Dynamic Chiropractic

CHIROPRACTIC TECHNIQUES

Rehabilitation for Low Back and Neck Pain

ENDURANCE TRAINING AND MUSCLE FIBER TYPES

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In the current literature, primary goals of rehabilitation for both low back and neck pain consistently include improvement of muscular endurance.[1,2,3] *Endurance* may be defined as the ability of a muscle to maintain a sustained, submaximal contraction, and is considered a subcategory of muscle strength. Muscle strength includes three characteristics: *strength*, the ability to generate force; *power*, the ability to generate force quickly; and *endurance*, the ability to maintain a sustained submaximal contraction.

The back and neck muscles, which provide dynamic postural stability, are working against gravity from the moment we get out of bed until we return for sleep 12 to 18 hours later. McGill noted that back muscles are designed for endurance capacity. He highlights that a stable spine requires endurable muscles, not necessarily strong muscles.[4]

Understanding the importance of endurance is essential in designing an effective rehabilitation exercise protocol. In order to maintain control and alignment of spinal joints during sustained posture and dynamic joint stability during movement, muscle patterns that reduce tissue strain, avoid trauma and provide optimal function are needed.[5] Endurance is crucial to maintain this control over many hours throughout the day.

Recent research indicates that only about 10 percent of maximal voluntary contraction of the back stabilizing muscles is needed to create sufficiently still and stable joints during the course of everyday activities. In a segment damaged by ligament laxity or disc disease, slightly more may be needed.[5] Research has shown that efforts of just 25 percent of maximum voluntary contraction (MVC) provides maximal joint stiffness.[6] Therefore, endurance is much more important than absolute muscle strength in most patients; however, a strength reserve is needed for unpredictable situations such as a fall, sudden load or quick movements.[7]

The association of poor back muscle endurance and increased risk of developing first-onset and recurrent low back problems appears to be much greater than the association of poor strength and low back problems. In a 10-year longitudinal study, strength appeared to have little or a very weak relationship with low back pain. In contrast, muscle endurance, when separated from strength, appeared to be linked to better back health.[8]

Similarly, research on the cervical spine has found that neck pain may result in reduced endurance and easy fatigability of both flexors and extensors.[9] In addition, greater fatty infiltration in neck stabilizing muscles, including the rectus capitus posterior major and minor, multifidi, and semispinalis cervicis, has been found in patients with whiplash-associated disorder.[10] In a series of clinical trials, Ylinen, et al., demonstrated that either endurance or strength training over the course of a year can significantly reduce neck pain and disability.[11] Furthermore, at three years

follow-up, these benefits are still maintained.[12]

Our appreciation of the importance of endurance in the prevention of first-onset low back problems, and in reductions of the frequency and severity of recurrences and chronicity, dates back to the early 1990s. A study by Luoto, et al., in 1995 found that in subjects with no previous history of back pain, those who demonstrated poor performance on the static back endurance test had a 3.4 times greater risk of developing first-onset low back pain in the follow-up year compared to those with medium or good performance on the same test.[13] In people with a history of previous episodes of back pain, lumbar extensors were found to be weak, highly fatigable and atrophied, and displayed abnormal activation patterns and excessive fatty infiltration.[14] The term *atrophy*, when applied to muscles, indicates reduced contractile cross-sectional area, reduced density and fibrofatty infiltration, and is associated with reduced EMG activity, easy fatigability and loss of endurance.[15]

Atrophy can develop in many of the multiple muscles involved with core stabilization. The multifidus is the most extensively studied of these back stabilizing muscles and has been considered by many researchers as the single most important stabilizing back extensor muscle. In a review article, Ebenbichler reported that the multifidus contributes nearly 70 percent of the stiffness resulting from muscle contraction in the neutral zone of the lumbar spine.[16]

Polus described the multifidus as playing a significant role in maintaining stability of lumbar spine segments. He noted that the multifidus undergoes pathological change after episodes of acute LBP, including atrophy that does not recover after resolution of symptoms. In addition, he explained that this lack of recovery of local musculature is presumed to lead to an increased vulnerability of the lumbar spine to further injury and risk of recurrence of acute episodes of LBP.[17]

Very recent research indicates that atrophy is not confined solely to the multifidus. Atrophy also can develop in the iliocostalis, longissimus, psoas, and quadratus lumborum in subjects with chronic low back pain (CLBP). The authors conclude that the finding of atrophy in paravertebral muscles necessitates the use of exercise programs.[18] And a 2008 study assessing the endurance of back stabilizing muscles in healthy teenagers and in teenagers with CLBP reported that poor endurance can occur in several groups of muscles. Teens with CLBP were found to have poor endurance of the trunk extensors, hip extensors and quadriceps.[19]

In a chapter reviewing muscle stabilization protocols in Liebenson's 2007 text, Osborne and Cook[20] noted that restoring endurance in neck or back pain can have a significant impact on chronic pain, function and disability, and is an initial goal of rehab. Endurance loading maximizes blood flow/perfusion and healing. Emphasis is on improving the tonic holding capacity (aka endurance) of the spinal stabilizers. Osborne and Cook explained that endurance is trained in deconditioned patients with loading at 30 percent to 40 percent (MVC) in three sets of 12-14 repetitions. Furthermore, they report the clinically important and encouraging finding that spinal musculature endurance levels can increase by 100 percent to 150 percent with endurance training within eight weeks in typically deconditioned patients.

The reason that endurance training is performed at only 30 percent to 40 percent (or less) of MVC is that at this level of muscle demand, type I fibers are primarily recruited.[21] No matter what the workout intensity, type I motor units, which are capable of only approximately 20 percent of a muscle's force production, are recruited first.[22] If the workout intensity is low, these motor units

may be the only ones recruited. If the workout intensity is high, such as lifting heavy weights or intervals in track, type I motor units are still recruited first, followed by type IIA and type IIB if needed.[23]

Type I muscle fibers are the sole muscle fiber type with a high mitochondrial density, high oxidative capacity, high capillary density, and high myoglobin content, resulting in a high resistance to fatigue and the greatest endurance capacity of all muscle fiber types.[24] Types IIA and IIB, although capable of substantially greater power output, have an anaerobic metabolism, lower mitochondrial and capillary density, and less myoglobin. As a result, type IIA and IIB muscle fibers have a much faster fatigue rate and do not provide endurance capacity.

In order to train endurance, safe, relatively low-load, high-repetition exercises that demand significantly less than 50 percent of MVC, can be used. Unlike strength exercises, which are typically performed at 70 percent to 80 percent of MVC, endurance exercises of longer duration and lower effort can be done daily or even twice daily, without the need to take days off in order for the muscles to recover.[25] Therefore, daily exercises may be prescribed. This exercise frequency assists patients in establishing an exercise habit, reduces their fears about being active and exercising, and helps them incorporate exercising as a vital part of their daily routine.[26]

With this type of information, the clinician can explain and prescribe a safe and effective exercise training program, along with chiropractic care, and achieve quantitative, documentable outcomes. This not only eliminates any uncertainty or dispute about whether the care is effective, but also boosts patients' endurance capacity and resistance to recurrences. Perhaps as importantly, a successful exercise protocol can improve patients' confidence in activity, overcome their fear-avoidance beliefs, increase their activity tolerance, and enhance their health-related quality of life.

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