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PRESENTS THE COACHING SERIES…

"A PANE IN THE GLASS"

The Physicist, the Exercise Physiologist and the Coach

I get email messages from athletes, instructors and coaches from all over the curling world. It's one of the great joys to be able to respond, as best I'm able, to the questions that are sent my way. One such email came from a coach in la belle province, who is also a physicist and it was copied to a friend and colleague who is an exercise physiologist (and curler) who works with athletes in our sport at all levels but specializes in working with our most elite.

I responded to that first email from a coaching perspective and the exercise physiologist did the same from his. Two things became abundantly clear at that point. First, I was not the expert in this matter and that led to my second epiphany, stay out of the way and let the experts continue the dialogue.

I felt their replies to one another were so outstanding, I asked them if they'd allow me to share them with you. Obviously they said "yes" and did so without reservation. The ideas expressed here are not intended to be definitive in nature. They are presented based upon experience and expertise but more to open a dialogue. We do not know where this will go but I encourage interested readers to contact the three of us with more questions or data relevant to the topic. But first, some introductions are in order.

The "physicist" is ***Jerome Gazdewich*** *(jgaz@videotron.ca). He is originally from Saskatchewan, where he started curling well over 30 years ago, and now resides in Quebec, where he obtained a Level III Coaching Certification for curling. He has a Bachelor's Degree in Engineering Physics, with Great Distinction, from the University of Saskatchewan, a Masters Degree in Engineering Physics, from McMaster University, specializing in lasers and optical communications, and an MBA from Concordia University. Professionally, he has over 19 years of experience in aerospace and high tech., in engineering and management positions, working mostly on space related programs.*
Currently Jerome's main curling interest and concentration is on high performance coaching. In particular he finds aspects such as the physics of curling, development of strategy & tactics, and team dynamics to have many synergies with his professional background in engineering physics, program management, and strategic management.

The "exercise physiologist" is ***Bob Comartin*** *(comartin@shaw.ca). Bob is a Registered Kinesiologist - BCAK and a Certified Strength and Conditioning Specialist – NSCA. He has spent a considerable amount of time studying Sports Medicine. Bob has a Bachelor of Human Kinetics, Honours Kinesiology, University of Windsor, 2 years as Assistant Athletic Therapist and Strength Coach with the BC Lions Football Team , 10 years with West Coast Kinesiology working as a rehab consultant and as Director of Sport Science Programs. Bob is currently the Lead Strength & Conditioning Specialist for the Canadian Curling Association as well as Curl BC and the Senior Sports and Fitness Leader with the City of Port Coquitlam.*

He is actively involved in helping athletes plan, prepare, and persist through their training with education and the use of sound sport science and sport medicine principles.
Bob is a level 2 badminton coach and former Ontario provincial finalist in men's doubles and a competitive amateur golfer having played the AGT tour in British Columbia and Washington.
He enjoys playing badminton, golf, volleyball, running, weight lifting, and curling as well as anything his daughter wants to play.

On your behalf I want to thank Jerome and Bob for allowing us to "look in" on a fascinating dialogue.

Enjoy (but you may wish to have a scientific dictionary close by)!

BT

Hi Bob/Bill,

I've been recently combining my interests in curling, coaching, and physics to do some analysis of the physics of curling. In this regard, I'm sending you this note to ask for your comment and input pertaining to some issues involving the delivery. I hope you will find it of interest – any feedback you can give me would be greatly appreciated.

Cheers
Jerome Gazdewich

Bob/Bill,

As an interested disciple of curling, I've been putting some time into an analysis of the "physics of curling". A key aspect of any such investigation is an analysis of the delivery. Although I firmly believe, as Bill has pointed out in the past, that there is no one perfect or correct delivery, my intent is more an improved understanding than to achieve the perfect delivery.

One of my guiding tenets in a delivery is to keep it as simple as possible, thus minimizing all motion that isn't absolutely necessary. Personally I've changed my delivery a number of years ago for this reason, modeling it at the time after David Nedohin, yet personalizing some aspects. In doing so I've eliminated the lift and backswing altogether, going only to a small backswing for peel weight. Perquisite to this delivery is a strong drive from the hack leg and a good arm extension and release.

With this in mind, I've been looking at a more rigorous analysis of this delivery. A number of questions are immediately evident (which is why I've decided to contact you):

1. What is the available energy in the "drive or push" leg when simply pushing out of the hack from the stance position (i.e. with no backswing)? Note that I am making a clear distinction between a no-lift delivery (i.e. the rock is not lifted off the ice) and a no-backswing (or b/s) delivery where the body/hips are not significantly raised and moved backwards behind the hack (i.e. "parked") usually accompanied by a step-back with the slide foot.
2. What is the actual physical effect of employing a backswing (as described above)?

To explore the first question I've run the following tests, to which I'd like your comment. I've made an assumption, from a body kinematics perspective, that a simple jump test from the stance position would provide me with a reasonable measure of the potential energy that is stored (or realizable) from the drive leg. Using my junior girl's team as test subjects, I had them start in a stance position (as if in the hack at the start of their normal delivery) and

then jump as high as possible pushing only with their drive leg, and recorded the height of the jump. A measure of the potential energy is obtained by multiplying this number by their mass, or weight (no simple feat getting this from teenage girls), and the gravitational constant, g (i.e. 9.81 ms/).

Next, I had them deliver rocks by pushing out of the hack as hard as possible directly from the stance position (i.e. with no backswing) and releasing the rock with no arm motion or release (i.e. rock rotation). By measuring the ensuing rock velocity at release, and correcting for the energy lost in their slide, I was able to calculate/estimate the velocity of them and rock as they pushed out of the hack. From this number, and knowing their mass and rock mass, I can calculate the kinetic energy in the delivery.

By comparing the kinetic energy of the delivery with the potential energy of the jump test I am attempting to get a feeling for how much energy can be realized from the drive leg. The intent of these measurements is to answer the following questions:

i. Is there enough energy in the leg for a no-b/s delivery to comfortably and consistently throw up to take-out weight;
ii. If the answer to (i) is reasonably yes, then can the jump test represent a reasonable and quantifiable training tool to measure leg strength.

So Bob, from a pure body kinematics point of view, do you feel that the jump test as I described, reasonably represents the energy state of the drive leg in the stance at the start of the delivery?

I would describe my initial tests as preliminary and therefore somewhat rough (i.e. there is potential to increase their precision with some additional effort). But, averaging both a number of jump tests and deliveries, with delivery measurements taken on two separate days, I obtained kinetic energy to potential energy ratios (KE/PE) for three of the four test subjects (i.e. 5 test points) in the range of 70% to 80%. For one of the girls (i.e. two test points) the ratios were 62% and 67%, but she is known to have a weaker push than the others and so this result is not unexpected.

These tests also highlighted the importance of the drag during the slide. By extending the slide to the hogline before release they were generally unable to deliver normal take-out weight. However, by releasing at the T-line, this was generally not a problem (hence the importance of getting accurate slide drag measurements in determining energy).

This result suggests that for a competitive athlete (if not always for the recreational curler) with decent leg strength, an optimum release point, and a good arm extension, a no-b/s delivery is a realistic option (I know it works for me and Nedohin).

I believe the answer to the second question is really one of a more detailed analysis of body kinematics in the "park" (i.e. at the brief pause at the top of the backswing at the transition to the forward swing or the "park") position.

Some have suggested that such a backswing provides a mechanism to generate extra weight by using the "falling motion" of the body to add forward momentum to the rock. In other words, the weight of the falling body from the park into the "bottom-out" position adds energy to the delivery. I believe that such an effect is minimal at best and that the main benefit of the forward fall is in the timing of the delivery. I am not aware of any measurements or analysis that shows this one way or the other. Rather, I suspect that the main "weight generation" benefit (as there most certainly is one) is that the "park" position essentially "pre-tenses" the drive leg thus increasing the amount of potential energy realizable from the leg, or if not, then increases the amount of energy that can be realized (eg. from 70% or 80% to some greater number) although how this would be possible is not evident, so I would assume the former. Another benefit may be that it gets the body in a better position to apply maximum push against the hack (in

a similar fashion I think that performing a kinematic or force/joint analysis will show that having the toe higher in the hack, or at least off the bottom of the hack, puts the body in a position to get a better push off the hack hence realizing more potential energy stored in the leg).

Another question is the weight transfer between the slide foot and the hack foot that is often taught. Outside of accentuating the "falling forward motion", I don't see any useful purpose to this motion, again, unless it pre-tenses the drive leg in some manner so as to increase the energy available at the point of maximum push, essentially making the push out of the hack more of an impulsive motion rather than a continuous motion. If fact, I believe that transferring weight in the park position between feet results in lateral motion of the COG (body center-of-gravity) which contributes to the common lateral rock motion (or "bulge") at the start of the forward swing. I believe that it is better to keep the COG well centered with a fairly even weight distribution between the slide and hack feet. This of course is not an issue at all in the no-backswing delivery.

If this is true (i.e. the parking motion simply pre-tenses the drive leg) then, this "extra potential energy" is accessed through the "pulling" motion at the start of the forward swing, as described by Bill in APIG #18. If this is not done and the athlete pauses as the COG passes over the hack, then the pre-tense is lost as the leg muscles relax.

These energy analyses also illustrate two other points worth noting. First, the potential energy created by the raising of the body COG (i.e. upward movement of the hips) is essentially the same for both the lift and the no-lift delivery. The issue is one of translation of this potential into forward motion, or simply take-up in the leg as the body drops. I would contend that essentially all (but not necessarily all) forward motion is a result of leg drive in the no-lift delivery.

Secondly, the kinetic energy imparted to the rock represents only about 20-33% of the kinetic energy generated in the delivery. In other words, most of the work goes into accelerating the body. A simple analysis shows that in a lift delivery swinging the rock one foot off the ice and releasing it without pushing out of the hack should provide enough kinetic energy to the rock to put it through the house (i.e. release velocity ~2.5m/s). Therefore in a lift delivery, leg drive still needs to do most of the work to accelerate the body out of the hack. Only another 20-30% is needed in the no-lift delivery to get the same results.

This illustrates the importance of drag during the slide. Obviously, less drag means less energy is required in the delivery for a specific release point. Also, obviously, drag, or low energy deliveries, can be compensated for via an optimum release point. This also points out that release point can be used as an adjustment for weight control. Although I believe this is rarely done, it is certainly an option for adjustments from draw to take-outs or peels for some curlers. I have made drag and rock friction measurements, but I'll save that for another time. These measurements permit release points to be calculated for specific rock velocities.

A third issue, which I'll also save for another day, is the potential energy available from the arm extension and forward wrist motion accessible in the follow through. I suspect that these mechanisms provide an adequate complement/supplement to the no-lift, no-backswing delivery, for a competitive curler. In fact, the delivery is all about energy management.

I apologize if I've been long-winded here, so let me summarize my questions to you Bob:

1. Does the jump test represent a reasonable measure of energy available (i.e. translatable to kinetic energy in the rock and sliding athlete) to the delivery in a no-lift, no-backswing (i.e. push from stance) delivery;
2. Is the effect of the "park" position in the no-lift, backswing delivery really one of pre-tensing the drive leg so as to provide for an increased push over that available or accessible in the no-lift, no-backswing delivery.

In other words what are the body kinetics involved here? If the answer to (1) is no, then can you suggest a more appropriate test?

Any and all comments you can provide would be greatly appreciated.

Thanks
Jerome

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Jerome and Bob,

Wow, I was most impressed with your informed view on this subject. I think we'd make a great team, the physicist, the exercise physiologist and the fly-by-the-seat-of-your-pants participant observer! I don't mean to be flippant in that sentence as I try as much as possible when I work with coaches, instructors and athletes to have the "sports science" to back up what I espouse.

I like role playing as a way of illustrating various teaching points. In clinics, I frequently ask the assembled participants to place a paper cup or facsimile on the near pin. I then challenge them to slide so that "the natural momentum of the slide" is just enough to allow the sliding foot to come to rest at the cup, no more, no less. That's all the instruction I provide. Before they attempt the challenge, I make only one restriction. They must use the correct hack given the sliding foot. From there, they can be as creative as they wish. Most of the athletes assume the traditional hack position with its prerequisite body movements, all of which are not intended for an 11 ft. slide. The result is that the vast majority of the attendees to the clinic fail on their initial attempts (i.e. they exert too much power). I use this challenge for a variety of reasons not the least of which is that it gets them out of what I call "automatic pilot". They have to "think" about the sources of power but not from a maximum perspective but rather from a minimum perspective. It's fun to watch them think about how to slide just 11 ft.!

When they've made many attempts at that challenge, I ask them to place the paper cup, on the center line still, but at the top of the house. The challenge now is to "add" just six feet to the slide, not five or seven. By this time, success usually comes more readily but when I call the group to me, I ask for volunteers to "describe" how they added just 6 ft. but I place a restriction on the explanations. They are not allowed to use the term "leg drive". They have to express their answer in a different way. What I want them to do is start to think like a Jerome or Bob and not a Bill! Now, here's the role playing. I ask for a volunteer. I position him/her beside me and announce to the group that I'm going to use my fist to strike the volunteer at the top of the arm (i.e. shoulder as I stand to their side). I "ham" this up as with arm fully extended against the volunteer's shoulder, I ask them if they're worried. Of course they are not as I have "no power" since my arm is fully extended therefore there is "zero" potential (kinetic) energy. Then I fully flex to build up as much of that potential energy as possible. At that point, I tell my "volunteer" that I'm following through on my promise to hit the shoulder with my fist. Of course I extend extremely slowly so that the result is a "tap" on the shoulder.

Obviously I'm attempting to illustrate that power and the control of it can come from various sources. I then ask the rhetorical question to the group, "To add just 6 ft., do you build up more potential energy by increasing the amount of flex in your hack leg? Or do you use the same amount of flex but extend more quickly OR is it a combination of the two?" And herein lies my teaching point. I can't tell an athlete how he/she controls velocity of the body, but I'll help make them aware of the possibilities and provide them with the opportunities to discover it!

I complete the challenge by progressively moving the paper cup further toward the hog line. I change lines of delivery and go into all that that entails and finally I ask the athlete to close his/her eyes in the attempt (which of course brings visualization and imagery into play).

I really encourage athletes, as you both have pointed out, to NOT put the toe of the hack foot onto the bottom of the hack but to keep it on the sloped portion.

When I work with recreational curlers, inevitably the question of power and its sources is raised. I have attached an article that I'll update for "A Pane in the Glass" very soon which identifies eight sources of power ("You Have the Power"). I make the point with the curlers that most athletes use two or three of the eight and if they feel they need more power (i.e. peel weight) that might be better served by adding an additional power source than by trying to get more out of the ones they current employ.

It's late and I'm packing for that "Purple Heart Bonspiel" in Winnipeg so I'm out. I hope this helps and let's continue this discussion!

Bill

Hi Bill,

Thanks so much for getting back to me with this so quickly, you make a lot of good points! Perhaps we do make a good team, but I think your wealth of experience and knowledge can't be over-emphasized!

I like your teaching point with the cup, I'll have to add that to my bag of tricks, if that's ok. It's a great way to get them thinking about weight control and what they're actually doing in the delivery. As you've said in the past weight control is one of the most important, if not the most important, skills for a high performance curler, and I certainly agree.

Also, good article attached, and the references contained there-in. Both Bob and yourself have given me some good stuff to think on. Most definitely I'd like to continue this discussion.

Good luck in Winnipeg!
Jerome

PS: I would certainly be happy to elaborate on any issues raised in this note and of course to engage in a discussion on this topic.

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Hi Jerome,

I'm now in my third year of curling and I have tweaked my own delivery along the way, of course with help from awesome people like Bill. I have a very slight backswing, only for the purpose of "unsticking" the rock thus preventing rock resistance at the start of my delivery. The only time I deviate from this is when I need to deliver hit weight and here's why:

1) The no backswing delivery, primarily, uses hip extension to push from the hack. If a young athlete does not have enough hip extension strength to make the required shot, then something else has to change in order to make that shot. That change will either be the biomechanical position while pushing out of the hack or adjusting their releases like you had mentioned.
2) Hit weight shots require a lot more power and thus a more powerful biomechanical movement is required to generate maximal force in a short period of time. Instead of hip extension it is more like a jump. This is also where the "Myotatic Stretch Reflex" comes to play or what you were referring to as "pretensing". This can just as easily be done in a no-lift delivery. The biomechanics out of the hack of a hit weight shot are similar to a sprinter out of the blocks. There is a much greater forward lean in order to maximize what we call "triple extension" (extension of the hip, knee, and ankle). The goal is to generate as much force against the hack in the shortest time so toes should not touch bottom of hack. The myotatic stretch reflex is activated when a muscle is prestretched and the resulting factor is a reflex action to contract. In fact, the

greater the load or the speed of activation, the quicker the reflex and the greater contraction of the muscle. This is trainable. With strength training as a base, power training (ie plyometrics/jump training) can improve one's muscle physiology.
In ancient Greece, Olympic Broad Jumpers (AKA standing long jumpers) used to hold hand weights in the pre-stretch/loading phase (to increase the myotatic stretch reflex activation) while releasing them during the jump phase.

3) Yes, I do believe the jump test from a stance position represents the energy state or "work" of the drive leg for the delivery. I use a single leg squat test for strength, more from an injury prevention point of view. I believe that a curling athlete should be able to lower themselves to the floor balancing on one leg, and be able to touch the opposite knee to the floor and rise up to the starting standing position.
4) Another issue that I've noticed recently is an increase in knee pain in the drive leg. In a deep knee bend position, anterior soft tissue can compress the patella into the underlying hyaline cartilage. The posterior horns of the medial and lateral meniscus are also compressed. Our new no backswing delivery may be the cause. Just pay attention to this and allow them some rest time if complaints arise. Better yet, make sure they warm up before playing, develop their quadriceps strength, and use ice if sore.

I hope that I answered your questions sufficiently. Which part of this great country are you from?

Yours in Health,

Bob Comartin

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Hi Bob,

Thanks very much for this!

Just to make sure I understand, hip extension refers to the action of pushing out from the hack with the drive leg from the stance (i.e. sitting position). Further, this same hip extension motion is what is mostly used in the jump test, from the sitting/stance position. The Myotatic stretch reflex is activated when adding the backswing (i.e. hips up and back supported by slide foot) motion, hence more energy available from the leg. (Thanks for giving me the technical term – it makes it easier to go research it further.) I really like your description of the motion as more of a jump. In fact, when curlers make this motion too abruptly, usually resulting in the slide foot coming out too fast and either crossing the line of delivery (resulting in drift) or moving it beside the rock (because the foot-rock timing is off), I always refer to it as "jumping out of the hack".

Also, the lean or falling forward is not so much to add momentum but to maximize the triple extension.
Understood. The upside of tapping the myotatic stretch reflex then is the generation of extra energy, but the downside is, because of the greater power (i.e. energy released in a short time) resulting in quicker acceleration of the body, if the alignment is off (due either to bad body positioning in the stance or bad motion of the slide foot coming under the body) all, or most, of the energy gets directed off-target. In simple terms, it's harder to control and/or correct during the slide. Of, course if you have great delivery mechanics, like most elite curlers then this is not an issue. I think also, as you suggest here with the triple extension, the leg drive is not solely due to the thigh muscle, but also to the calves (and partner muscles) through the ankle joint rotation if the foot is positioned high in the hack.

One more question about the hip extension and jump test: does the (KE/PE) ratio of 70-80% (i.e. ratio of delivery energy driving out of the hack to the energy in the jump) sound about right. Obviously where I'm going here is the utility to do a jump test at the start of the off-season training schedule, perform leg strength training, measure

improvements in the jump score, and then translate this to ability for up-weight shots and tweak either the delivery or release point accordingly (or conversely work on reducing drag/friction in the slide – which for many club curlers can simply amount to using a thicker slider or getting that knee off the ice).

Finally, thanks so much for your point (4). I was not aware of this but will keep an eye out for it. Most knee soreness that I've come across is associated with the slide knee. Your comment is quite timely too since at our last practice, and after our last video session, I've been trying to get the girls to sit up straighter in the hack, mostly to get their backs straight and to stop leaning too far forward at the start of the delivery (which can lead to all kinds of bad things). To help them visualize what I wanted them to do I had myself videoed as well (nothing like practicing what you preach). Later upon analyzing the video I was a little amazed to find that when I draw a line down my back (back needs to be straight), a line along my arm holding the rock (straight from the side but not stiff) and a line along the top of the thigh of my slide leg, I got essentially an equilateral triangle. Further to my amazement, when I left the triangle on the computer screen and put up the second video I found my body position fit exactly within the triangle again (not meaning to brag here, but it allowed me to make the point of consistency in the stance). The reason I bring this up is to say that when you are sitting in the hack in your stance such that the top of the thigh of your slide leg is essentially parallel to the ice surface it also increases the angle of your trunk with the thigh of the drive/push leg. Thus is it correct to say then, that you are in much less of a "deep knee bend" position then if you are in (as I say to the girls) a "scrunched forward" position? If this is the case, then there would also be a good safety/health issue here for ensuring a good sit-up straight stance position to keep pressure off the push knee. Or is the "deep knee bend" issue one that manifests itself later in the push with a no-backswing delivery?

Thanks again,
Jerome

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Hi Jerome,

Sorry for the delay in response time. Work, curling, and child-entertaining keeping me busy. I am certainly enjoying this discussion because every time I have an idea I like to go try it out on the ice.

Biomechanically speaking, in the no backswing delivery set up, posture is upright and hack toe is even with slider heel. The knee angle of the drive leg is lower compared to the knee angle of the sliding leg. Even with a slight lift, the drive-leg knee angle is still less than 90 degrees. (A joint/muscles at it's end ranges of motion are at its weakest points.) As you begin the forward movement, on a draw weight shot, the quadriceps act more to stabilize our height than to propel us forward. If it were to act as a prime mover then the body would be forced upwards instead of forwards. Only when the thigh of the drive-leg is near-perpendicular to the ice will the quadriceps act as a prime mover for horizontal displacement. However, in that position the gluteus maximus will take over, so-to-speak, and hip extension would be the main source of power. So, knee extension is not a great influence in forward motion, but rather carries/stabilizes the body through the start of the forward motion then simply extends as the gluteus maximus exerts force through hip extension in order to move forward. In delicate shots, I do believe we all have a large enough gluteus maximus to throw the weight needed...but please don't tell your young girls they have large gluteus maximii.

If throwing huge weight is "the call" then the quadriceps will need to be called upon to provide power rather than just stability/strength. The spine will need to be in a neutral power position, as well as the hip, knee, and ankle, just like a horizontal jump (triple extension). Try this right now...get out of your chair, put your feet in a balanced position, and get ready to jump in the air...but when you get to the bottom position (just when the myotatic stretch reflex is activated) STOP!! Notice the angle of the ankle, knee, and hip, as well as the posture of the spine. That is the position that generates maximal power or what we call in any sport "the power position".

From an injury-prevention perspective, there is a lot of strain on the drive-leg knee because at a low angle, the quadriceps have poor leverage on its ability to control knee extension in that position. But we are asking it to do just that, which is another reason why I like the single leg squat test. While balancing on one leg, if they cannot touch their non-balancing knee to the floor, in control, then they do not have the strength/stability to hold their body weight in a low squat position in and out of the hack. This low squat position in the hack puts the knee in a loaded forward flexion position. This is a position that trainers and physios will often recommend that someone never goes into. However, if someone strength-trains effectively throughout the changing seasons, warms up before heading into the sport environment, cools down afterwards, ices if needed, and uses hot/cold treatments and other recovery tools in spiels, then it is much more unlikely that they will have any problems with this.

Sport is about competing and we strive to stay healthy to keep on competing. All sports have injuries due to the demands of the sport. That's why it's not called "fitness". Fitness is what we do to keep healthy in order to keep on competing.

So Bill, I have to ask you a favour, "Can you change a line in your "You Have the Power" article? Under "Leg Drive" you make the comment "Note to seniors: in the off season, concentrate on strengthening your legs. It's one of the first things to go as we age and with some "care and feeding" those legs can remain strong! "We need all athletes, not just seniors to strengthen their legs.

Strength is a precursor to power. I would recommend that you use the early part of the non-competitive season to build strength and the later part of the non-competitive season to build power.

As far as your question comparing (KE/PE) or available energy, I would guess that you could make that relationship. The only thing that might affect your test results upon retesting is the learned factors (improved coordination in the jump test), i.e. the girls are very familiar with throwing take-outs but might not be so familiar with the vertical jump test. Once they become familiar with the jump test, they may show greater values due to improved coordination, but not make the same improvements in the other test. Just a thought....

I have mentioned some training ideas for on-ice activity in the past but have never really heard it put to use. What might be interesting in the early competitive season (late summer/early September) is to start a graduated take out simulation exercise by having the athlete hold one rock in each hand. Then try a rock in each hand with another in front of them, etc... In-the-hack training against resistance is a great way to improve power in a sport-specific setting. As long as the delivery mechanics are not compromised, it should be a great on-ice training tool for power.

Well, time to get moving on with my day.

Bob

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Hi Bob,

Again, thanks a bunch for this. I think I've got a much better understanding now of what's happening biomechanically during the delivery, especially as regards what the quad is doing. I've lately been hearing much talk of the 2 step delivery vs the 3 step delivery. It seems to me that the 2 step, which is being advocated more for draw shots, utilizes primarily the hip extension for power/energy, while the 3 step is advocated for the up-weight shots, employing more of a backswing and thus tapping the Myotatic stretch reflex. To use similar terminology, my delivery which I described in an earlier email, would be a 1 step (i.e. the 2 step without the hip lift at the start), although I approach the 2 step as I need to up my weight.

I think this understanding of the delivery really underscores the importance of training and conditioning and this will help me with my athletes - not only in the sense of training the power muscles, but also with respect to how the knees are affected.

When planning out the jump test, I put a lot of thought into what the proper start position should be (i.e. from a standing position allowing the athlete to bend down and then jump as high as possible, or to start from the squat

position as if in the hack at the start of the delivery). In the end I thought that starting in the stance/squat position would be more representative, and which I think you've confirmed. I'm wondering now if the standing start with a progression through the "power position" may be representative of the 3-step backswing delivery including the Myotatic stretch reflex. When I was experimenting with this I found, surprisingly, that I had higher jumps (i.e. measured vertical height h) from the stance position, which reinforced my decision to use that for the test. After a little consideration it was apparent that much of the additional height simply came from moving through the standing position from the squat before the push really came (I hope that's clear). In tests from the standing position, I took the initial height as the standing height and then measured the height of the jump. But from what you are saying, I think now, that I need to mark the initial point when in the power position, and then measure the height of the jump from that point. This would definitely give a higher vertical displacement, h. However, to do this properly, one probably needs to video the athlete against a scale to get a good measure. I've been using touch points and then measuring between the points. This is easy to do at the start since the athlete is not moving, and at the top of the jump by having them stretch and make a mark at the top of the jump. However, in the second case they would move through the power position quickly and it would be awkward to get a touch point. I am curious though to see how the results would compare. If it works, it could be a way to quantify the extra energy coming from a proper 3-step delivery.

Also, you are correct in pointing out the need for good coordination of the jump. In practice, if the jump is obviously awkward, or there is significant lateral motion in the jump, I neglect the result and have them repeat it. Another source of error, and related to jump coordination, is a tendency to push somewhat off the slide foot/leg, which would result in an overestimate. However, as you say, there is a learning factor here, and in the end I was happy with the preliminary tests. I only accepted a data point after I got a minimum of 3 jumps which had a "reasonably" small spread. I then averaged the three points for the calculation. I also had them rest/recover if I didn't get consistent results after a few jumps in row (nominally three). In practice, the jumps were actually more consistent than I expected.

I think a bigger database is needed to determine if my 70-80% factor is the norm, or simply just the number for the couple data points I have now. If indeed it is "the norm" than a measure less than 70% could be a quantitative indication to an athlete that efficiency improvements in the delivery are in order (i.e. not making the most use out of those glutes). However, I recognize that my database is too small right now to be too conclusive.

I like your suggestions for "in-the-hack strength training". I will experiment with them. As you point out, the main thing is to ensure that it doesn't introduce any bad-habits in the delivery mechanics, but I think if one is aware of this, then the resistance training can be beneficial. If you have any other ideas for on-ice training, I'd certainly like to hear them.

Don't worry about the delay in responding – we should all be so busy.

All the Best
Jerome

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Bob,

Per our earlier exchanges, the Myotatic Stretch Reflex was identified as the main source of extra power for up-weight shots using the "3- step" delivery. However, besides strength/power another important physiological factor in the delivery is flexibility. Although static or gradual stretching is appropriate for all curlers, novice, intermediate, and advanced, there may be times, particularly for competitive curlers, where one may want to use proprioceptive neuromuscular facilitation (P.N.F.) techniques to increase specific joint flexibility. If I understand these correctly, these exercises involve the Myotatic Stretch Reflex. My question is this: if you use P.N.F. techniques to increase

joint flexibility do you at the same time reduce the ability to generate energy (hence power) via the Myotatic Stretch Reflex mechanism. If so, then if you're using the Myotatic Stretch Reflex to generate power (i.e. throw up-weight) are you not faced with a trade-off with flexibility in the drive leg? Or, will increased joint movement actually result in increased energy overall even if the power/impulse may be reduced because the muscles are more relaxed? If indeed a trade-off exists here, then would the following be a consideration. Flexibility is more of a concern for the slide leg where stabilization of the body is important in achieving a good body position in a well-balanced slide, and therefore P.N.F. techniques could be employed here, but not necessarily for the drive leg where strength and power are more of an issue.

Cheers
Jerome

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Hi Jerome,

I believe the main source of power in the 3-step delivery would be as a result of changing the biomechanics to access triple extension and that the Myotatic Stretch Reflex would simply be another source, not the main source of extra power.

I wrote some tips on flexibility a while ago that challenged the main stream thought on stretching. Gradual or developmental flexibility is only recommended to those with range-of-motion (ROM) deficits. Young girls may not need to do much, if any, stretching if they already demonstrate full ROM. My recommendation to curling athletes is to get an assessment and stretch the areas that are tight. After games and practices, run through a stretching program but only hold stretches that feel tight or appear limited.

Although curlers need hip FABER (flexion/abduction/external rotation) flexibility in their sliding leg and hip extension flexibility in their drive leg, there is the ability to overstretch and change one's delivery because of it. So my comments are to be careful with delivery specific flexibility exercises because we don't want to lose our ideal delivery proprioception/position. This can be observed by athletes who are too flexible and lack strength and come out of the hack dropping into a "bottom out" position instead of controlling their movement to a stable ideal position. Too much flexibility can render a joint unstable and at risk of injury.

PNF stretching is a progressive and developmental form of stretching. It should be done by those who require a significant amount of improvements. It is a form of partner stretching that requires good communication and someone who knows what it should feel like and what they are trying to accomplish. Otherwise it could do the opposite of what you are trying to achieve. When a muscle is stretched, the sensors within a muscle, called muscle spindles, create a reflex (Myotatic Stretch Reflex) causing the muscle to tighten. In a static stretch, over time, the reflex abates and relaxation of the muscle can occur. In PNF stretching, a contract cycle of a few seconds does a couple things. One, it activates a sensor in the tendon called the Golgi Tendon Organs which controls muscle tension and thus momentarily inhibiting the stretch reflex. And two, it helps reduce adhesions, scar tissue, trigger points, etc that have built up over the years from lack of warm ups, cool downs and general recovery activity. That is why it is seen as a developmental form of stretching.

Because this is developmental stretching it should primarily be done in the "Early Non-Competitive" season (AKA off-season), after their limitations have been identified in a functional assessment.

Many studies have concluded that any form of static or PNF stretching (held longer than 30 seconds but not greater than 60 seconds) before a sport activity requiring strength/power, has shown a reduction in power production. This is why static stretching is no longer recommended prior to competition and why dynamic stretching is the activity of choice. Dynamic stretching activates a multitude of physiological factors where static stretching puts the body to sleep, so to speak. However, static stretching after competition can put muscles into a relaxation state and thus improve recovery.

I guess what I'm saying is, there's a time and place for all stretching. Some athletes need to do more of it than others and that should all be based on their postural/functional assessments. I see aerobics instructors doing PNF/partner stretching in their classes, because they saw it at a workshop, and really, most of the participants didn't need it.

I hope that answered your question and possibly sparked a few more...

Bob

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Hi Bob,

Thanks, this certainly has answered my question. My concern was indeed training specific as opposed to pre/post competition. My team has been doing the dynamic warm-up for that the last 2 yrs and static cool-down (although it can be difficult to get juniors to always do the cool-down). In particular thanks for the cautionary parameters you've outlined. One final question on this subject though, what are the standards for full or normal ROM - what's the best way to evaluate/assess this? Can this simply be a question of finding a good stable slide position and then checking for tightness or tension in specific joints?

Cheers
Jerome

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Hi Jerome,

The best way to deal with ROM quantification is to have them assessed by a physio-kinesiologist, or athletic therapist. They are all familiar with functional/postural assessments and should be able to provide you with a summary as far as their limitations in flexibility and specific muscle strength. They should also provide the corrective stretching and strengthening exercises to deal with these limitations.

As far as delivery-specific flexibility, video capture and your interpretation/assessment of what their delivery should look like is best. Head movement or drop when they leave the hack is one area to look at. Someone who is hypermobile and lacks strength will likely be the person who just drops into their delivery position. I was once at a camp where a coach asked me if I had any recommendations for a young girl who would just drop into her delivery. My recommendation was resistance training to improve muscle strength and to use drills that force her to control her movement. In this specific situation, I think Bill's drill regarding sliding to the pin and no further would make her aware of what her body is doing.

I think the best example of a controlled delivery is Brad Gushue. I'm sure there are plenty others but I had the opportunity to watch him again at the Bear Mountain Curling Classic last weekend and his delivery demonstrates what we call "Perceived Effortlessness". From the point he leaves the hack to the point of release, his head doesn't move and he is in a strong and stable position.

Therefore, it is always a balance of strength and flexibility for best practices. The funny part about guys and girls and training is that guys will usually go to the gym to lift weights and girls will usually do some cardio and stretching or yoga. Funny how each will gravitate towards their strength when actually the girls should be lifting weights and the guys should be doing the cardio and stretching. Just a general observation....

Bob

It's at this point that I usually encourage you to enjoy working with your athletes. I hope we have not made that process more confusing. To repeat, if you have any questions of Jerome, Bob or yours truly, please don't hesitate to ask!

To be continued!