The purpose of the Point/Counterpoint Column is to provide a respectful and balanced discussion in relation to controversial or current topics in the fields of strength and conditioning, nutrition, and human performance.

COLUMN EDITOR: Andrew J. Galpin, PhD, CSCS, NCSA-CPT

Abdominal Crunches Are/Are Not a Safe and Effective Exercise

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ABSTRACT

THE ABDOMINAL CRUNCH IS A WELL-KNOWN EXERCISE PERFORMED BY GENERAL AND ATHLETIC POPULATIONS FOR THE PURPORTED BENEFITS OF IMPROVING FITNESS ATTRIBUTES, SPORT PERFORMANCE, AND CORE MUSCLE FUNCTION. DESPITE THE BENEFITS, PARTICIPATION MAY INCREASE ONE'S RISK FOR LOW BACK PAIN. WHILE A CLEAR VERDICT ON THE RISK-TO-BENEFIT RATIO REMAINS ELUSIVE, A DISCUSSION OF THE AVAILABLE SCIENTIFIC EVIDENCE (OR LACK THEREOF) SHOULD GIVE PRACTITIONERS THE ABILITY TO DETERMINE THE UTILITY OF THIS EXERCISE FOR THEIR CIRCUMSTANCE. WE WANT TO HEAR FROM YOU. VISIT **NSCA-SCJ.COM** TO WEIGH IN ON THE POINT/COUNTERPOINT QUICK POLL.

POINT

The crunch has long been considered a staple exercise for working the abdominal musculature. Despite its widespread inclusion in strength training programs, however, the crunch has recently come under scrutiny as a potentially dangerous movement that should be avoided by the general public. This claim is based on the hypothesis that vertebral discs have a finite number of bending cycles and surpassing this limit ultimately leads to disc damage (15).

Evidence that the crunch is deleterious to spinal health has primarily been derived from ex vivo (outside the living) research using cervical porcine models. These models involve mounting spinal motion segments in hydraulic devices that apply continuous compressive loads in combination with repeated dynamic flexion and extension cycles (7–9,20). After applying bending cycles that range from 4,400 to 86,400 combined with ~1,500N compression loads, partial or complete herniations have been noted in the posterior annulus of most discs analyzed. Given that the crunch has been shown to produce ~2,000N of spinal compression (4)–an amount greater than the forces applied in the research–this has been held up as evidence that the crunch predisposes the discs to injury.

While on the surface these findings may seem to provide compelling evidence for a direct relationship between spinal flexion and disc damage, caution must be used when attempting to extrapolate results from ex vivo research to practical in vivo settings. For one, inherent differences exist between animal and human models that limit generalizability between the 2. With respect to the spinal flexion models used, the absolute range of motion of the porcine spine is smaller than that of humans during both flexion and extension actions (3), which compromises generalizability to dynamic spinal flexion

exercise. It is also important to note that spinal tissue in living humans adapts to the stress of progressive exercise by getting stronger and, thus, is able to withstand greater applied stressors over time (5,16,18). In addition, the number of continuous loading cycles used in the body of research far exceeds those employed in traditional programming for the crunch exercise. In contrast to many thousands of repeated flexion and extension cycles, typical abdominal strengthening protocols involve a fraction of these repetitions. Moreover, many hours of recovery are afforded after an exercise bout, allowing sufficient time for spinal tissues to recuperate and remodel. Finally, the research in question took the spinal segments to the end range of flexion. It has been shown that reducing the range of flexion from 13 degrees to 11 degrees causes a ~50% decrease in bending stress to the posterior annulus (2). Importantly, the crunch is a limited range movement that works the spine nowhere close to its end range flexion capacity and, thus, results in much less stress on the discs (11,19).

To the author's knowledge, no studies to date have been performed to determine whether a cause-effect relationship exists between performance of the crunch and spinal injury. Damage to the vertebral discs from exercise occurs when fatigue failure outpaces the ability of the tissue to effectively remodel, which is predicated on factors that include genetics, the interaction between load and posture, how rapidly the load is increased, and the age and health of the individual (1). Given the adaptive nature of the discs, a case can be made that performance of the crunch actually has a positive effect on tissue remodeling provided that the exercise is performed in a fashion that does not exceed disc loading capacity.

Although some claim that static abdominal exercise provides all the benefits of dynamic spinal flexion, this may not necessarily hold true in practice. It has been shown that spinal flexion promotes nutrient delivery to the intervertebral discs (12,13), which has been speculated to occur through a pumping action that heightens transport and diffusion of molecules into discs. Importantly, age-related reductions in spinal nutritional status have been linked to compromised cellular function, which can lead to disc degeneration and possibly even apoptosis (6,14,21).

Dynamic spinal flexion strength/power is also relevant to many athletic endeavors including wrestling, baseball, tennis, gymnastics, soccer, swimming, and track and field. The principle of specificity dictates that optimizing performance should include exercises that directly work the muscles in the manner that they are used in a given activity. The crunch seemingly would be a viable exercise in this regard.

Finally, performance of the crunch may promote greater abdominal muscle hypertrophy compared with static core exercises. Dynamic concentric and eccentric actions have been shown to elicit distinct morphological adaptations at the fiber/fascicle level, including differences in regional specific muscle growth (10). Eccentric actions seem to be particularly important to the hypertrophic response (17), possibly related to exercise-induced muscle damage.

As a rule, there are no "bad" exercises, just improper prescription and application for a given individual. Based on logical rationale, it seems prudent that those with existing spinal conditions including disc herniation, disc prolapse, and/or flexion intolerance avoid performance of dynamic spinal flexion exercises. However, for those with healthy spines, the crunch would seem to be a safe and effective exercise when loading and volume are prescribed within the scope of individual abilities.

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COUNTERPOINT

The abdominal crunch, hereafter referred to as a "crunch," may not be safe for all. The relative safety of a crunch is not something that can be narrowed down to a dichotomous answer. The general and athletic populations are both heterogenous groups of people, each with different needs and individual risk factors. Nevertheless, certain exercises such as the crunch may indeed be harmful to select individuals with certain medical conditions (past or current) or risk profile. Moreover, crunches may potentially increase one's risk for injury to the lumbar spine because of the nature of repetitive flexion, rises in lumbar intradiscal pressure and ensuing muscle imbalances that may occur as a result of a biased exercise program. Lastly, crunches performed incorrectly may be responsible for injuries of the lumbar, thoracic, or cervical spine.

There are medical conditions that would be a concern with respect to performing the crunch. Several conditions come to mind (e.g., diastasis recti, osteoporosis [due to risk of compression fracture (21)], and various hernia subtypes); however, the focus of this column will be primarily on pathology of the lumbar spine intervertebral disc, hereafter referred to as "disc pathology." Although various subtypes of disc pathology exist, intervertebral disc herniations (posterior, central, and posterolateral) and tears of the posterior annulus are the primary concern. The reasoning for this concern is fairly straight forward with respect to the clinical and biomechanical evidence. From a clinical research perspective, there is no question the nucleus pulposus (NP) (center of intervertebral disc) moves in response to loading and that flexion movement or positions (traditional crunches are strictly flexion-biased movement) of the lumbar spine induce a posterior-directed movement of the NP in vivo (1,3,4,7,9,10,14). In addition to the pattern of nucleus movements identified among human subjects (in vivo), in vitro evidence suggests flexion is associated with a posterior migration of the NP, as well (11,15,20). The concern over influencing posterior-directed movement of the NP resides in the fact that symptomatic disc herniations are primarily the result of posterior-induced migration of the NP (6). It would be erroneous to assume that everyone who does an abdominal crunch will develop disc pathology. However, those with previously diagnosed disc pathology or concurrent low back pain may indeed be at risk for recurrence or exacerbation. Moreover, positions or movements that require flexion, and those requiring abdominal activation, have been shown to produce a rise in lumbar intradiscal pressure (18,19). Specific to the crunch (supine crooklying position with contraction of abdominals to a limited range), evidence suggests that an intradiscal pressure increase ranging from 40-108% may occur (19). Increases in pressure combined with a flexion-biased movement would seemingly present a cumulative risk.

In addition to biomechanical evidence, there is a considerable body of evidence that has linked specific movements or positions to worsening a symptomatic disc herniation. Invariably flexion-biased activities are often the source (6,23). Moreover, evidence suggests that individuals who have a condition associated with worsening from flexion movements will have a poor outcome and experience worsening of symptoms with activities that focus on repeated flexion (17). Furthermore, evidence has been consistent citing a worsening of one's clinical presentation with repeated flexion when a confirmed disc pathology is present, based on the diagnostic gold standard of discography (6,23). Thus, it seems reasonable that a crunch, despite having limited flexion when compared with a traditional sit-up, would worsen symptoms arising from disc pathology. Although there are no studies specifically implicating abdominal crunches as an etiological cause of a specific person's disc herniation, an absence of evidence does not imply an evidence of absence. For example, a systematic review published in 2003 concluded that there is no evidence to support the use of parachutes for preventing mortality during free-fall from a plane (22). Should we abandon the use of parachutes in the lay population? Given standards of research and subject protection, most would agree that a study designed to determine whether indeed a particular exercise could "herniate" a disc would be unethical.

Last, the abdominal crunch may perpetuate trunk muscle imbalances associated with and predictive of low back pain. Evidence, that is, both prospective and retrospective has shown that imbalances of the flexor-to-extensor ratio in the trunk is a risk factor for low back pain (2,13,16). Specifically, when the flexor strength dominates the extensors, individuals are more likely to develop low back

pain (11). Moreover, individuals with low back pain often have existing imbalances beyond that of asymptomatic person's, further suggesting risk (13). In addition, evidence has suggested that individuals who are athletic or perform routine resistance training present similar muscle imbalances favoring the flexors when compared with extensors (5,8,12). These imbalances, however, must be interpreted with caution as the performance of abdominal crunches alone cannot be tied to these imbalances and most of the studies have not presented details with regard to training patterns. One may consider the possibility, albeit theoretical, that trained individuals may develop a remodeling response that would afford their disc tissue a certain remodeling response to the stresses of a crunch, offering a degree of protection. Nevertheless, if an imbalance exists, performing abdominal crunches in the absence of balanced extensor training would seemingly perpetuate one's risk. Thus, the solution resides in a balanced training program as opposed to avoiding exercises such as the crunch.

With regard to specific recommendations, a rule of avoiding crunches is not supported by the evidence. Certainly among individuals with a current or history of disc pathology, these exercises would be considered a precaution and left to the decision of a healthcare practitioner. Evidence does support the position that sustained or repeated flexion is likely to cause a worsening of symptoms among individuals with a symptomatic lumbar disc herniation, as a result of intradiscal pressure increases and the nature of repeated flexion (6,18,19,23). Assuming there are no precautions to performing abdominal crunches, a balanced exercise program that includes both strengthening of the spinal flexors and spinal extensors would seemingly mitigate injury risk from muscle imbalances and subject the spine to more balanced forces. However, this recommendation may generate the question of whether extension exercises are safe and effective.

Conflicts of Interest and Source of Funding: The authors report no conflicts of interest and no source of funding.

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