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Understanding Disuse Atrophy

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Observations from clinical practice have indicated that one of the most significant detrimental effects of disuse on the body is muscular atrophy. Disuse atrophy might occur from an injury that forces the individual to keep an area in a cast for a prolonged period.
It also might occur in situations in which bed rest or non-weight-bearing is mandated for rehabilitation from an injury. Regardless of the cause of the disuse, we now have learned a great deal about what occurs in muscle tissue as a result of disuse, and it's clear that it leads to significant muscular dysfunction.

Muscles throughout the body are comprised of different types of fibers. Human muscle has two primary fiber types. The first is called type 1, or slow-twitch muscle fiber. These fibers are most prevalent in muscles used for endurance, such as the postural muscles of the body. The second fiber variation is type 2, or fast-twitch fibers. These fibers are more prevalent in muscles that do short, powerful bursts of activity. Note that not everyone has the same percentage of fiber type in each of his or her muscles. That is one reason some individuals excel at distance running, while others excel at sprinting. In animal studies, there is some indication that disuse atrophy affects these two different types of fibers at a different rate.[1] However, in humans there is no conclusive evidence to suggest either type of muscle fiber atrophies faster than the other.

It's surprising how fast disuse atrophy might occur. This has been studied by investigating what happens during limb immobilization after injury. One study found that muscle wasting was detected in as little as three days following immobilization.[2] The degree of atrophy experienced in a muscle depends on how that muscle is used. For example, it's evident that disuse atrophy occurs much more rapidly in antigravity muscles than in their antagonists.[1] Antigravity muscles are the primary ones used to hold us upright and resist the downward pull of gravity. This is one reason you see atrophy in the quadriceps muscles much more quickly than in the hamstrings.

Another factor related to disuse atrophy that is very evident with the quadriceps, is the position of immobilization. It has been shown that disuse atrophy is exacerbated for a muscle held in a shortened position. Most knee pathologies keep the knee immobilized in extension, rather than in flexion. When the knee is in extension, the quadriceps are passively shortened and the hamstrings are held in a lengthened position. The passive shortening of the quadriceps encourages the loss of integrity of sarcomeres in the muscle.[1] This is one of the primary reasons range of motion is limited following immobilization. Immediately after the immobilization, it's important to encourage adequate stretching of the quadriceps fibers to speed the return to optimal function.

Interesting studies about muscle atrophy have been done with astronauts and cosmonauts aboard the space shuttle and the space station.[3] These individuals develop significant amounts of muscle atrophy after spending time in a zero-gravity environment. At first, it was thought the lack of movement was what led to the muscular atrophy, but recent studies have indicated otherwise.[4] During space shuttle missions, the astronauts often are engaged in vigorous muscular activity while carrying out their work on equipment. What appears to be more significant for all muscles of the body is the absence of load-bearing and muscular effort required to resist gravity.

It appears disuse also might have detrimental effects on neuromuscular function, in addition to the structural changes in muscle tissue. Several researchers examined muscle strength after immobilization and found there was a greater degree of strength loss compared to the amount of muscle atrophy measured by muscle size reduction.[5] Because the strength loss was greater than the degree of muscle atrophy, there appears to be something else occurring other than muscular atrophy alone. It has been suggested the strength loss is due to an inability to recruit the motor unit properly. In essence, there is a "forgetting" of how to properly coordinate motor function that occurs from disuse.

It has been established that there are significant structural, neuromuscular and biochemical changes in muscles as a result of disuse. We also know from clinical experience that massage appears to have significant beneficial effects in restoring range of motion following immobilization or inactivity. It would be valuable to take these concepts and look at them together, to see if there is some better understanding we might gain of how best to use massage to combat muscular atrophy resulting from disuse.

References

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