Neuromuscular arthroosseous plasticity

Further development of traditional physiotherapy concepts Renata Horst

Neural plasticity

The high number of collateral connections in the brain enables the variability that is necessary for movement behavior (8). Receptors exhibit plasticity depending on use. Synaptic transmissions are stronger or weaker depending on the need.

If certain parts of the body are not used due to weakness, chronic pain or even fear, a change in the cortical representation fields can be detected (9-14).

Ramachandran (15) noticed that amputees who had lost their hand could actually feel it o n their face and upper arm. He had the idea of giving them their hand

"by having them observe movements of their intact hand. This created the optical illusion that both hands were moving.

The recent discovery of the mirror neuron system offers a possible explanation for the importance of mental visualization of realistic movements for motor learning. The mirror neuron system is located in different areas of the premotor and limbic systems. These neurons are involved in recording information that is relevant to the task. The experience of the actual movement with the

Support from the therapist enables the patient to visualize the movement. This allows them to acquire "knowledge" about the characteristics of the movement.

Fig. 1_Patient after traumatic arm resection and replantation, 18 months after the accident

Fig. 2_Mobilization of his carpal bones during activity

knowledge of performance / "knowledge of results," 16). ▪

FIGURES

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Fig. 3_Almost two years after his accident, he can lift moderately heavy objects, which is important for his participation

Fig. 4_Four years after his accident, many activities, such as opening a beer bottle with a lighter, have been automated

Muscular plasticity

Depending on functional requirements, muscle mass is either built up or broken down. Although strength training leads to muscle hypertrophy, it cannot be concluded that the same muscle is automatically able to perform different activities skillfully (1, 2, 3). Each activity requires a specific recruitment sequence (intramuscular coordination) and specific timing within the required muscle synergy (intermuscular coordination). The frequency of muscle fiber recruitment is also determined by the respective task (17). Muscle strength training therefore requires training in different contexts in which the muscle is used and in the way in which it is used. Eccentric muscle work requires sufficient

Fig. 1_The fibers of a stiff, weak bicep of a stroke patient are approximated in the sense of an "action massage", during which she tries to smell the orange

Fig. 2_ Here the fibers are extended for the eccentric activity, during which the orange is placed back on the table

This requires elasticity and the ability to deal with gravity. In general, lying positions tend to address non-contractile structures. Promoting the elasticity of contractile structures requires upright body positions.

Some pathologies are associated with changes in the type of muscle fiber.

In the case of spasticity, for example, there is a transformation from phasic to tonic muscle fibers (18). Similar change processes occur with increasing age (16).

FIGURES

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Arthroosseous plasticity

Muscle activity is required to both move and stabilize joints. Thus, changes in muscle activation muscles cause changes in the skeletal system. For example, if the hip extensor synergy is too weak to stabilize the ileum on the femur, then the ileum tilts ventrally and consequently the femoral head is overloaded. Osteophytes are formed as a protective mechanism. Adaptation occurs even if the pressure on the bone mass decreases.

Functional requirements determine the structure

The shape of the skull has changed over the course of evolution. The area in which language is organized

The Broca's area of the brain (Broca's cen- trum) became larger at the time that language developed (19). This area of the brain (Broca's cen- trum) is responsible for controlling the finger, tongue and facial muscles and for hearing sounds. All these bodily functions are involved in the communication process (20).

Postural control and reciprocal innervation are organized in a task-specific manner

Postural control can be defined as follows: The ability to stabilize the center of the body over the support surface under both static and dynamic conditions and to align the body segments with each other. It includes the organization of diverse sensory strategies that are required for orientation. An important characteristic of postural synergies, which distinguishes them from abnormal synergies, is that they can be varied as required.

Sherrington (21) described reciprocal inhibition as a general method of coordinating priorities for goal-directed behavior (22). The execution of an arbitrary motor action requires a specific muscle fiber recruitment sequence

Fig. 1_Patient after incomplete transverse incision C7 with tinitus symptoms; he writes a lot on the computer and has poor head control when driving a wheelchair; action massage for the digastric muscle to decompress the posterior auricular artery

and a specific muscle activation sequence. Depending on the task, the antagonist must be inhibited or co-active. Fast, goal-oriented voluntary movements require inhibition of the antagonists during the acceleration phase (23). In contrast, slowly controlled movements or holding activities require co-activation. Activation of the antagonists (24). Environmental factors also play a significant role. Depending on the influence of gravity, movements must be controlled eccentrically.

FIGURES

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Fig. 2_He actively pulls his tongue downwards to the right; his mandible is mobilized in protraction to relieve the dorsal capsular structures and the auricular nerve; after one treatment the patient is symptom-free; one year later he is still symptom-free

Development of protective mechanisms

One hypothesis on which the treatment methods of the N.A.P.® concept are based is that during rapid goal-oriented action, in which the antagonists should normally be inhibited, they may instead be co-active. This strategy is organized as a result of pain experiences or also out of fear, for example of falling, so that the protective task is guaranteed. For wound healing, "freezing" the injured structures is initially a sensible strategy so that healing can take place. The same strategy is required to ensure stability, for example when walking on an unstable or slippery support surface.

Scientists have shown that protective mechanisms are controlled via the connection between the amygdala of the limbic system and the autonomic nervous system. These processes are implicit, i.e. unconscious (25). Since muscles are recruited variably, depending on requirements, this supports the above treatment hypothesis. One of the biochemical processes triggered by activation of the sympathetic nervous system is the production of serotonin.

Fig. 1_Patient diagnosed with MS; action massage of the adductors; the therapist applies longitudinal traction to the abdominal muscles while the patient rolls on her back

tonin, a neurotransmitter that is required for long-term memory. This explains the fact that all protective mechanisms may be

be "learned" (25, 26). In order to prevent these protective mechanisms, which are necessary in the acute phase, from becoming chronic, it is important to have positive experiences with the injured body part as soon as possible through various meaningful activities.

Inhibition of protective mechanisms through habituation

Habituation can be understood as a behavioral response to repeated unpleasant stimuli that are harmless. It involves an increasing decrease in response to a repeated stimulus. This process takes place unconsciously. Habituation allows you to shift your attention from one situation to another when information that was initially running in the background suddenly seems important and all previous stimuli continue to have an effect. Inhibitory neurons trigger a predictable and coordinated response to specific stimuli by controlling all competing stimuli.

Fig. 2_During the "putting on shoes" activity, the adductors are also activated eccentrically

suppress all but one of the reflexes. A single motor neuron adds together all the facilitatory and inhibitory impulses it receives from other neurons. On the basis of this calculation, an adequate response is generated (22).

FIGURES

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Hands-on and hands-off to promote motor control

Voluntary goal-motor activities are organized both cortically and subcortically (24). It has long been assumed that sensory information is necessary to initiate movements (21). Studies have shown that movements can also be executed without sensory afferents (27). Since movement programs are predetermined, cognitive information, such as visual and auditory stimuli related to the environment, is important for movement planning. Tactile sensory information is primarily needed for feedback in order to check whether the planned activity was successful and enables corrections to be made towards the end of the movement (28). The result of this

It is known that tactile information during the execution of planned actions can be helpful in promoting coordination and dexterity. The question here is not whether hands-on or hands-off is more useful, but how the therapist's hands can provide meaningful information, i.e. where and, above all, when they can be useful. Perceptual processes include the search for the information that is essential for the respective hand and the most efficient strategy for achieving the hand's goal. Sensing alone is not much use to the brain. Sensing what is happening is what is important. This is not subject to consciousness (29).

Distal body parts are primarily organized consciously, i.e. cortically, and require visual information from the environment. Proximal body parts are organized

The movements are primarily controlled unconsciously, i.e. subcortically, and require proprioceptive information. This means that where you move to is controlled consciously and how you move there is controlled unconsciously.

Within the N.A.P.® concept, goals are communicated by means of visual and verbal information, depending on the patient's potential. The therapist's hands are used as a possible tool to ensure the correct biomuscular situation, which cannot be controlled neuromuscularly. This provides the brain with information on which neuromuscular activity is required in each case. In the course of motor learning, these synergies should be recruited automatically if possible, in the sense of "re-setting the brain".