

The Lunge: Concepts in Function

Part One: Screening

“Shouldn’t the middle of knee sit directly over the second toe during a full lunge...”

The above is an extremely common statement heard on courses, discussions and conversations concerning movement screening, functional training or rehab. It could be that we have far more challenging concepts and bigger issues to chew over, but this one is still a firm favourite.

It is unclear where the concept of the knee staying over and not transgressing the second toe originated, some claim its origins were a Duke University study back in 1978. This author's reading, research and discussions have definitely led him to believe that this “old nugget” could be a case of unsubstantiated wisdom. The most common theme to come across is that this essential move will reduce loading forces and be less injurious to the knee, especially when allied with a femur/thigh that sits horizontally, and with a foot that is orientated in-line with said femur. However Escamilla et al 2010, took 18 subjects through their 12 rep max long step lunges and short step lunges whilst recording forces and EMG recruitment patterns. The researchers found insignificant ACL tension in the short lunge with greater knee flexion taking the knee past toes. The researchers found significantly greater PCL forces in the long stride lunge, where the knee stays behind the toe line.

A closely related bolt-on will be the addition of a vertical and centred spine. You will come across strong suggestions that the calf, quad and hamstring groups will be less prone to stress/injury with this magic move, and that the whole thing will be more “stable” if these clearly defined guidelines are strictly adhered to. It becomes “common knowledge” with countless examples of this within instructional articles... an example being Dyan Quesada in her article Anatomy of the Perfect Lunge, 2006 stating, “the most common error made when performing this exercise is not keeping the back in a straight line when bending both knees”.

However accepted they have become, it is possible to struggle with these concepts. It is simple, if this truly is the most efficient way of performing this movement, then this will be quite clearly be the most common way to find it performed in “real time” athletic function. So if we observe lunge based sports and activities we would see that the most efficient and effective athletes employ the most efficient and effective lunge form, especially if they have also been trained by folks who are great believers in the knee over toes universal concept. It would make sense to study a sport that dictates that multiple lunges have to be performed... such as Badminton. Without doubt badminton players must master the lunge, be it to get to a drop shot, defend the mid court, or as part of the repetitive but essential practice drills they perform on court. If anyone can display or benefit from perfect lunge mechanics it will be badminton players.

We would expect to see this:



But you will find this:



What is seen in free-play is the body making all sorts of angles and shapes, often at the extremes of 3-dimensional movement, but clearly still recognisable as a lunge. It is common to observe these same shapes in most other dynamic sports as well, be it hockey or fencing, or a sport with no handheld driving force such as soccer. Put simply, the body is doing whatever it can to “get there”, and the best athletes are able to pull this off successfully. So what happened to the perfect lunge form? It is important to declare early that these movements are being driven by extreme environmental necessity, and that the athletes are performing close to their thresholds. It is also clear that if we asked them to do this, and only this, during both their training preparation and court-play time, there would probably be dire consequences. But have no doubts, when the umpire calls play, or the referee blows the whistle, that the shapes that our athletes will be striving for will look like those above. It is our job to train, maintain and rehab these athletes to a point where they can make these shapes not only safely, but also somewhat better than the next athlete. The question must arise, where does the conceptual, yet universally approved and accepted, 90/90 lunge fit into all this?

When discussing the sport of badminton, we can look a little deeper into its association with the lunge and recognise a potential 3 tier pattern:-

Tier 1 At the Gym: during the athletes strength and conditioning sessions, the lunge is certainly popular, but its form is predominantly along aligned 90/90 criteria. Stride lunge and line lunge walks are common, and the heavy loading sessions are all wisely performed with aligned and reproducible form.

Tier 2 Technical On-Court Drills: Not surprisingly badminton players do a lot of court drills, refining, rehearsing and optimising the essential shot making skills that they will call upon during game play. Repetition is essential, or at least unavoidable, and in this sport it is not unusual for the coaches to set up tables full of hundreds of stacked shuttlecocks and “multi-feed” them over the net in specific hitting patterns... short to long, mid-court side-to-side saves, short and recover and short again etc. Hundreds of lunges are performed, with the majority pretty “clean”, maybe not always 90/90, but often not far off. The skilled coaches can manipulate this by subtle pace and direction changes of their feeds, but on most occasions the athletes drop into a rhythm that allows them to arrive at these shots in some tidy and reliable body shapes. And of course there is a reason... these drills are predictive, they have to be, the athlete is striving for this bio-motor rhythm and the skilled coach has to hold them off from their end range threshold otherwise the drill will breakdown. The “chaos factor” that is the characteristic of competitive free-play is diluted by the aims and demands of the drill, and the extreme shape-making is equally diluted. (*note to reader; diluted doesn't mean “easy”*)

Tier 3 Competitive Play: This is the unpredictable “chaos” during the expansive nature of competitive game-play lunge mechanics. Please refer again to the images of free play.

This article is using badminton as its focus, but the 3-tier observations above can be applied to many other sports, or we could say “sports-preparation” as a whole.

What is apparent is that there seems to be a “leap of faith” between each of these three tiers. The use of the lunge is neither seamless or functionally progressive. If we believe that ultimate performance relies upon ultimate preparation, then there seem to be gaps. Is our training and conditioning truly supporting a high success rate with multi-dimensional threshold lunge ability, or are we coming up short?

The Primal Lunge

The lunge has become known as one of the primal or primary patterns of movement (Chek, 2003). Think of it as a biomechanical “constant”, or an essential building block of many more complex movement sequences. It is an essential component of dynamic sports and activities, a tool that can be used during the training and preparation for these activities, but it has also become a biomechanical “marker” for assessment of movement competence. Our understanding and application of movement screening is growing and almost all screening systems, including our own at Physical Solutions, will include observation and interpretation of a “lunge” as part of its protocol.



The unadulterated, standard, textbook, anterior lunge will be the mainstay of most assessment protocols. Perhaps with a stick down the back, or may be “in-line”. It's a good choice as we can observe front leg force absorption, lumbo-pelvic control, spinal angles, trail leg release and right/left symmetry among many other things.



This simple screen is without doubt a powerful and recommended assessment tool. Assessment techniques such as Cooks FMS system may highlight this vertical spinal posture, and for perfectly valid reasons of reliable comparative interpretation. If your client/athlete is struggling to control the range, stability and timing demands of this fundamental movement, then it is not difficult to see that they may have issues when they want to employ it at speed and under load and fatigue during their more dynamic activities. The screening observation may give the “green light” for the trainer to intervene with corrective and progressive training protocols that help “clean up” the client’s issues with their lunge screen. But there lies the problem... their dynamic activities will go on to ask more of this lunge, and our screening protocols should reflect this inevitability. Just because you are competent with the fundamental anterior lunge doesn’t mean you will demonstrate the same competence with the production and recovery of a frontal plane lunge, or a transverse plane one, or a lunge that incorporates opening the anterior muscular “chain”.

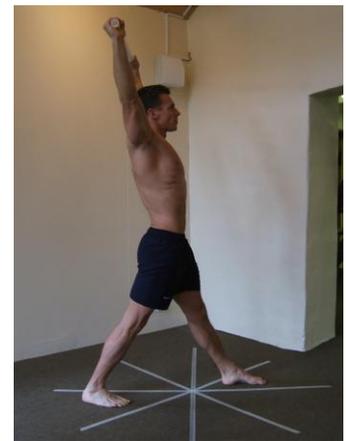
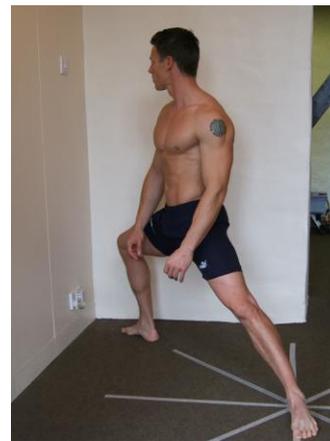
Tier 2 Lunge Screens

anterior with overhead raise

frontal plane

transverse plane “open out”

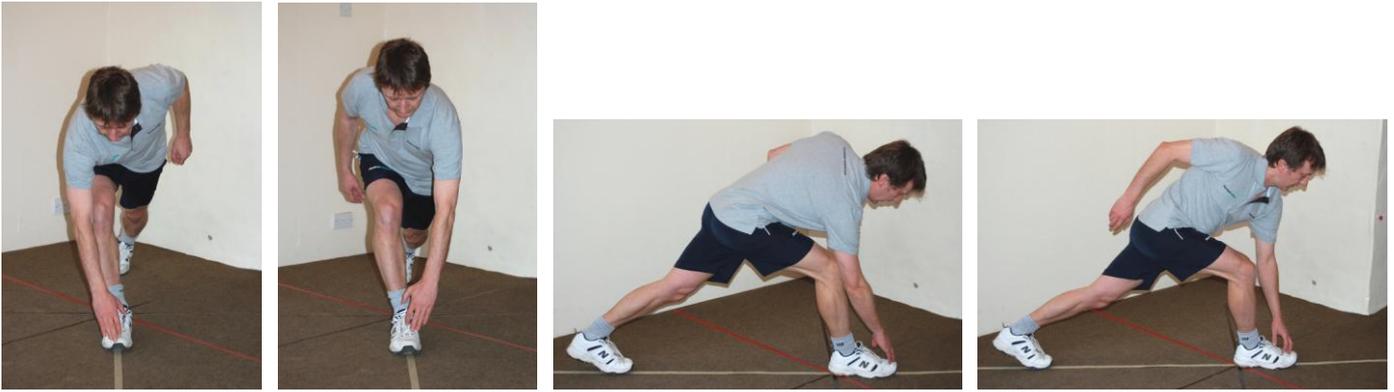
posterior heel down with raise



Fans of the toes over the knee please take a look at these examples. Even though we have altered the lunge mechanics to help focus our observations, there is still a strong flavour of “alignment” to these moves. The knee is in fact sitting over the lead foot in the first 3 examples, the trunk stays centred and often upright, with the pelvis relatively level. So is this the way to do it? Are they the biomechanical markers that we are looking for? It would help to consider these variations of the lunge as “2nd Tier” movement screens. There is more variation and motor expansiveness than a simple anterior lunge (1st tier screen), but the movement is still quite predictable in its nature and competent movers will perform them in “default” mode, with the body sub-consciously taking the safest and most reliable route to get the job done. A bit like the skilled badminton athlete performing their court drills within their threshold. Of course less competent or functionally compromised movers will show us dysfunction.

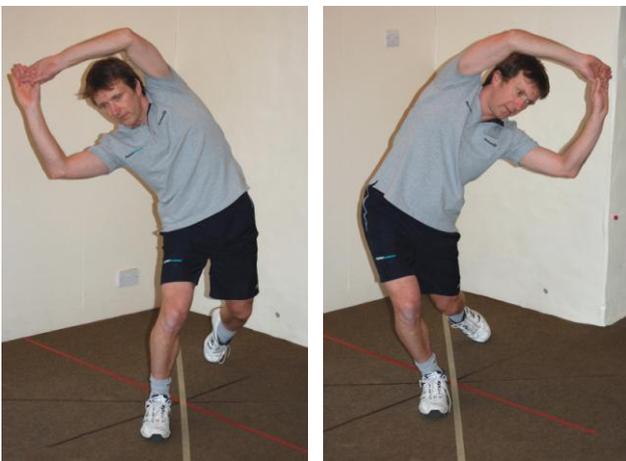
The question arises... can we claim that we are fully understanding an athletes’ movement competence without taking our screening of the lunge into 3rd Tier territory? This is a “level” of movement where we see the elements of chaos and sheer necessity driving the body into making more extreme shapes and moves. Of course if we decide to do this we need some form of order to this apparent chaos to ensure our screening remains reproducible, comparable and sets recognisable benchmarks. We have to concede that it is extremely difficult to test at absolute threshold, but we can find ways to get closer to it and still gather reliable results.

Tier 3 Lunge Screens



From a standing position an anterior long lunge with alternate toe touch is performed. In this case it is also performed “in-line”, narrowing the base and exposing more frontal plane demand. Note how the athlete has to:

- get through the forward leg hip and rear leg calf, decelerate and recover with the posterior muscular chain
- displace and control the centre of gravity away from the lumbo-pelvic “safety zone” and over the lead leg
- add a compound spinal rotation to make the reach
- the athlete is encouraged to push back and out of this lunge to the standing start position in order to assess their ability to re-gird and recover from an end range lunge



This is another anterior lunge and recover, but this time incorporating a full range frontal plane drive. Notice how the pelvis counter displaces against the trunk dragging the knee with it **outside the foot**. Efficient lateral chain function decelerates and recaptures this dynamic movement... or in the case of movement dysfunction it will fail to do this and regional distortions, pronation and restricted range may be observed and recorded. (Frontal plane stability has been somewhat under estimated in many athletic assessment protocols)



The lunge is now performed into the frontal plane but includes a full range and dynamic transverse plane drive. Notice how this exposes lead leg dynamics. In this case the right leg is driven to the right and we observe it releasing into a pronation deceleration with a contra-lateral trunk rotation and a supination deceleration with the ipsi-lateral rotation. We should also expect to see efficient control of relative internal and external rotation at the hip.



This is an anterior in-line lunge incorporating a full range transverse plane reach backwards. It drives the trunk into extreme counter rotation if the **left** foot is forward and left shoulder driven back, but also tests control of the trunk and lumbo-pelvis “opening out” as the shoulder drives to the right. A big question of control and resistance (stability) is asked of the lead leg as it anchors and modulates this total body movement.

We have travelled a long way from the standard primal lunge. Without doubt we have also come a long way from worrying about the single criteria of whether or not a knee is sitting directly above a second toe. The process will see you investigating force absorption and production mechanics, muscular chain function, core and dynamic stability, motor patterning, specific regional movement control, symmetry, and doing this in multiple planes... an exhaustive list, but actually the recipe of motor function. You have choices to seek out where your athlete's strengths are and expose where their weaknesses lie. In fact an understanding of one single “movement” has almost become a basis for observing an athlete's global motor competence... READ THIS SENTENCE AGAIN. This is a concept that could be at the hub of what we do. On first impression it does sound a bit unwise. Why restrict your assessment of a client's expansive athletic ability to variations of one test movement? However ALL dynamic movements are subject to ever present “functional constants”, with many of these constants listed above and to recap, all revolving around our ability to deal with gravity, ground reaction, momentum control, force absorption and re-girding production... and all in a balanced, 3-dimensional, reproducible and often high threshold manner. So in fact we could consider that we are not actually testing the “lunge”, but merely using it as a tool to test our client's competence with these all important **functional constants**. A lack of competence with these has consequences for ALL movement, and not just the one you have chosen to test and observe. This framework of 3 Tier thinking can be applied to all of the familiar test/primal movements that we commonly apply in our movement screening processes. It can be easily adapted to a squat, or a jump, a single leg dip, and to some extent to a pull or a push. The test movement can be expanded from its most primal foundation 1st tier presentation all the way up and close to its 3rd tier threshold, and most of this is done by applying the outlined framework of the 3 planes of movement and an expanding threshold of range. Once comfortable with this you have a system that can provide you with a huge insight into an athlete's movement competence. If necessary, this can be taken further with other components being added such as external loading, speed and repetition/fatigue.

Initially it can appear daunting though because quite frankly it looks like a lot of work, especially when considering we mentioned that this is just one of the fundamental movements that we could opt to screen. This does not have to be the case, and in fact we only employ 3 or 4 max of these fundamental movements within popular screening systems. Humans are uniquely bi-pedal, and our functional locomotion is driven by our ability to sling one foot in front of the other, control it, recover it, and do it any which way that is needed. Understanding this most primal component of our motor capability has to be a prime target of movement assessment and manipulating the way we evaluate a lunge can help us in this process.

Is it wise to employ this 3 tier lunge process at every client and athlete that we work with? Almost certainly not. Our screening systems and skills need to be adaptable. We all work with different communities and face different constraints. We absolutely need the more standardised screening systems that provide us with definitive quantitative reasoning tools, just as we also need to develop and trust our abilities in

observing and interpreting movement from a more qualitative perspective. What helps is that once we start to observe and discuss function in motion we recognise distinct “rules of engagement”. These are the functional constants. They never change and they provide us with a common language to share.

What could be the way forward in applying a more expansive approach to lunge screening? Without doubt, always trust and test the basic anterior lunge variations because they are a proven reliable indicator. However, practice, and when able to, employ using a frontal plane, transverse plane and posterior lunge variation and develop your observations of good benchmarks for these movements. When comfortable with this you can become more expansive and where possible choose variations that are relevant to the activities that your athlete will be performing, or challenge the integrity of the movement patterns you are rehabilitating/training. Test, test again, observe change, and evaluate progress.

So far we have just stood back and looked at the lunge as a movement observation tool. The second article in this series will investigate what we can do with it as a training tool.

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