Super Stiffness

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At a gymnastics or martial arts meet, or at a weightlifting competition, listen to the coaches advice to the athlete – Stay tight! This means to maintain stiffness. Being stiff ensures that there will be minimal energy losses as forces are transmitted through the linkages. Optimal performance requires stability, and stability results from stiffness. Stiffness in the body results from muscular co-contraction. Be stiff, and be compliant. Knowing the difference and when to be one or the other is a major way to improving performance.

When a muscle contracts, it creates both force and stiffness. Force creates joint torque to support postures and create movement – but sometimes the force will enhance joint stability and sometimes it will compromise stability. It depends on the magnitude of the force and its relative magnitude relative to all other muscle forces acting at the joint. In contrast, muscle stiffness is always stabilizing. A stiff muscle buttresses against perturbations from all directions. Stiffness at one joint buttresses the development of explosive power at another. Stiffness is also enhanced by positional techniques of the body segment linkage where one segment can be stiffened against another – for example, stiffening an arm against the torso.

When all muscles at a joint stiffen together a “super stiffness” phenomenon generally occurs. The total stiffness at a joint suddenly becomes more than the sum of individual muscle stiffnesses. Consider the abdominal wall in creating “core stability”. Rectus abdominis, external and internal oblique and transverse abdominis appear to bind together when all are active to create a super stiffness higher than the sum of each individual muscle. For those activities that demand high core or torso stability, all muscles must be activated – never isolate one. Furthermore, as will be shown later, high performance in athletics requires rapid muscle activation onset and force development, together with equally rapid reduction of muscle force. Super stiffness needs only to occur briefly in such cases, but if it needs to be brief, the motor control system must be highly tuned to ensure optimal super stiffness.

Consider a lifter in competition. The core must be extraordinarily stiff to minimize energy losses and ensure that the torso will not buckle. Super stiffness is required with all muscles contributing. Some individuals have recently begun to advocate “drawing in” the abdominal wall during the exertion – this is ill founded. Not only does super stiffness and stability demand all muscles to be stiffened but they must be maintained at a distance from the spine. Sailboats with masts needing stability achieve this with rigid spreaders of the guy wires or rigging. Vasily Alexeyev achieved the spreading of the muscles to enhance stability with girth. In contrast to the manoeuver of abdominal hollowing (not recommended), try performing the abdominal brace. Here is how to begin teaching the

brace. Begin by standing in a relaxed upright standing posture with sufficient erectness so that the torso extensors are inactive – palpate them to be sure. Then contract the entire abdominal wall and feel the back musculature contract. This is the brace – all muscles around the torso stiffen to ensure stability. Now the focus is on matching the intensity of the contraction to the stability demand of the task. Interestingly enough, stiffness and stability is an asymptotic function – in other words a lot of stability is achieved in the first 25% of the maximum contraction level. Thus 100% muscle contraction levels are rarely needed – the trick is to activate many muscles to achieve symmetric stiffness around a joint.

As a professor and consultant I see too many people who succumb to bad backs during the effort to increase fitness. No wonder. Building true strength and function is elusive for many following the traditional American approach dominated by body building concepts. Of all the variables required for optimal performance, building muscle strength is the easiest component to enhance with training. Far more difficult is the enhancement of the foundation components of healthy motion and motor patterns, joint stability and endurance. And only then with this foundation can serious strength with speed and power be developed.

The Ultimate Approach

Our work on back fitness and injury mechanisms over the years has led to the development of a 5 stage program documented in my textbook "Ultimate Back Fitness and Performance". Briefly, building the ultimate back requires core stability and follows a 5 stage process that ensures a foundation for eventual strength, speed and power training. The stages are:

Stage 1. Groove motion patterns, motor patterns with corrective exercise
- basic movement patterns through to complex activity specific patterns
- basic balance challenges through to complex balance specific environments

Stage 2. Build whole body and joint stability (with super stiffness)
- build stiffness and stability while sparing the joints
- ensure sufficient stability commensurate for the demands of the task

Stage 3. Increase endurance
- basic endurance training to build the foundation for eventual strength
- activity specific endurance (duration, intensity)

Stage 4. Build strength
- spare the joints while maximizing neuromuscular compartment challenge
- speed strength and multi-articular functional strength
- optimal timing and "steering" of strength

Stage 5. Develop power, agility

- develop ultimate performance with the foundation laid in stages 1-4
- blend compliance with stiffness

Overlay for all stages: The position of performance
The balance environment

Short range stiffness, super stiffness and performance

The abdominals form an interesting illustrative study. They are not designed for great length change. Consider the rectus abdominis that has transverse tendons interrupting the series arrangement of sarcomeres. This is to transmit significant hoop stresses, developed in the abdominal wall, transversely through rectus so that it is not ripped apart. The key is to realize that the rectus muscle is designed to develop short range stiffness. Trying to train the muscle by performing curl ups over a gym ball misses the point of its function. Top boxers, martial artists and weight lifters, know how to train the muscle group for short range stiffness. Plyometric training of the group with medicine ball catches and throws, ballistic short range, and rapid contractions are techniques to optimize the storage and recovery of elastic energy potential. Read "The Naked Warrior" by Pavel, to see the tests and training for super stiffness in sustained contractions – his technique of using a stick looking for "soft areas" when performing a pushup is an excellent example.

Super stiffness is used by the best football hitters, golfers, martial artists and weightlifters. Consider the hit in football where maximum speed of approach requires the combination of sufficient stiffness and compliance. But at the instant of impact a total body stiffness is generated by rapid contraction of all muscles. This is what makes the impact so devastating by some. Breaking the board by the martial artist requires the skill of compliance to build speed with rapid super stiffness just at impact. The axeman splitting wood uses the same technique. The professional golfer who has a relaxed backswing but rapidly obtains super stiffness at ball impact is the one who achieves the long ball. The one who tries to swing too hard too soon actually decreases speed of movement. Muhammad Ali, Bruce Lee, Vasily Alexeyev, all knew the secret of Super stiffness. Understand the relationship between speed, compliance and stiffness and you will be achieving ultimate performance.

Source

McGill, S.M., Ultimate back fitness and performance, Wabuno publishers, 2004. Available from www.backfitpro.com

About the Author

Stuart McGill is a Professor of Spine Biomechanics and is the Chair of the Department of Kinesiology at the University of Waterloo in Canada. He has been the author of over 200 scientific journal papers that address the issues of low back function, injury prevention and rehabilitation, and performance training. Collectively this work has received numerous scientific awards. He sits on the editorial boards of the journals SPINE, Clinical Biomechanics, and Journal of Applied Biomechanics. As a consultant, he has

provided expertise on assessment and reduction of the risk of low back injury to various government agencies, many corporations and legal firms and professional/international athletes and teams from many countries. In addition to seeing patients sent for consult, he teaches clinical courses regularly around the world. His other textbook was entitled “Low Back Disorders: Evidence Based Prevention and Rehabilitation” published by Human Kinetics.