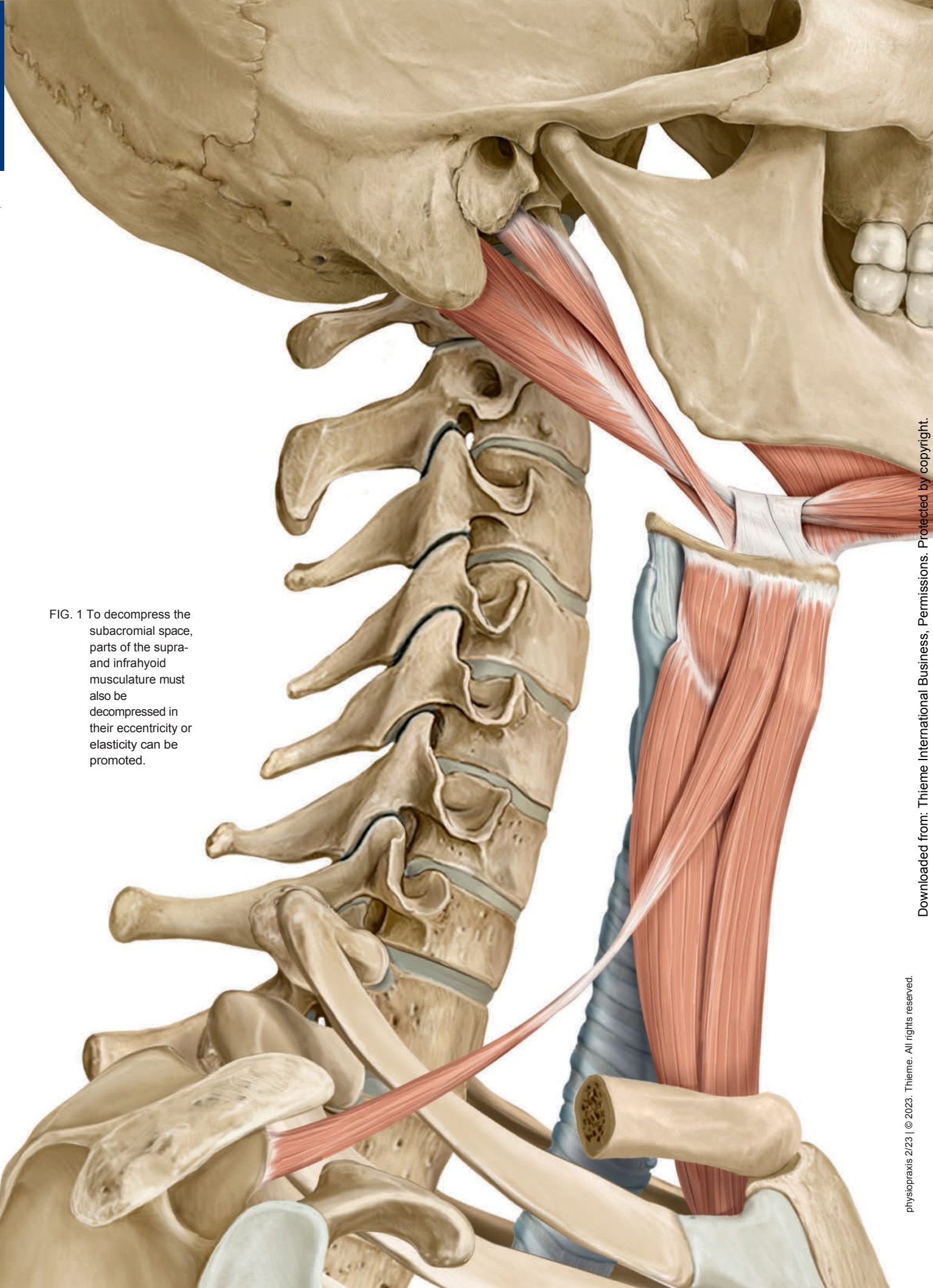


FIG. 1 To decompress the subacromial space, parts of the supra- and infrahyoid musculature must also be decompressed in their eccentricity or elasticity can be promoted.





Filigree house of cards

Painful shoulder *Shoulder pain* is complex. Gold standards are lacking due to insufficient evidence. Too narrow a focus on imaging, for example, neglects biopsychological, biomechanical and neuroscientific aspects. A history that is too vague sometimes overlooks the actual cause of the pain. Sindy Albrecht explains why even (micro)traumas lead to pain and pathological movement patterns. Motor relearning succeeds through meaningful and non-painful everyday activities.

Countless publications deal with the "sub acromial Pain Syndrome" (SAPS), which is often referred to as "shoulder impingement". According to the definition, the reduced subacromial space is responsible for the pain and restricted movement. Imaging procedures then attest that the patient has a "humeral elevation", a "Critical Shoulder Angle" or an altered "acromiohumeral index" [1]. It remains unclear how the humeral protrusion occurs. And whether calcium deposits under the acromion or at the tendon insertions actually cause the symptoms is questionable. Frozen shoulder is also the focus of numerous publications. Its primary form is considered idiopathic. The typical course is characterized by three stages (pain, frozen shoulder, recovery). The time required for complete restoration of shoulder mobility is ten months

up to about four years in some cases. The prognosis is very individual and depends on the timing of the start of treatment. The X-ray diagnosis is unremarkable. There is still no gold standard for treatment [2, 3].

For both types of painful shoulder, there is little evidence for the effectiveness of surgical and therapeutic interventions. Surgical procedures do not necessarily work better than conservative treatment approaches for SAPS [4]. Despite intensive research and a wide range of treatment options, there is also a lack of evidence to define a standardized and effective treatment method for physiotherapy [3, 5]. At the same time, the possible causes and treatment options - i.e. biomechanical, biopsychological and neuroscientific aspects - are usually viewed in isolation from each other and not understood as mutually influencing factors.

Root cause analysis → In view of these uncertainties, the question is

In the case of SAPS, the question is whether the elevated humerus or the calcium deposits are actually the cause and not just a "symptom" or an "abnormality" in shoulder complaints. And can a frozen shoulder really develop independently of other diseases or previous trauma? It is conceivable that SAPS and idiopathic frozen shoulder may be due to a hitherto frequently neglected pathology far removed from the

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A visit to the dentist can throw us off balance and shake the house of cards.

shoulder. For example, previous trauma to the head, cervical spine, thorax or even the feet could disrupt the biomechanics and lead to pathological movement patterns. It is also often neglected that pain and pain memory can negatively influence movement restrictions: If shoulder patients move their arm less due to pain and therefore "neglect" it, this can result in a "orthopaedic neglect" (👁️ GLOSSARY, p. 28) can develop. The interaction of pain, movement deficits and avoidance behavior worsens the prognosis, reduces the quality of life and has serious consequences for the patient's level of activity and participation.

(Micro)traumas with (macro)consequences → Everyone suffers countless (micro)traumas in the course of their lives. The spectrum ranges from a bruise after a minor fall to hospitalization after a serious traffic accident. Many of these injuries are accompanied by no restrictions relevant to everyday life and are trivialized as "not so bad". To a certain extent, the human body can compensate for (micro)traumas. However, this compensation has limits, and long-forgotten traumas can be relevant for the treatment of newly occurring shoulder pain. The balance of our body can be compared to a house of cards: With every (micro) trauma, the house of cards can begin to totter, become unstable, but still remain standing. In the end, all it takes is a small knock to cause a collapse (👁️ FIG. 2).

In the medical history, previous (micro)traumas are recorded at best, but are rarely linked to the pain and restricted movement of the shoulder that "suddenly appeared out of nowhere". However, we should take this information seriously and question its relevance to the current symptoms. At the same time, patients - often unconsciously - give us various clues about possible biomechanical causes of their shoulder complaints. Head position, eyes, dental occlusion, voice and movement patterns can be the first indications of impaired biomechanics. In addition to a

In addition to good observation skills, communication skills are also required. Targeted and sometimes openly formulated questions open up more space for patients to share information.

An image is an image → A diagnosis that focuses primarily on the shoulder joint carries the risk of overlooking and neglecting relevant (micro)traumas. With the exception of clearly confirmed diagnoses, such as a rupture of the rotator cuff, the main focus at the start of treatment should not just be on imaging. If, for example, an X-ray shows a shape of the acromion that deviates from the norm, this does not necessarily have to be the cause of the shoulder pain or justify an indication for surgery. An abnormal shape of the acromion is usually congenital and the body or its biomechanics have adapted accordingly. So why should the abnormal shape of the acromion be the cause of shoulder pain decades later?

The crux of the matter → It is possible that the real problem lies in a (micro)trauma that even patients consider to be trivial. Even minimal injuries change biomechanics, postural control and (proprioceptive) perception. In the case of a painful shoulder, cervical spine trauma or visits to the dentist, sometimes weeks or months ago, may be associated with the pain or stiffness. Infections, e.g. of the paranasal sinuses, are also relevant. This is due to axoplasmic flow or "double crush syndrome" (👁️ GLOSSARY, p. 28) [6, 7].

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We should rather speak of the caudally rotated acromion instead of "high humerus".

Many aspects must be taken into account for a holistic view of shoulder pain. In addition to the physiology and biomechanics of the shoulder and its interaction with the musculoskeletal system, the complex relationships between pain, protective tension, the autonomic nervous system, stress and psychological factors must also be considered. Because the Since "orthopaedic neglect" can lead to changes in cortical representation, the neuroscientific background of motor (re)learning of movement is particularly relevant to therapy.

Biomechanics → As the most mobile joint in the human body, the shoulder is dependent on muscular elasticity and eccentric control. For this reason, special focus must be placed on intra- and intermuscular coordination in therapy. For a

To ensure sufficient mobility, the cervical spine, thorax and scapula must be stabilized preactively. Like the cervical spine, the feet must also provide sufficient punctum fixum. Postural control, which enables us to straighten up against gravity, must be guaranteed. During overhead movements, external rotation and especially muscular coordination and elasticity are important so that the humeral head does not hit the acromion. Otherwise, the tendon of the supraspinatus muscle or the subacromial bursa can be irritated or damaged. For example, when you pick up a book from a shelf, your rotator cuff must preactively stabilize the shoulder in external rotation, while the pectoralis minor muscle, among others, allows the subacromial space to open by providing sufficient elasticity. The scapulothoracic rhythm, the cervicothoracic junction (CTÜ) and the thoracic spine (BWS) play an equally important role. Postural control therefore not only enables the body to straighten up against gravity, but also ensures the physiological range of movement of the arms.

Errors in the system → Subcortical pre-planning (feedforward) is essential for everyday activities [8]. Before you grab the book from the shelf, a feedforward takes place unconsciously. In the course of this subcortical pre-planning, your brain makes a decision before the

actual initiation of movement, via the selection of the motor program, takes into account muscle synergies and coordinates your movements. (Micro)traumas or incorrect planning can lead to biomechanical disorders.

Inter- and intramuscular coordination and movement planning are of central importance for the treatment of painful shoulder disorders. In view of this complexity, the question arises as to whether (micro)trauma can be responsible for the loss of postural control in SAPS and whether the symptoms are due to a caudal rotation of the acromion rather than a "high position of the humerus". Specifically: Increased tension of the omohyoid muscle and the

M. pectoralis minor can lead to protraction of the shoulder and thus promote caudal rotation of the acromion. Structures in the subacromial space are thus compressed and pain can occur.

Pressure relief → To decompress the subacromial space, the eccentricity and elasticity of various muscles must be promoted. To improve the preactive stability of the head, cervical spine and thoracic spine, among others, and to promote a physiological scapulathoracic rhythm, the focus is on the following muscles:

- suboccipital musculature
- M. omohyoideus
- M. digastricus
- M. sternocleidomastoideus
- M. pectoralis minor
- Diaphragm
- M. latissimus dorsi

Painful experiences → Our brain organizes itself according to its experiences. Pain is an experience, and many shoulder disorders - regardless of their cause - are often accompanied by pain. For the perception of pain

The nociceptors, among others, are responsible for this. These perceive threatening stimuli and report to the brain that potential tissue damage is imminent. This vital protective system is influenced by an individual evaluation system in the brain.



FIG. 2 Even distant and seemingly insignificant injuries can affect the biomechanics of the human body. like a delicate house of cards - to teeter and collapse. © eshma/stock.adobe.com

→ *Background knowledge*

Glossary

Orthopaedic neglect

Orthopaedic neglect is a (movement) neglect of at least one limb due to reduced mobility and/or pain that is not preceded by a neurological disorder. It is a learned disuse [8].

Axoplasmic flow and double crush syndrome

The axoplasmic or axonal flow is the transport of macromolecules and in particular proteins between the cell body (soma) and the axon of neurons. The transport from the axon to the soma is referred to as "retrograde", and that from the soma to the terminal head of the axon as "anterograde". The "double crush syndrome" describes damage to a nerve pathway due to mechanical impairment at more than one site. The mechanism of this syndrome is still unclear. It is possible that swelling or mechanical inflammatory stimuli could be responsible for the nerve's sensitivity to further mechanical constrictions. be the cause [6, 7].

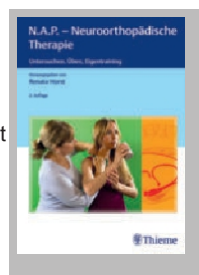
Neuronal plasticity

Neuronal plasticity describes a dynamic process in the brain, among other things. The representation of body areas is adapted depending on the amount of sensory experience and the environment [9, 20]. It is an activity-dependent process in which connections between neurons and synapses are established competitively [9, 28]. The more stimuli present, the greater the likelihood of brain adaptation and fine-tuning of movements [9, 28].



Bridge between neurology and orthopaedics

N.A.P. stands for "neuro-orthopaedic activity-dependent plasticity". It is a physiotherapeutic concept for promoting motor strategies in everyday life (ADL). In this book, you will learn in detail how to proceed in therapy in order to successfully treat your patients according to the N.A.P. concept. Case studies illustrate the concrete implementation. Take your chance to win one of two copies by clicking on www.thieme.de/physiopraxis > "Competition" by 8.3.2023 to the keyword "Neuroorthopaedic therapy".



Due to a misinterpretation of the brain, an agonizing pain can persist even without activation of the nociceptors [9]. This aspect is of enormous importance for the treatment of chronic pain patients.

Patients with frozen shoulder initially only have slight pain-related movement restrictions, which become ingrained in their pain memory. Those affected learn in which situations and with which movement patterns they feel pain. The more often they avoid pain-inducing movements and use compensation strategies, the more likely it is that these will become their new everyday strategies. If pathological movement patterns are used repeatedly, neuronal plasticity leads to reorganization at the neuronal and synaptic level [10, 11, 12].

Avoidance strategies are primarily associated with the fear of pain during movement [13, 14, 15]. Such "pain-related fear" often leads to protective tension with high concentric muscle activity and therefore to disturbances in intra- and intermuscular coordination [16]. This reduces eccentric muscle activity and the elasticity of muscular and fascial structures. In the worst case, this leads to atrophy and an orthopaedic neglect if we maintain the movement avoidance strategies. In the case of pain-associated movement anxiety, it is important - in addition to alleviating the pain - to provide anxiety-free therapy in a pain-free area; otherwise, negative or painful movement experiences can reinforce the learned disuse.

Neuronal plasticity → Lack of movement and injuries lead to fascial thickening [17]. Active, meaningful and context-related movement promotes the elasticity and eccentric activity of the muscles and can release fascial thickening. It is important that these are not abstract movements in free space or isolated strength training, but everyday movements. This enables feedforward for movement planning (start and end point of the movement) and also promotes neuronal plasticity (GLOSSARY). In neurology, it has been shown that stroke patients relearn movements best when they actively use the affected arm in a context that makes sense to them [18, 19]. Actively performing meaningful everyday movements promotes neuronal plasticity: "What fires together, wires together" [20, 21, 22]. Although the literature here refers to stroke patients with central damage, reorganization at the cortical level has also been demonstrated in complex regional pain syndrome (CRPS) of the upper extremity, which is caused by peripheral damage [23]. It should be differentiated here that the central damage in stroke patients requires other areas of the brain to learn to compensate for the lost activities in their cortical level. "area of responsibility" ("positive" neuronal reorganization). In CRPS, the learned non-use of the upper extremity leads to areas of the brain that are no longer used, in this case parts of the upper extremity, being overwritten.

resulting in an orthopaedic neglect ("negative" reorganization). Fortunately, this can be reversed (in part) through active exercise, as neuronal plasticity is a continuous, activity-dependent process. Neurology and orthopaedics can therefore not be rigorously separated from each other.

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*We are often too vague in our
anamnesis and overlook relevant
(Micro-)traumas.*

separate. And this connection can presumably also be applied to conditions such as SAPS and frozen shoulder. Even if there is little evidence in this regard, active and context-related movement could break through the learned disuse in shoulder patients and alleviate their pain. In patients with frozen shoulder, activity-oriented therapy is more effective in terms of pain reduction and motor relearning than structure-oriented treatment with manual therapy and PNF [24]. In activity-oriented therapy, the elasticity of body structures and the biomechanics are restored by the therapist's hands within a context that is meaningful and relevant to the patient's everyday life. Even if activities are practiced in structure-oriented therapy, such as PNF, no consideration is given to the biomechanical situation and work is carried out against resistance.

This makes a decisive difference to the outcome of therapy.

Passive measures should be avoided due to the limited motor planning. The reduced control of movement and the resulting

"PainRelated

Fear" can increase the protective voltage.

Stress, anxiety & depression → Chronic pain leads to stress. And stress can in turn have a negative impact on the perception of pain. Permanent tension therefore increases sympathetic tone. The increased release of stress hormones such as cortisol leads to a reduced oxygen supply to the tissue. This can shift the pH value into the acidic range, which can have a negative impact on fascial and nerve gliding [25]. (Neuro)yoga, treatment of the CTÜ, for example, are suitable for stress regulation and lowering the sympathetic tone, as this is where the nuclei of the sympathetic nervous system are located, as well as aerobic training.

It should not be forgotten that chronic pain is an additional psychological burden. Patients with frozen shoulder often suffer from sleep disorders, anxiety and depression [26]. This is particularly true if, despite frequent visits to doctors or therapists, neither the cause of the pain can be determined nor the symptoms alleviated. This results in a high level of psychological stress, which affects the quality of life of frozen shoulder patients more than the movement restriction itself [27].

Conclusion → Shoulder pain is - regardless of the diagnosis a complex topic. Because not only biomechanical but also biological, psychological and neuroscientific aspects must be considered, a detailed medical history is essential. It is possible that the cause lies in a long-ago (micro)trauma that has a lasting effect on biomechanics and postural control. Even long-forgotten and seemingly insignificant injuries can cause the biomechanics of the human body - like a delicate house of cards - to totter and collapse. In order to better understand the complexity of painful shoulders, we also need to focus more on neuronal plasticity, the influence of movement-associated pain and psychological aspects. A continuous change of perspective is important, and biomechanical aspects should also be reconsidered by speaking of a "caudally rotated acromion" rather than a "high humerus".

In the treatment of patients with SAPS and frozen shoulder
The priority is to restore physiological biomechanics.

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*Neurology and orthopaedics
cannot be strictly separated from
each other.*

len. To this end, postural control and the eccentric control and elasticity of the fine motor muscles should be improved. The first choice is active, meaningful and non-painful everyday activities. Within these activities, the biomechanics are facilitated by therapists according to the motto "as little as possible, as much as necessary". Positive movement experiences enable the resumption and maintenance or further development of everyday movements. Through this "classical conditioning" of movement, many patients notice a rapid improvement in their symptoms.

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"Manual swallowing therapy".