

# Exercise and The Spine

## Tissue Adaptation and Remodeling

### Tissue Adaptation and Remodeling

```
<!-- /* Style Definitions */ p.MsoNormal, li.MsoNormal, div.MsoNormal {mso-style-parent:""; margin:0in; margin-bottom:.0001pt; mso-pagination:widow-orphan; font-size:12.0pt; font-family:"Times New Roman"; mso-fareast-font-family:"Times New Roman"; color:windowtext;} p {mso-margin-top-alt:auto; margin-right:0in; mso-margin-bottom-alt:auto; margin-left:0in; mso-pagination:widow-orphan; font-size:10.0pt; font-family:Arial; mso-fareast-font-family:"Times New Roman"; color:#000033;} @page Section1 {size:8.5in 11.0in; margin:1.0in 1.25in 1.0in 1.25in; mso-header-margin:.5in; mso-footer-margin:.5in; mso-paper-source:0;} div.Section1 {page:Section1;} --> Tissue Adaptation and Remodeling
```

The presence of physical stress causes adaptive responses in all tissues of the human body including the spine. Physical stress is defined as the force applied to a given area of biological tissue. The level of stress required to initiate an adaptive response varies between each tissue. The fundamental principles of tissue adaptation to physical stress can be used to help guide multidisciplinary spinecare, physical rehabilitation and the development of exercise programs.

Chiropractic physicians and physical therapists have particular expertise in the application of non-operative therapeutic approaches which promote favorable tissue adaptation and remodeling. This includes exercise, activity modification, postural therapy, modalities, braces and the use of orthotic devices. There are numerous physiological and biochemical factors which influence a tissues response to physical stress, but these are not always easy to modify. Certain medications can influence the ability of tissues to favorably adapt to physical stress. For example, corticosteroids can cause a reduction of inflammation in one tissue and cause atrophy in other tissues such as skin, bone, and muscle.

Age is another important variable which can influence a tissues ability to adapt and remodel to physical stressors. In general aging has a negative effect on tissue adaptation. The true effect is not entirely obvious for some of the apparently negative effects felt to be secondary to aging may actually be due to an age-related reduction in physical activity.

### Musculoskeletal System

A mild to moderate degree of physical stress can have a very positive effect on adaptation within the musculoskeletal system. A high level of physical stress can cause injury to supportive tissues. The magnitude as well as the duration of physical loads and strain both play a role in adaptation and injury. Musculoskeletal tissues such as cartilage, bone, ligaments, muscles and tendons exposed to levels of physical stress that are higher than normal respond by adapting and remodeling in a manner that makes them stronger and more resistant to injury. For tissue to respond favorably the recovery period has to be adequately. If the recovery periods are too short the tissue cannot repair itself and it remain in a vulnerable state susceptible to be injured if the loads placed

upon them become to high.

Controlled and gradual use of resistive exercise can be used to make muscles stronger and more capable of performing work. This approach causes muscle fibers to enlarge or hypertrophy. Higher-than-normal physical loads placed on bone will stimulate the remodeling process in bone. There are specialized cells in bone called osteoblasts which lay down for more bone under the adequate stimulus. This process is described well by Wolff's Law which states that with the proper level of stress the supportive pillars in bone called trabeculae will increase in number, become thicker and stronger. The structural changes occur along the orientation of the physical stress which is placed upon the bone. This is also true of other musculoskeletal tissues. The tissue adaptation and remodeling process will correspond with the orientation of the higher than normal stress. Tendons and ligaments respond to exercise-induced stress with increases in their cross-sectional area, stiffness, and ability to withstand tensile loads.

Tissue that is deprived of physical stress undergoes atrophy rendering it weaker and less capable of maintaining integrity under increasing loads. Each tissue of the musculoskeletal system requires a minimum threshold of stress to remain strong. Musculoskeletal tissues undergo atrophy at a faster rate than they hypertrophy. In other words it takes a relatively short period of stress deprivation to cause adverse tissue changes. For example, muscle can lose as much as 30-40% of its ability to perform work as the result of a 4- to 6-week period of inactivity. The bone mineral density of bone becomes reduced after a few months of reduced stress. Ligaments also become weaker if an adequate amount of stress is not placed upon them.

## Nervous System

There is increasing evidence to support the theory that physical stress and the pattern and intensity of physical activity leads to some structural and biochemical changes in the peripheral and central nervous systems. The nervous system not unlike other tissues in the body is dynamic and always responding to the stimuli placed upon them.

The central nervous system adapts to the demands placed on it. One of the ways that neurons adapt is thorough structural and functional changes, a process referred to as plasticity. Neural plasticity is a fundamental lifelong process that allows the brain and spinal cord to receive information and form appropriate adaptive responses to the same or similar stimuli. This is accomplished through the establishment of new and more efficient connections (synapses) between nerve cells and a change in the internal structure of neurons. It has been well established that the brain is constantly reorganizing itself in order to adapt. This is a daily process that takes place between the nearly one trillion neurons in the brain. This dynamic process is driven and influenced by genetic factors, environmental stimuli and by the actions of the person.

The term synapse refers to the connection between nerves. The strengthening of some synapses and atrophy or loss of others is a process called pruning. Experience and repetition determines which nerve connections will be strengthened and which will be lost. Without adequate stimuli, nerve cells can die through a process called apoptosis. Ineffective or weak nerve connections are essentially "pruned" in much the same way a gardener would remove a branch to give a plant the desired shape. This process allows for more efficient control and function of the body including muscle coordination and cognitive function. It has only been during the last two decades that enormous body of research has emerged revealing that the brain never stops changing and adjusting. Short term memory including muscle memory also depends upon electrical and chemical events in the brain and spinal

cord.

After brain injury plastic changes occur to help restore function. This is part of the healing process. This is felt to also occur within the spinal cord or the spinal nerves after injury. Chronic pain, poor posture, limited movement and muscle weakness can all contribute to the development of detrimental adaptation within the central nervous system. Sometimes adaptation can lead to detrimental changes which may contribute to more chronic pain.