9) STRENGTH TRAINING AND ENDURANCE PERFORMANCE

In endurance performance, we are limited by weak links in the physiological system. Making an already strong link stronger doesn't keep a chain from breaking if you still have the same weak link. Throughout the MAPP, I have repeatedly discussed maximal oxygen consumption, lactate threshold and efficiency of movement as major components of any endurance performance. We have talked about the heart and how it responds to training. We have discussed the skeletal muscles and their primary adaptations. Now I want to think out-loud a little bit about how, or IF strength training fits into the endurance athlete's training program.

First let's define strength training. For the endurance athlete, I will call any exercise that is designed to increase the size and/or maximal strength of a muscle or group of muscles strength training. Many endurance athletes are lifting weights 2 to 3 times per week and swear by it. Others never lift a weight and excel.

Second, let's make sure we understand that strength training for health versus strength training for enhanced performance are two different beasts. I think there are excellent reasons to strength train for health. As we age (especially beyond 50 or so) our bodies tend to lose muscle mass. Retarding this change is definitely beneficial. Maintained or increased muscle mass helps to prevent body fat accumulation, maintain functional mobility, decrease risk of adult onset diabetes etc. From here out I am speaking only about PERFORMANCE!

Big Versus Little - Muscles in Isolation

Let's say that we remove a biceps muscles from two different endurance trained rowers. One muscle is 50% bigger than the other (cross-sectional area). We hook up these muscles to an artificial machine and perform a test (I know this is gross but it is just a hypothetical situation. We would never do this to well trained rowers!) Which muscle will be able to perform more work in a 6 minute all out test? Well, the bigger one will, of course. That is, assuming that both muscles are well adapted to repetitive work (lots of mitochondria) and both are receiving plenty of oxygen. So if all other things are equal, the big muscle outperforms the small muscle.

Big versus Little - Muscles as part of a Package

If we extend the above situation to say a big body builder and a skinny guy like me, does the bodybuilder win? Probably not (I hope not at least). Why? Because now the rules have changed, or I should say the performance limitations have changed. In the isolated muscle above I said that the muscles were 1) equally endurance trained and 2) supplied with unlimited oxygen. When we put the muscles back inside a real body, neither of these conditions are true.

Mitochondrial Dilution

When a bodybuilder trains, the goal is to make each muscle fiber as big as possible. Muscle fibers have contractile protein, mitochondrial protein, and other components. Increasing the relative proportion of one component (like more contractile protein) means that you have relatively less of everything else in the same fiber (like mitochondria). From an endurance standpoint this is not a good adaptation. We even give it a name in sports physiology circles, mitochondrial dilution. The bodybuilder's muscles may actually become more easily fatigued as they get bigger, because their mitochondrial density is not increasing at the same rate. The bodybuilder accepts that because the name of the game is size, not endurance.

It is possible for the endurance athlete to gain some muscle size and maintain mitochondrial density, but it requires that the volume of endurance training be maintained. If you are a runner and you decide to get stronger in the weight room by really doing a lot of strength training 3 days a week for an hour, you will probably drop some of your running volume to fit it in. After 6 months you have gained 5-10 pounds of muscle, you look really good, and you are running 2 minutes slower for 10k! Why? Well besides having to carry around 5-10 more pounds of muscle that you can't use when you are running, you have probably lost endurance capacity in those bigger stronger quads. So, you have a lower lactate threshold due to the detraining of your leg muscles, plus you are less efficient due to the increased bodyweight (and decreased training volume). Oh well, at least you LOOK Fast.

But I have read that strength training helps endurance performance !?

It can, definitely. But we have to look at the reasons more carefully. For example, perhaps you are a runner who has had a hip injury that lingered and lingered. Over time your running style accommodated and now you run with a

"seated" style and do not employ your hip extensors effectively. A weight training program employing highly specific exercises designed to teach you to activate your hip extensors, as well as strengthen them, can make you more efficient by improving work distribution in the leg muscles, and therefore faster runner. A lot of this change may be due to improved motor function as much as increased muscle mass. Specific strength training can help us to teach our brain to communicate with the right muscles. The same is true of the rower with the weak low back. Strengthening this area can correct the weak link and allow optimal connection between force generators and the oar. However, the concept that just making muscles bigger and stronger will automatically translate to faster endurance performance is Wrong!

Oh yea, What about Oxygen?

Remember VO2 max? What is the major limitation to VO2 max? Right, the maximum capacity of the heart to pump blood and deliver oxygen to the muscles. Anytime we are doing an activity that uses a lot of muscle (running, rowing, XC skiing, mountain biking), the challenge falls on the heart to match oxygen supply with the demand. Even in the world champion, the heart is incapable of pumping as much blood as the muscles could receive.

Consequently, adding muscle mass will not result in increased maximal oxygen consumption. The heart is already being asked to do all it can do. Your endurance machine is a set of highly integrated components. You have to look at how all the pieces fit together to produce the final product.

Learning from the Para-Olympians

Now having said all of that, here is a thought question for you. Watch an elite marathoner run across the finish line. He or she raises toothpick size arms into the air in victory and jogs off on those skinny but brilliant legs. No excess muscle there. Just the right amount to get the job done.

Now take a look at another marathon race, this time the wheelchair race for para-athletes. The winner rolls across the line with a final push of the arms, raises them in victory and you are caught staring at one impressively muscular set of pythons! Is this the marathon or the bench press? What gives? For the wheelchair endurance athlete, muscle mass is an important part of the package. The reason for this apparent contradiction in everything I have said goes back to the HEART.

The wheelchair racer is depending on a much smaller total volume of muscle to do the work of the marathon race. The total volume of muscle is small enough that the heart is no longer the limiting factor! So, in this situation, gaining muscle mass in combination with endurance training results in a more powerful endurance engine. In fact, these unique conditions may result in a greater hypertrophic response to endurance training independent of supplemental strength training in a weight-room

Applying the Lesson

This example above came to me in a strange way. I got a message from an Australian who was familiar with the lifeguard boat races down under. He said these guys had bigger upper bodies than "regular" rowers and were very strong, but not quite as good on the ergometer. I had to think about that a bit to decide what it meant. Then I remembered "They don't have a sliding seat!" Which means of course that the legs are taken out of the game and rowing becomes an upper-body only sport. Hence the bigger upper body just like the wheel chair athletes. So, as I thought about that while driving up to Lillehammer for my first mountain bike race, the wheel chair scenario hit me, and I understood things better. I was pretty excited!

Now what can we learn from this? If you are in a sport like kayaking that is a small muscle mass endurance sport, then strength training plays an very important role because it helps to increase the size of your endurance machine. If you are a runner, then you will not benefit from the same volume of strength training and may actually lose speed. Running already employs a large mass of muscle that can work at a level that exceeds the oxygen delivery capacity of the heart.

Now, if you are a cross country skier, you have a unique situation. Your sport often requires that you use a lot of muscle simultaneously, making the heart the limiting factor and excess muscle mass wasteful. However, when you are double poling, the conditions change and the mass of endurance-trained upper body mass that you can engage becomes very important. Double poling is efficient and important in ski racing. So for the skier, strength training is far more important for the upper body than for the lower body. And for women, it is even more critical. The reason is that women start with a bigger gap between upper and lower body strength then men. Here in Norway, the elite junior women invest a lot of energy doing things like uphill double poling to strength train the upper-body in a highly specific way. They have much to gain by strength training.

If you are a rower, I am not sure what to tell you exactly. Increased upper body strength may allow better work distribution and therefore slightly improved rowing economy but I don't know that for sure. The act of rowing training already improves the rower's ability to generate force with both legs simultaneously compared to untrained people. Much of the rowers strength depends on coordination, not just muscle mass. Rowing has a mixed tradition when it comes to strength training. Some great programs do a lot, others do none. So the jury is still out. More on all this when I can be more definitive.