DR. ALFEN – TEAM SCIENCE

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Abstract:

Recent studies have suggested that chronic back and neck pain may initially be mediated by a deconditioning of the paraspinal muscles. Imaging studies have revealed local morphological changes such as atrophy and fat infiltration. Specific strengthening therapies targeting these muscles provide promising results for avoiding and curing the pain. The best clinical outcome has been achieved by using extension machines with restraint systems to minimize the activity of other muscles groups causing maximal fatigue in the back muscles. The training protocol is characterized by dynamic extension movements with low frequencies (one set, once/twice per week), high intensity causing momentary muscular failure and limited, pathology-based range-of-motions. Before and after therapy an isometric strength test is commonly performed to measure the current strength levels and monitor the results of treatment. It is assumed that up to 80-90 % of chronic patients can recover from their pain symptoms by performing this exercise type. The clinical outcome, however, is influenced by the severity of structural changes in the spine and other individual factors. For optimal treatment it is essential that the protocol including range of motion is customized to the patients' pathology and that patients' lifestyle is considered.

This knowledge has been integrated into the Dr. Alfen Medical Strengthening Therapy including SPEXS Spine ILE and ICE and the Alflexus Software. Current research projects in the Dr. Alfen Spine Center and collaborating universities are furthermore working on keeping a high standard and integrating the latest research data.

Background:

Deconditioning of paraspinal muscles is the major cause for chronic back pain

Despite extensive research on acute and chronic low back pain, the neurophysiological mechanisms and morphological changes associated with this condition have not yet been fully elucidated. However, it is well established that deconditioning of the paraspinal back muscles (Figure 1) plays a key role in this process (1) and is known to be a risk factor for developing back pain. On the other hand, conditioning of these muscles can significantly reduce this risk and decrease the pain (2). Most discussed in this context is the strength and structure of the multifidus, the most medially located back muscle and the largest one that spans the lumbosacral junction. It primarily serves to maintain the erector posture of the trunk and to abduct and rotate the trunk (3). The multifidus muscle is important for stabilizing the “neutral zone” range of motion of the back and is thus essential for maintaining back health (4). Contrarily a dysfunction is associated with low back pain. Specific exercises targeting these muscles have been shown to cure patients from back pain and to maintain back health (2,5).

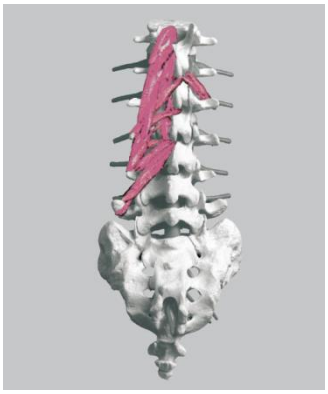

Figure 1: Paraspinal muscles in the lumbar spine

Morphological changes in low back pain

Morphological and imaging studies have revealed that patients with low back pain exhibit significant atrophies in the paraspinal back muscles compared to healthy controls (Figure 1.19.2) (6-8). Comparison of different stages of back pain has furthermore shown that in acute patients decreased cross sectional areas of the erector spinae and psoas major often occur, whereas in chronic patients atrophy in the paraspinal multifidus muscle is more dominant (9,10). Apart from muscle size distinct fat infiltration into the paraspinal muscles (Figure 2) has been associated with low back pain, disability, low muscle function and pain intensity (11-13). This correlation was mainly found in adults and older individuals (14-16). Another discussed feature is the conversion of muscle fiber II into I leading to less adaption to aerobic exertion (17). Furthermore, studies have revealed that the corticomotor control of lumbar multifidus muscles is impaired in

chronic low back pain (18). Analyses of multifidus muscle biopsies have furthermore measured elevated inflammatory processes, decreased vascularity and active degeneration in back pain patients highlighting the complexity of these mechanisms (19).

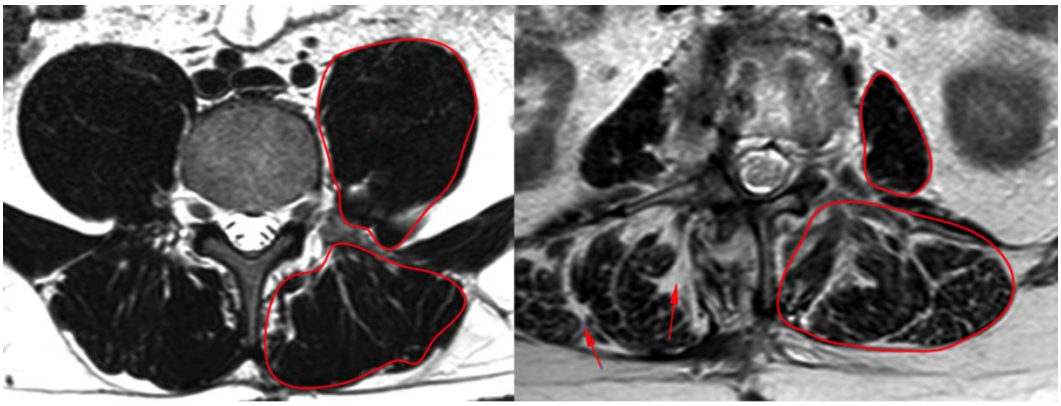

Figure 2: Cross section of the lumbar spine and its surrounding muscles of a healthy individual (left) and one with back pain (right). Patient's back muscles exhibiting atrophy and fat infiltration (arrows).

Several authors have suggested that those structural features may result in a lack of spine stability and may eventually lead to more dramatic changes such as spine degeneration and disc herniation. In a MRI study by Min and co-workers it has been found that multifidus atrophy was more pronounced in back pain patients with radiopathy than in those without (20). In another study by Ekin and colleagues, disc herniations were more frequent in patients with multifidus atrophy (15). Furthermore an association between fat infiltration in the multifidus and the erector spinae muscles and disc height and modic changes has been determined (12). Additionally, a correlation between disc degeneration, paraspinal atrophy, fat infiltration and facet joint degeneration in patients with disc herniation has been found (3). The presence of disc degeneration signifies a two-fold risk of chronic back pain (21). Even for patients with stenosis, lumbar kyphosis and spondylolisthesis, morphological changes and imbalances in the local paraspinal muscles have been suggested to contribute to these disorders (8,22-24). In conclusion, there is significant evidence that strong paraspinal muscles are required for maintaining and regaining spine health, weakening on the other hand is associated with spine disease and back pain.

Is physical activity the key to spine health?

Numerous studies have established a link between physical activity and spinal health. In fact, a lack of physical activity is associated with narrower lumbar intervertebral discs, high paraspinal fat content and occurrence of chronic low back pain (25). Studies on astronauts have furthermore shown that unloading may disrupt lumbar spine stability (26). Obesity as a consequence of consistent physical inactivity strongly correlates with reduced disc height (27). Another factor that influences spine health is age. Disc degeneration was found in up to 90% of

the older population (21). Fat replacement in the paraspinal muscles increases with age and is more progressive compared to other muscles in the human body (28). Thus, there is a need of physical activity for maintaining and regaining spine health during life span. However, exercise per se does not seem to be the solution. In fact, the type and intensity of physical activity may be the determinative factors. In a MRI study on Olympic high-level athletes 52% of the examined spines showed moderate to severe spinal diseases (29). Furthermore, atrophy of the multifidus muscle together with low back pain has frequently been found in elite athletes (30). The results of these studies indicate that even individuals performing high doses of activity on a regular basis are prone to developing back pain and spinal disorders. It can thus be concluded that exercise interventions should be designed for targeting primarily the paraspinal muscles, especially the multifidus muscle. These exercises can effectively minimize the risk of developing back pain and can potentially cure patients from this condition. Based on this knowledge medical strengthening therapy by Dr. Alfen has been developed.

Analogy to pain conditions in the neck region?

Compared to chronic low back pain there are fewer studies on pain conditions in the neck region. However, the results of these studies suggest similar mechanisms to occur as described for low back pain, namely a deconditioning of the cervical paraspinal muscle (Figure 3). Patients with chronic neck pain exhibit a smaller cross-sectional area (CSA) of the cervical multifidus and the semispinalis capitis muscle compared to healthy individuals (31-33). Cervical myelopathy has been found to be associated with increased fat infiltration and CSA asymmetry at the level below the compression (34). Even patients with chronic whiplash exhibit atrophies in several local muscles (35). Cervical radicular pain seems to be associated with atrophy in the longus colli muscle (36). Furthermore, cervicgenic headache is suggested to be influenced by atrophy and fat infiltration in the local muscles (37). It can be summarized that muscle imbalances and deconditioning processes seem to be associated with pain conditions in the neck region. Exercise selectively targeting these local muscles may have a beneficial effect on these conditions.

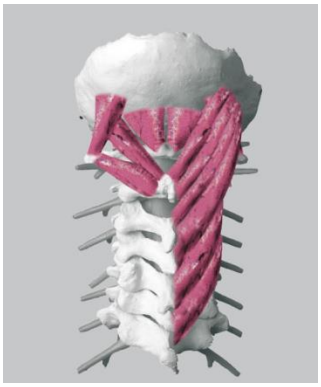

Figure 3: Paraspinal muscles in the neck region

Selective conditioning of the paraspinal and lumbar extensor muscles

As it is evident from the previous paragraphs that a specific conditioning of the lumbar extensors and paraspinal muscles needs to be warranted for optimal treatment of back pain (1). In fact, exercise programs causing hypertrophy of the multifidus muscle lead to pain relief in patients with chronic back pain (30). However, selective targeting these muscles is challenging as the hip extensors (gluteus, harmstrings) may contribute to a greater degree of measured torque and influence muscle fatigue (2). For this purpose, several training devices have been developed and advanced over the years. The best clinical outcome has been achieved by using a restraint system where the pelvis is stabilized and the patient is seated in semisitting position (Figure 4) which is the basis of Dr. Alfen ILE and ICE. Posterior pelvis stabilization enhances the recruitment of lumbar extensor muscles during dynamic extension. Semisitting position minimizes the activity of hip extensors and lower extremities compared to seated position (38-40). With these additives more fatigue at the low back can be achieved. For quantification of lumbar strength repeated measures of isometric lumbar extension strength can reliably be used (41,42). For effective assessment, the following requirements need to be fulfilled: Pelvic stabilization, standardization of testing positioning and correction of body weight (42,43).

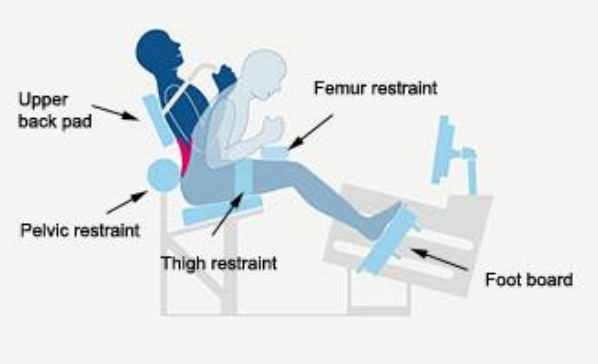

Figure 4: Lumbar extension machine with several restraints

Clinical outcome

Scientifically it is evident that isolated extension resistance training provides superior results for rehabilitating patients from back pain than any other type of exercise (5). It appears to be sufficient and effective for significant and meaningful improvements in perceived pain and disability (44,45). This clinical outcome is associated with increased isometric lumbar extension strength (46). In an unpublished study (submitted) from our clinic, 88.5% of patients reported improvements in pain symptoms. These results are astonishing as the patient material included many patients with severe and advanced spine disorders. Only about 10% of patients that were diagnosed by other doctors as surgery indication needed to be operated eventually. These findings are supported by a recent study by Steele and co-workers in which it has been shown that intervertebral discs can heal and regenerate with medical strengthening therapy (47).

Isolated lumbar extension resistance exercise in the neck region

For conditioning of the paraspinal neck muscles the same principles as for the lumbar spine should be applied. Through several restraint systems the neck muscle activity is increased. Patients are restrained via seat belt, shoulder harness, and torso restraint to prevent any additive strength effect from trunk musculature during the testing and training procedure (Figure 5). Studies have shown that cervical extension training enhances isometric strength, and that repeated measures can be used for quantification. As described above, deconditioning and structural changes in the deep cervical extensor muscles are known to be associated with neck pain and related disorders (48). Specific isolated cervical extension exercise has been shown to have the potential to increase isometric neck strength (49) and thus decrease neck pain symptoms (50). Even patients with migraine and headache may respond to this treatment option.

Figure 5: Cervical extension machine with several restraints

Outlook:

It can be summarized that medical strengthening therapy by Dr. Alfen which integrates the scientific knowledge about restraint systems is a effective useful tool for avoiding and curing chronic back and neck pain. As it also customizes the protocol to different spine pathologies its clinical outcome is superior to any other machines. However, for optimal spine health it is essential to condition the paraspinal muscles as early and often as possible in order to prevent spine diseases and chronic pain. Thus the Dre. Alfen machines can also be used as preventing measure.

Overview research projects

Project 1:

How strong is a healthy back? - A multicenter study on the back strength levels in 1000 healthy individuals without back pain

In collaboration with the German Sports University in Cologne and the GMKT (German Medical Strengthening Therapy) Society we have measured the strength levels in the lower and upper back via a static force test in almost 1000 healthy individuals from age 14-79. This is the biggest study that has ever performed on this issue. The main goal was here to have a huge standardized data set that will be integrated into the SpeXs Spine devices.

Our results suggest that the data raised from previous studies are not representative and need to be corrected especially in the extension position.

External collaborators:

Prof. Ingo Froböse, Ph.D., M.Sc. (German Sports University, Cologne, Germany)
Dr. Stephanie Jäckel, Ph.D., M.Sc. (University of Tübingen)
Ruth Hendrix, M.Sc. (MedAix, Aachen, Germany)

Project 2: Comparison of strength levels between healthy individuals and patients with chronic back pain

In a retrospective analysis on more than 15000 patients we have analyze and compared strength levels of healthy individuals (from project 1) with patients suffering from chronic back pain. Patients are divided into several subgroups based on their degree of pathology.

Our results clearly show that patients exhibit a significant lower strength level than healthy individuals.

External collaborators:

Prof. Billy Sperrlich, Ph.D., M.Sc. (University of Wuerzburg, Germany)
Dr. Vahid M. Harandi, Ph.D., M.Sc. (Lund University, Sweden)

Project 3: Clinical outcome of SpeXs Spine Concept by Dr. Alfen on chronic back pain including 6 and 12 months follow ups

In this study we have analyzed the clinical outcome of the SpeXs Spine Concept by Dr. Alfen on more than 15000 patients. For this purpose we compare pain scores (VAS, visual analogue scale) and questions about habits and disabilities before and after the treatment. Furthermore we have made follow-ups 6 and 12 months after the therapy.

Results on almost 1000 patients reveals that there is a significant decrease of pain perception with a high patient satisfaction rate. This result lasts for several months and years when minimum of one training session every months is performed.

External collaborators:

Prof. Marion Maar, Ph.D., M.D. (Northern Ontario School of Medicine, Canada)
Florian Wagenblast, M.Sc. (University of Tuebingen, Tuebingen, Germany)

Project 4: Imaging for the diagnosis and outcome of MTT

For the diagnosis of pathologies in the upper and lower spine magnetic resonance imaging (MRI) is currently still the first choice. However, based on the latest advances in technology it needs to be evaluated whether ultrasound imaging can also detect early signs of spinal degeneration including fat infiltration into the back muscles. As ultrasound imaging is a rather cheap diagnostic tool and is available for many medical doctors its use for spinal cord pathologies can bring many advantages. For this purpose we are going to set up a large study in which we compare and quantify structural changes in patients compared to healthy individuals. Hereby we will focus on detection of fat infiltration and blood flow by the use of traditional ultrasound, color Doppler and elastography.

In a second study we measure the amount (in percentage) of fat tissue by MRI and changes mediated through MTT.

External collaborators:

Dr. Heiko Braun, M.D., Ph.D. (Radiologist, Höchberg, Germany)

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