for Fascial Health & Athleticism

Jasper Cramp

Nutritional involvement in healthy fascia

Various amino acids, vitamins, minerals, and fatty acids need to be supplied through the diet either as building blocks and cofactors for collagen synthesis or because of their antioxidant and anti-inflammatory properties.

An example of how poor nutrition can affect the musculoskeletal system is laxity of the anterior cruciate ligaments in female athletes, who often suffer from hormonal imbalances and eating disorders.

Optimal nutrition is also crucial for tissue repair and recovery processes.

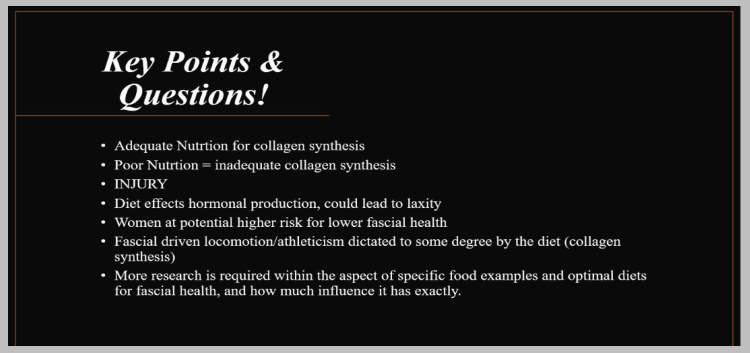
Importance of healthy fascia in sports

In athletics, healthy fascia is crucial for efficient transmission of force and optimal visco-elastic properties of the fascia to store and release energy.

Also, the proprioceptive characteristics of fascia are important for joint stability.

Despite all the modern facilities and possibilities, we see more and more complex injuries in sports, and this might have to do with fascia health and joint stability and flexibility.

In a publication by Vleeming et al. from 1995 (https://pubmed.ncbi.nlm.nih.gov/7701385/) on the role of the TLF in integrating the activity of muscles, the authors argue that the common attachment of several big muscles in the body means that the TLF has an important role in integrating the load transfer between different regions and that the gluteus maximus and the latissimus dorsi muscles contribute to the coordination of the contralateral pendulum between upper and lower limbs in e.g. running or swimming.



Idea for a study:

Put athletes on a special diet and do a before and after biopsy of the tissue. The athletes would all need to have a particular VO2 max to know they are coming in very good shape.

Assessing fascia to begin with to see if there are differences to non-athletes.

The diet for 12 weeks or so, and then take a biopsy again to see if there are changes.

Integrate also a sham diet (give them some nonpotent powder).

It could be interesting to look into the veterinary literature. There are a lot of papers published about how to feed cattle to put on more meat or less meet or more connective tissue, and about meat quality.

Also, racehorses get a specific diet.

Could be interesting to first look into that literature, because study will need to generate big differences.

However, due to particularities of digestive systems (pH in stomach of dogs, 7 stomachs in cattle), you have to be careful with extrapolation. There is an interesting book called "One medicine" by Matt Morgan looking into what we can learn from animals in terms of human medicine.

It might be difficult to measure inflammation in the blood with the usual methods, but epigenetic proxies of CRP and possibly interleukin 6 might work better. Having a deeper look into this might reveal possible ways to identify silent inflammation.

It is important to catch neurogenic inflammation early, and it will likely change through diet, too.

Discussion

The combination of the mediterranean and the DASH diet has been shown to reduce silent inflammation.

Other options to try or look at:

Fasting

Literature from astronauts or cancer patients (stress on body as in athleticism)

Adding amino acids to (myo-)fibroblasts

Ratio omega 3 to omega 6

Microbiom/Dysbiologies

Branched-chain amino acids/y proteins (?)

Loss of nutrients through cooking practices or long-distance transportation versus eating something that is still "living"

Upon request, Jasper Cramp is happy to share the references for this presentation plus the link to a video on biomechanics comparing two football players.

Structural Integration in Chronic Pelvic Pain

Martina Kasper-Jędrzejewska

The case report describes the application of Structural Integration (SI) in a female patient (professional singer) with pelvic pain and other urogenital dysfunctions. It is part of a larger project registered with the ISRCTN Registry for clinical trials, follows the CARE Case Report Guidelines, is approved by a bioethics committee and got the informed consent by the patient.

A new perspective on chronic pain suggests focussing more on peripheral tissue mechanisms (muscle, fascia, and neuronal networks) instead of the traditional diseased-organ concept. Fascia pathologies like densification and decreased plasticity also help explain concurrent symptoms and pathologies.

In 2023, specialists from the European Association of Urology published an article on the myofascial pelvic pain syndrome relating it to trigger points in the muscle or fascia (Abreu-Mendes et al. 2023; https://doi.org/10.1016/j.euf.2022.07.007)

The Case Report

The 26-year-old patient had a 6-year history of lower urinary tract symptoms, characterized by aching pain in the urogenital diaphragm, which had started gradually. After pharmacotherapy and a 2-months pain-free interval, the symptoms returned after a period of stress.

Selected findings: partial and delayed relaxation after pelvic floor muscle contraction, altered sensation in the superficial urogenital diaphragm, pelvic floor muscle tenderness, and swayback posture.

Delayed and incomplete relaxation (together with increased tone, if present) suggest an overactive pelvic floor (which is not synonymous with a strong pelvic floor). The swayback posture increases intraabdominal pressure.

Patient-reported outcomes (PRO) gave evidence of central sensitization, catastrophic thinking related to pain, intermediate depression, sensorimotor neglect, and an impact of the pelvic floor disorders on the health-related quality of life.

Functional assessment of the pelvic floor muscles by surface EMG showed elevated resting baseline (> 2 mV) indicating non-relaxing muscles and increased tone.

Intervention:

10 sessions of Structural Integration, one session every two or three weeks, between July 2022 and January 2023.

Also, the principles of Trauma-Informed Care were followed.

Post-intervention measurements showed

- A reduction in the central sensitization score (possible explanation: reduction in evoked pain from trigger points, for example, resulting in reduced nociceptive input to the central pain system, resulting in decreased sensitization at the spinal and supraspinal levels).
- A decrease in psychological distress and ratings of depression (less „catastrophizing“ can decrease pain intensity/sensitivity), an important positive change in body image, less impact of pelvic floor dysfunction on quality of life.
- An improved resting baseline plus normalization in phasic contraction and tonic contraction amplitude in the surface EMG.

BRIEFLY SUMMARIZE

- The results from this case study show us that create a successful program of intervention for people experiencing pelvic pain clinicians must design individually tailored, multimodal treatment plans which include pain neuroscience education, cognition targeted, time-contingent exercise therapy, stress management, alongside other broader social and cultural considerations, as well as a longer-term focus in order to achieve optimal outcomes.
- Chronic Pelvic Pain women characterize by dysfunctional pain system as expressed by hypersensitivity of the peripheral and central pain systems, as well as dysfunctional pain modulation as well as psychological distress, manifested as high levels of anxiety, pain catastrophizing, depression, and central sensivity syndrome.
- Structural Integration can be a new option in the chronic pelvic pain conservative tretment.

Discussion

Given that the patient is a professional singer, the head and jaw area and their influence on the vagal nerve might have had a role in the stress-related complaints. SI is a very holistic method and also addresses these areas. During the 10 sessions, it tries to rebalance the whole system. Touches the whole body, not just the problem.

From clinical experience, this case report is representative, because women with pelvic pain often have problems with signals from inside the body and very high readings in the surface EMG. SI was chosen because a biopsychosocial model was needed. Just exercise or manual therapy or physiotherapy was not enough. To add the biological component, like e.g. dietary advice, is difficult with the system in Poland.

There are also HRV data available for this patient, but due to software problems these could not be accessed before the presentation.

Another idea for the future would be to measure cortisol levels.

Hakan Oflaz developed a special device (pneumatic balloon) to measure intravaginal pressure. This device could provide relevant additional information.

There is a very short description on page 13 of the EFREM protocol 2022:
http://fasciaresearch.de/Summary%20EFREM%202022_Version%202.pdf

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Further Presentations

Katja Bartsch und **Gunda Slomka** presented preliminary data from a survey on the application of foam rolling in the clinical practice of athletic coaches/ trainers, physiotherapists/manual therapists, sports scientists, yoga teachers etc. in Germany, Austria, and Switzerland.

The results suggest a need for better knowledge transfer from research into clinical practice.

However, research of course needs input from clinical practice. Therefore, please have a look at the ongoing initiative to capture adverse events associated with foam rolling under:

https://www.fasciaresearch.de/Einzelfallanalyse_final_Formular.pdf

(for German-speaking colleagues only)

Davide Fiori presented the current status of his systematic review on the prevalence of depression and anxiety in adults affected by common musculoskeletal disorders.

Lucas Bohlen presented the current status of his upcoming randomized controlled trial on the effects of osteopathic techniques on the microcirculation of the lumbar myofascia in healthy subjects.

We thank **Miriam Wessels** for her “elephant on the catwalk” movement break, which kept not only our fascia happy.