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KIN 322: Biomechanics

May 13, 2016

**Individual Project: Soccer Kick With
Curve**



Introduction:

I began playing competitive soccer at the age of 5 years old and played at the highest level until I broke my ankle at 14 which ended my soccer career. I am still involved in the sport and have recently began playing again. One of my best assets as a soccer player was my ability to curve a soccer ball whether it be for a pass or a free kick. After I broke my ankle, I found it difficult to curve the ball like I used too and I wanted to use this project as a way to improve my soccer kick to curve a ball. I want to be able to understand the mechanics behind my soccer curve to see how I can improve and get back to how I used to be able to kick before and perhaps become even better.

There are many relevant contextual factors involved in this soccer curve. Some of them include accuracy, whether or not the ball is moving, and my distance from the ball. I can curve a ball for a pass or a shot in the middle of action of the game or I can curve the ball during a free kick. The rules of soccer state that the ball must be placed where the foul took place and the ball must be fully stopped and in place. The rules also indicate that players from the other team are allowed to stand in front of the ball, but they need to be a minimum of 10 yards away from where the ball is placed. This will affect the angle in which I kick the ball if I am shooting it and want to place the ball over the wall and into the goal.

A special force in this kick that is present is friction. Friction between my foot and the ground needs to be intact in order for my right foot to remain firmly against the ground to allow for adequate accuracy to be generated from my left foot.

Anatomical Analysis:

The movement of my soccer kick with a curve has been broken down into the preparatory, propulsive, and post-propulsive phases. Each phase has been identified in the pictures. The preparatory phase begins at frame 6 and ends at frame 11. The propulsive phase begins at frame 11 and ends at frame 14. The post-propulsive phase begins at frame 14 and ends at frame 22. The five most important joints involved in my kick are my left ankle, left knee, left hip, spine, and my left shoulder.

Active Muscle Groups:

There are many active muscle groups during the preparatory phase. The beginning of the preparatory phase is primarily concentric tension, but as the counter movement is initiated, eccentric tension begins. The following muscles groups are active at their respective joints during the beginning and concentric phase of the preparatory phase:

<u>Joint</u>	<u>Muscle group</u>
Left ankle	Plantarflexors
Left knee	Knee extensors
Left hip	Hip extensors
Spine	Spine flexors
Left shoulder joint	Shoulder flexors

The following muscle groups are active at their respective joints during the end and eccentric phase of the preparatory phase:

<u>Joint</u>	<u>Muscle Group</u>
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Left ankle	Dorsiflexors
Left knee	Knee extensors
Left hip	Hip flexors
Spine	Spine flexors
Left shoulder joint	Shoulder flexors

Concentric tension is the primary muscle tension during the propulsive phase. The following muscle groups are active at their respective joints during the propulsive phase (Frames 11-14):

<u>Joint</u>	<u>Muscle Group</u>
Left ankle	Dorsiflexors Invertors
Left knee	Knee extensors
Left hip	Hip flexors Medial rotators
Spine	Spine flexors
Left shoulder joint	Shoulder flexors Shoulder abductors

The primary tension during the post-propulsive phase is eccentric muscle tension. The following muscle groups are active at their respective joints during the post-propulsive phase (Frames 14-22).


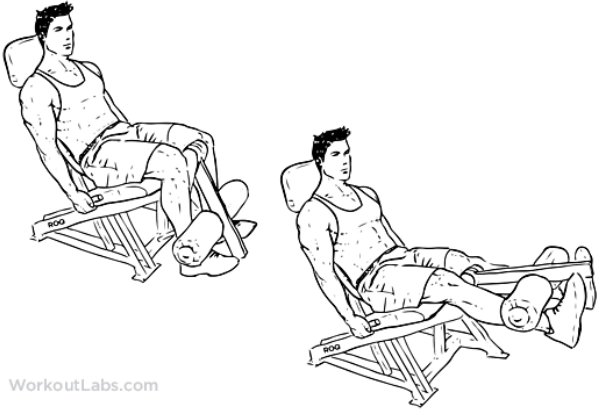
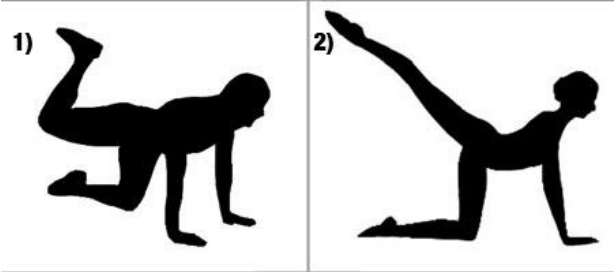
<u>Joint</u>	<u>Muscle Group</u>
Left ankle	Plantar flexors
Left knee	Knee flexors
Left hip	Hip extensors
Spine	Spine extensors
Left shoulder joint	Shoulder extensors



Five important muscles per joint:

<u>Joint</u>	<u>Muscle group</u>	<u>Muscle</u>
Left ankle	Plantarflexors	Gastrocnemius
Left knee	Knee extensors	Rectus femoris
Left hip	Hip extensors	Gluteus maximus
Spine	Spine flexors	Rectus abdominus
Left shoulder joint	Flexors	Anterior deltoid

Exercises to strengthen muscles:

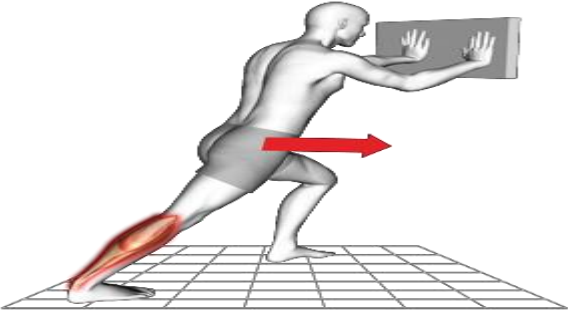
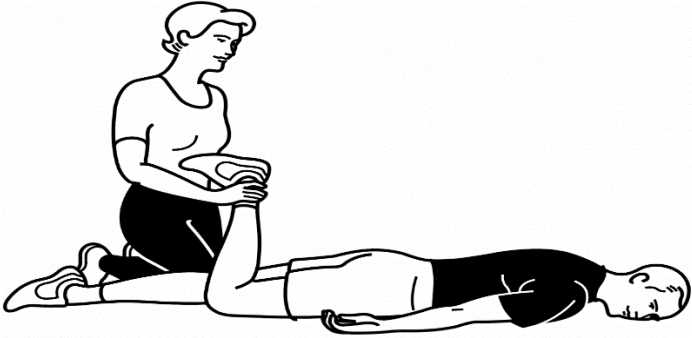
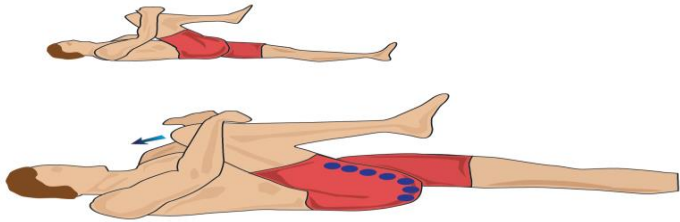
<u>Muscle</u>	<u>Exercise</u>

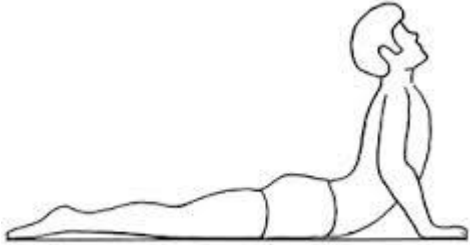

<p>Gastrocnemius</p>	<p>Calf raises</p>  <p>http://fatburnandfitness.com/wp-content/uploads/2014/10/Calf-raises.jpg</p>
<p>Rectus femoris</p>	<p>Leg extensions</p> <p>http://workoutlabs.com/wp-content/uploads/watermarked/Seated_Machine_Leg_Extensions.png</p> 
<p>Gluteus maximus</p>	<p>Glute extensions</p>  <p>http://codyapp.wpengine.netdna-cdn.com/wp-content/uploads/2013/06/barre_exercises_glute_kickback.jpg</p>

Rectus abdominus	<p>Plank</p>  <p>http://lovelyyoga.com/images/plank2.jpg</p>
Anterior deltoid	<p>Front raises</p>  <p>https://www.pulseos.com/wp-content/uploads/2013/10/Front-Raises.jpg</p>

Exercises to stretch muscles:

<u>Muscle</u>	<u>Exercise</u>
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<p>Gastrocnemius</p>	<p>Gastrocnemius stretch</p>  <p>http://2.bp.blogspot.com/-9ADs7SYJRJQ/UIMIXf5fhLI/AAAAAAAAAD4/MKAKxfnfuz0/s1600/image.png</p>
<p>Rectus femoris</p>	<p>PNF quad stretch</p>  <p>http://static.berkeleywellness.com/files/Thigh-stretch.png</p>
<p>Gluteus maximus</p>	<p>Knee pull</p>  <p>http://www.docpods.com/images/Gluteal-Buttock-Stretch-Back-WEB.jpg</p>
<p>Rectus abdominus</p>	<p>Cobra stretch</p>

	 <p>Cobra Posture</p> <p>http://www.cervical-spondylosis.com/yp_cobra.gif</p>
Anterior deltoid	<p>Reverse arm pull</p>  <p>http://www.sportsinjuryclinic.net/media/content/_master/134/images/shoulder-stretch-front.png</p>

Specificity:

In order to perform my skill, there needs to be a balance between power and guided/tracking activity. The power needs to be present in order to generate force to move the ball, especially when shooting. Guided activity is especially important in my soccer curve compared to a traditional soccer kick. It is very difficult to curve a soccer ball with full power. It is all relative to whether I am shooting or passing and the distance from my target. However, the majority of the movement requires a balance of both movements. In order to perfect my skill, I need to

mimic these types of activities during my training. Therefore, my training will be a combination of both power exercises and tracking movements.

To begin with, I need to make sure that I am focusing on both concentric and eccentric tension during my training. The primary way to incorporate both types of tension will be weight lifting. In order to get the most benefit for my muscles from the force-velocity graph, I will ensure that the concentric phases of my exercises are comprised of short bursts of power. During the eccentric phase, I will focus on controlling the weight down and forcing my muscles to work harder. This is because during the eccentric phase, more force can be generated with more velocity so slowing the weight down puts more demand on my muscles causing them to adapt and grow.

The majority of my workouts will be focused on my knee extensors and flexors, as well as my hip extensors and flexors. This is because these are the most active muscle groups that are used in my activity. I will also focus on enhancing my range of motion for these muscle groups to allow for compactness to increase in my knee during the pre-propulsive phase, specifically the eccentric tension which allow me to further activate the stretch-shortening mechanism. I will also look to increase range of motion at my hip to allow my leg to turn more and in turn put more of a curve on the ball when it is desired.

In regards to balance, I will perform exercises such as 1 legged box jumps to mimic the force demand on my standing leg during a soccer kick. I will also perform side to side suicides and dynamic lunges to activate my hip in a variety of directions and planes.

Safety:

I had to learn the hard way the importance of safety in my sport. When I broke my talus bone, the doctor told me that my calf muscles surrounding my talus bone were not strong enough so when I got kicked, my ankle was prone to break. My main focus will be bone safety, as well as other important safety factors that I need to take into account for my movement and my sport.

Bone safety:

Since I am young and my bones are still developing, I want to ensure that I have adequate strength in my bones to withstand the force I will be putting on them, especially my lower body. I will make sure to strengthen my muscles so that my bones will in turn become stronger and protect from another serious injury.

Muscle safety:

Another issue I faced while playing soccer was the deficiency in my hamstrings compared to my quadriceps, as well as the deficiency of my right leg compared to my left leg. Genetically, I have developed hip flexors as well as developed glutes. Playing soccer increased the strength in my hip extensors and also my hip flexors, but the primary growth was in the hip flexors. This led to my hamstrings being very susceptible and I had many hamstring pulls while playing soccer. To prevent this, I need to ensure proper strengthening and stretching of my hip flexors and extensors. If I feel my hip flexors are becoming stronger than my hip extensors, then I need to focus more on strengthening my hip extensors in the gym. Similarly, I need to ensure that my right leg is just as strong as my left leg. I am a left-footed soccer player so my left leg is overdeveloped compared to my right leg. I need to ensure bilateral balance both in terms of strength and stretch.

Training Safety:

When I was on the youth national team, we practiced daily, sometimes twice a day and sometimes even three times a day. I am nowhere near where I used to be, however, I want to ensure that I do not over train. I need to ensure proper rest and recovery. Since the sport primarily uses the lower body, it is difficult to take off from using my lower body all together. I can make sure to have heavier days and lighter days to allow my muscle to somewhat recover. I will make sure not to hit legs heavy in the gym if I have a training session just a couple of hours later. I will never really be doing maximal effort at the gym anyways, it will be to strengthen and condition my legs. I will also ensure that there is adequate stretching involved during the week to help my muscles recover. Lastly, I will ensure I have a proper diet to help meet my needs. I will make sure I have a good balance of all the macronutrients and make sure I properly hydrated and fueled for every training session.

Mechanical Analysis:

Using the POSSUM scale, I concluded that my soccer kick is a light, fast movement that requires maximum intensity of effort. This means there is a large range of motion using sequential coordination. There is a large number of segments and high amount of transverse action. Lastly, the foot contacting the ball should be as extended as possible. A copy of the POSSUM scale has been attached at the end of this project.

Quantitative Assessments:

For my quantitative assessments, I analyzed the range of motion of my knee during the propulsive phase, the speed of motion of my knee during the propulsive phase and the displacement of my foot during the propulsive phase.

I assessed range of motion at my knee during the propulsive phase using frames 11 and 14.

Frame 14 was the end at frame 11 was the beginning of the propulsive phase. I measured the angle at my knee at frame 14 and subtracted the knee angle from angle 11 to find my range of motion at my knee. My range of motion during the propulsive phase came out to be 108 degrees which shows a large range of motion which is ideal for my movement.

To assess speed of motion, I used the equation for angular velocity. I used the range of motion from the previous calculation and divided that by the time during frames 11-14. I found time by subtracting 11 from 14 which got me 3, which indicates there was 3 frames during the propulsive phase. I then multiplied that by 1 divided by the number of frames per second which was 30. I took 108 degrees and divided that by .10 seconds and got 1,080 degrees per second for my speed of motion during the propulsive phase. This calculation shows how fast my leg was moving and in my movement, the faster the leg is moving, the more power I can generate which is what I want.

Lastly, I assessed displacement of my foot during the propulsive phase. I used the same frames and measured the location of my foot at frame 11 and at frame 14. I made a mark on frame 14, the end of the propulsive phase, where my foot was placed during frame 11 and measured the difference between my foot at frame 11 and frame 14. I ended up figuring out the displacement of my foot was 7.3 centimeters during the propulsive phase.

The quantitative assessments I used were the ones that I felt were the most relevant to my movement, however, I could have assessed other components such as extension at contact or balance during the propulsive phase.

Qualitative Assessments:

The five core concepts that I chose to qualitatively assess were range of motion, speed of motion, coordination, number of segments, and extension at contact.

To begin with, my range of motion at my knee during the propulsive phase was large which is what is needed during this light fast, maximal effort. An experts range of motion at the knee during the propulsive phase is expected to be greater than mine in order to be to generate maximal velocity prior to the foot contacting the ball. A larger range of motion would allow for greater displacement which will allow more velocity to be generated.

The large range of motion will help to generate a fast speed of motion during the propulsive phase as well. This is what is necessary during this type of kick in order to generate as much power as possible. My speed of motion was fast, especially considering that I do not play soccer any more. I have maintained my strength training which allows me to generate a great deal of force for my kick. An expert is expected to have as close to maximal velocity generated as possible. This will allow the ball to be kicked with as much power as possible and make it difficult for an opponent to stop the ball.

An important aspect to note is that this movement is taking place in a closed system which allows for maximal velocity to be generated. This means that the amount of velocity generated by my body will go directly into the movement of the ball. If this was not a closed system and there was an external force acting on me such as a player making contact with me, this would decrease the amount of total velocity generated towards the ball.

In regards to coordination, mine can be seen as sequential. During the frames, my body can be seen moving in a sequential motion starting with the movement of my hip going to my knee

followed by the calf and finally the foot. This is optimal for my type of activity and an expert would have sequential coordination as well.

The next core concept I feel is important is the number of segments used. An expert will have a large number of segments being used during the kick. This means using both arms, both legs, as well as the trunk and the hip. The more segments used, the better the kick will be. After seeing my movement, it is clear that there is a large number of segments used including my arms, legs, hip and trunk which can be expected to be seen in an expert.

Lastly, I analyzed the extension of contact of my leg during the propulsive phase. My angle was 180 degrees at my knee which means my leg was fully extended during the kick. This means that I was able to generate as much power as possible. An expert would be expected to have the same angle as me during the propulsive phase. This ensures that there is full extension at contact which allows an increase in tangential velocity of the ball following contact. The greater the angular velocity, as well as the greater the radius, the more tangential velocity that can be generated.

Improvements:

Improvements could be made to any of the core concepts mentioned above. These core concepts can be changed to mimic that of a professional soccer player. The first thing I would begin with improving would be the range of motion of my knee during the propulsive phase. I would want to flex my knee more at the beginning of the propulsive phase to allow myself to increase angular as well as linear velocity while striking the ball. The next improve I could make is to increase my speed of motion. The faster I can go, the faster the ball will move. I would want to

get my speed of motion to be similar to a professional soccer player in order to allow the ball to move as fast as possible and make it difficult for any goalkeeper to stop my shot.

My coordination, number of segments, and extension at contact are already similar to that of a professional soccer player. I need to keep training the way I do in order to maintain these core concepts and help myself become an even better soccer player. Maintaining these core concepts and improving my range and speed of motion can make a huge difference in how fast the ball moves once leaving my foot.

Modifications:

A specific practice situation that could help improve my soccer kick is to consistently practice curving the soccer ball during a shot. These means taking over a hundred shots during practice from all sides of the field to help perfect my kick. Once I incorporate the changes to my core concepts, I need to practice utilizing these changes to help improve my kick. I could also include variations of the kick that include going for a longer range or a higher apex or increasing my accuracy. Changing the techniques will modify my core concepts which can make me more lethal as a shooter in soccer. Consistent practice is this movement will increase my form as well as my muscle memory. I could do drills that require me to dribble and then use this technique to shoot so that I also practice this movement using speed rather than just standing still. Being able to perfect this technique at any instance will make me an overall better soccer player.

Another way to make improvements that can increase my soccer kick is stretching. I have been very poor about going about stretching and this could hurt my game. Properly stretching will increase my flexibility at my hip and my knee. An increase in flexibility at these joints will mean an increase in range of motion as well as speed of motion which will ultimately increase the

speed that the soccer ball is released. Implementing both hip and knee flexor stretches more will have significant improves on my soccer kick.

Lastly, an important modification and I can improve is my strength training of my quadriceps, hamstrings, and calves. I could strengthen these muscles by implementing training techniques that include plyometric, ballistic, and power training. I plan on utilizing each type of training at least once a week to help improve all areas of the muscles mentioned.

Evaluation:

Once all of these improvements and modifications have been made, it is important to evaluate if these modifications have worked. I could do this by assessing if I personally feel my kicks have increased during practice or in a game. I will also continue to take video and qualitatively and quantitatively assess improvements in my core concepts. I will hope to see an increase in my ROM of my knee at the beginning of the propulsive phase as well as an increase in my speed of motion. These improvements will help increase angular velocity of my leg as well as velocity generated by my leg to move the ball as far and fast as possible.

If my changes work, the next step will be to continue to make even more changes. I will use film of games to analyze my shots taken during a game and the power generated. The main thing I will be looking at is the statistics of how many goals scored. The whole purpose of this is to make me a better soccer player and a player that can score more goals. If I am beginning to score more goals, than that means this technique is working. Next, I could improve another skill in soccer such as passing since this could also be improved using film.

I am hoping all of these biomechanical changes will work, however, there are a few non-biomechanical changes that are just as important to increase my performance, specifically my

soccer kick. The main one being my nutrition. If I am not adequately nourished for each training session and game, then I will not be able to perform like I should be. I need to continue to pay close attention to my diet in order to make sure I am ready to prepare and recover my body from my training sessions and games. Another important non-biochemical change that could be made is the improvement of my mental preparation and making sure I enjoy each training session and each game. Along with my injury the last time I played soccer, I also noticed a big decline in my mental part of the game. I began losing my passion and enjoyment for the game and I felt this kept me out of many games. Getting back to the basics of why I want to play and reminding myself that every time I step on the field will make a drastic change in my performance. I am hoping that a combination of the biomechanical and non-biomechanical improvements will make me an all-around better soccer player.