ACL PREVENTION IN FEMALE FOOTBALL

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“TARPLEY TEARS RIGHT ACL, WILL MISS WOMEN’S WORLD CUP

United States Women’s National Team midfielder Lindsay Tarpley tore her right anterior cruciate ligament in the 75th minute of Saturday night’s 2-0 win over Japan and will miss this summer’s Women’s World Cup in Germany. She is expected to miss six-to-eight months.

This is the same ACL that Tarpley tore in the final game of the 2009 WPS season with the Chicago Red Stars. She slowly recovered from that and made a strong comeback in 2010 with Saint Louis Athletica and, more notably, with the Boston Breakers. Tarpley was recalled to the US team in November and had scored two goals in just four appearances with the team in 2011.”
– equalizersoccer.com

Unfortunately, we hear of numerous sad stories like this, especially among women competing in pivoting sports. Many of these anterior cruciate ligament (ACL) injuries could have been prevented and in this paper we will tell you how.

HOW BIG IS THE PROBLEM?

Severe knee injuries, such as ACL injuries, constitute a serious problem. Unfortunately, they are frequent in many sports. Treatment is costly and it often takes 12 months or more to return to sport or in worst case, lead to early retirement. The long-term outcome is also a concern. A majority of athletes will develop osteoarthritis within 15 to 20 years after an ACL injury, regardless of treatment. Consequently, injuries represent a considerable problem for the athlete, their team and, given the popularity of sport, for society at large.

In football, as in other team sports characterised by sudden changes of direction, pivoting accelerations and decelerations, ACL injuries are a particular concern, especially for female athletes. A recent literature review, including 23 studies, demonstrated that female football players have a two to three times higher ACL injury risk compared to their male counterparts. Females also tend to sustain an ACL injury at a younger age than males.

Protecting the health of the athlete by establishing prevention routines early is the responsibility of everyone involved in sports including coaches, medical personnel, referees and the athletes themselves. To maximise the health benefits for players and to minimise the direct and indirect costs associated with injuries, early identification of players at high injury risk is key.

RISK FACTORS

As for most other types of injury, recent studies have suggested that a history of knee ligament injury is the predominant risk factor for a subsequent injury. However, the reasons for the obvious gender gap in the risk of ACL injury are not completely clear. Various researchers have suggested differences in anatomy, hormonal and neuromuscular function as potential...
reasons for the higher injury risk in women than in men. To date, however, there is little evidence linking all these potential intrinsic risk factors to noncontact ACL injuries and a great deal of controversy exists on the relative importance of the different factors.

The main external risk factor that has been advanced is the effect of friction between shoes and the playing surface. Investigations from Australian Rules Football and European handball suggest that a high shoe surface friction is associated with an increased risk of ACL injury. For example, when friction is high, the foot can abruptly stop while the athletes are out for a cutting or turning manoeuvre. This will cause the knee to twist suddenly at foot strike and collapse.

MECHANISMS
ACL injuries usually occur without direct player contact to the knee, many cases involve some sort of perturbation by an opponent (e.g. being pushed slightly off-balance just before landing). The mechanisms for non-contact ACL injuries are widely debated. What seems clear from several studies from various team sports and even alpine skiing is that knee valgus (where the knee collapses inwards into a ‘knock-knee’ position) is an important factor in many cases. This implies that avoiding valgus knee motion is important for preventing injuries.

PREVENTION
A variety of injury-specific and sport-specific preventive exercise programmes exist. Also, a growing number of programmes have been developed to reduce the risk of knee injuries in general and ACL injuries in particular. Studies from various sports typically show that establishing such programmes as standard warm-up programmes for teams can reduce the risk of injury by as much as 30 to 50%.

Typically, these programmes consist of exercises focusing on core stability, balance, dynamic stabilisation and muscle strength of the lower extremities. The exercises are often designed as structured warm-up programmes to ensure that all players use the programme regularly. One essential part is to emphasise the ‘hip-knee-toe in line position’ in all types of exercises, both
in plyometric, co-ordination and strength exercises. The primary goal of this strategy is to maintain posture and lower limb balance in an attempt to teach players how to control their knee position as far as possible in all situations (Figure 1).

A recent comprehensive review of the scientific literature focused on neuromuscular training programmes developed to alter risk factors associated with an ACL injury and to reduce injury risk in football players. The authors conclude that neuromuscular training appears to be effective in reducing ACL injury risk and that lower extremity strength and balance exercises, in combination with core and trunk control, seem to be necessary components of a successful ACL injury prevention programme. Since Alentorn-Geli et al. finished their thorough review, new studies in football have been published which reinforce their message: injuries can be prevented.

We have selected three knee/ACL injury prevention programmes to present all have been proven to prevent 30 to 50% of all injuries (Figures 2 to 4). Two of the exercise programmes presented here have been developed for football, while the other is for handball. These and other successful knee/ACL injury prevention programmes have several key aspects in common and keeping these in mind, they can easily be adapted to other sports.

PRACTICAL IMPLICATIONS - HOW, WHAT, WHEN?

What type of exercises?

ACL injury prevention works. However, we still do not know how to optimise injury prevention programmes to make them time efficient, which exercises are the ‘right ones’ or if such a thing exists at all.

Balance training alone and home-based training without instruction and feedback on proper movement technique (i.e. lower limb alignment, two-leg landings) is probably ineffective unless combined with other types of exercises for core and lower-limb strength, perturbation and jumping, with a continuous focus on knee control.

Another important challenge is to convince coaches and athletes to use the programmes. “Are the exercises really worth doing?” “The programme takes 20 minutes; do we need to do this programme every training session?” These are common questions. And the answers are yes and yes! If done properly, as many as every second injury can be prevented. Perhaps one day, through continued research, programmes can be developed which take less time and are even more effective.

To identify the minimal effective dose to reduce ACL injury risk is a daunting task. Also, we question: Which exercises are the key exercises in a programme: strength, balance, plyometric or agility are actually all of them?

When to start?

Most clinicians and researchers suggest that focus on injury prevention should start as soon as children start participating in organised sports. Generally, injury risk is low under the age of 12. Even so, from a motor learning perspective, including exercises to prevent injuries early can help develop ‘good habits’ and less vulnerable movement patterns, in addition to establishing correct playing technique and fair play attitudes.

(Continued on page 184)
Prevention of ACL injuries in team sport athletes

Level 1
Floor exercises
Running and planting, partner running backwards and giving feedback on the quality of the movement, change position after 20 s.

Mat exercises
Two players standing on one leg on the mat throwing to each other.

Wobble board exercises
Two players standing two legged on the board throwing to each other.

Level 2
Floor exercises
Jumping exercise—right leg—right leg over to left leg—left leg and finishing with a two-foot landing with flexion in both hips and knees.

Mat exercises
Jump shot from a box (30–40 cm high) with a two-foot landing with flexion in hip and knees.

Wobble board exercises
Squats on two legs, then on one leg.

Level 3
Floor exercises
Running and planting (as in week 1), now doing a full plant and cut movement with the ball, focusing on knee position.

Mat exercises
“Step” down from box with one-leg landing with flexion in hip and knee.

Wobble board exercises
Two players throwing to each other, one foot on the board.

Level 4
Floor exercises
Two and two players together two-leg jump forward and backwards, 180° turn and the same movement backwards; partner tries to push the player out of control but still focusing on landing technique.

Mat exercises
Two players both standing on balance mats trying to push partner out of balance, first on two-legs, then on one leg.

Wobble board exercises
One foot on the board, bounding the ball with their eyes shut.

Level 5
Floor exercises
Expanding the movement from week 3 to a full plant and cut, then a jump shot with two-legged landing.

Mat exercises
The players jump on a mat catching the ball, then take a 180° turn on the mat.

Wobble board exercises
Two players, both standing on balance boards trying to push partner out of balance, first on two legs, then on one leg.

Squats:
Imagine that you are sitting down on a chair. Perform squats by bending your hips and knees to 90 degrees, do not let your knees cave inward. Bend slowly and straighten up more quickly.

Nordic Hamstrings:
Your body should be completely straight from the shoulder to the knee. Lean forward as far as you can by using the hamstring muscles to resist the forward falling motion.

Squat–walking lunges:
As you lunge forward, bend your lead leg until the hip and knee are bent to 90 degrees. Do not let your knee cave inward. Keep your upper body and hips steady.

Lateral jumps:
Jump approx. 1m sideways from one leg to the other, like a skater. Land gently on the ball of your foot. Bend your hips and knees slightly and do not let your knee cave inward.

Sprunglauf:
Spring as high and far as possible off the supporting leg. Bring the knee of the trailing leg up as high as possible and the opposite arm in front of the body.

Figure 2: Prevention of ACL injuries in team sport (Myklebust et al10).
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Instructions</th>
<th>Repetitions/duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>One legged knee squat:</td>
<td>Slow movement with smooth turn, horizontal pelvis and non-supporting foot in front of body with slightly flexed hip and knee</td>
<td></td>
</tr>
<tr>
<td>Level A</td>
<td>Hands on hips</td>
<td>3-8-15 reps</td>
</tr>
<tr>
<td>Level B</td>
<td>Hold ball over head with straight arms</td>
<td>3-8-15 reps</td>
</tr>
<tr>
<td>Level C</td>
<td>Hands on hips; mark with non-supporting foot just above ground at 12-02-04-06 o'clock positions</td>
<td>3-5 reps</td>
</tr>
<tr>
<td>Level D</td>
<td>Bend down while holding ball and let ball touch ground outside supporting foot; make diagonal movement upwards and raise ball over head with straight arms on contralateral side</td>
<td>3-8-15 reps</td>
</tr>
<tr>
<td>Pair exercise</td>
<td>Teammate stands slightly oblique in front of you and ball is pressed between lateral sides of feet of non-supporting legs</td>
<td>3-5-10 reps</td>
</tr>
</tbody>
</table>

Pelvic lift: Supine position; lift pelvis from ground while keeping back straight

| Level A                   | Both feet on ground and hands across chest                                   | 3-8-15 reps          |
| Level B                   | One foot on ground and contralateral leg flexed in hip and knee 90° with both hands on knee | 3-8-15 reps          |
| Level C                   | One foot on football and contralateral leg flexed in hip and knee 90° with arms on ground alongside body | 3-8-15 reps          |
| Level D                   | One foot on ground and other in air; keep upper arms on ground with elbows flexed 90°; push away supporting foot and land on contralateral foot | 3-8-15 reps          |
| Pair exercise             | Teammate stands with flexed knees and supports heel of one of your feet in her hands; hands across chest and lift pelvis | 3-8-15 reps          |

Two legged knee squat: Slow movement with smooth turn, back in straight position and feet shoulder-wide apart with soles in contact with ground

| Level A                   | Hold ball in front of body with straight arms                                 | 3-8-15 reps          |
| Level B                   | Hands on hips                                                                | 3-8-15 reps          |
| Level C                   | Hold ball over head with straight arms                                       | 3-8-15 reps          |
| Level D                   | Same as level C but continue movement and rise up on toes after returning to starting position and stay briefly in that position | 3-8-15 reps          |
| Pair exercise             | Teammate stands next to you approximately 1 m away, facing opposite directions; hold ball between you with one hand and other hand on hip; apply slight pressure on ball while performing knee squat | 3-8-15 reps          |

The bench: Lift body and keep it in straight line

| Level A                   | Prone position; support on knees and on lower arms with elbows kept under shoulders | 15-30 sec            |
| Level B                   | Same as level A but with support on tip of feet                                | 15-30 sec            |
| Level C                   | Same as level B, but move foot to side and back to starting position; alternate sides | 15-30 sec            |
| Level D                   | Lie sideways with support on foot and lower arm with elbow kept under shoulder and other hand on hip; lift hip off ground and stay briefly in that position with good control before slowly returning to starting position | 5-10 reps            |
| Pair exercise             | Teammate stands behind you and holds your feet or lower legs; lift the body and walk forward by using hands on ground | 15-30 sec            |

The lunge: Take deep step with marked knee lift and soft landing; rear knee should not touch ground

| Level A                   | Hands on hips; move forward with each step                                   | 3-8-15 reps          |
| Level B                   | Hold ball in front of body with straight arms; rotate upper body while stepping forward and position ball laterally of front leg; move forward with each step and alternate sides | 3-8-15 reps          |
| Level C                   | Hold ball over head with straight arms; perform forward lunge and push back with front leg and return to starting position | 3-8-15 reps          |
| Level D                   | Hold ball in front of body with straight arms; perform sideways lunge and return to starting position | 3-8-15 reps          |
| Pair-exercise             | Teammate stands in front of you 5-10 m away; perform forward lunge while making throw-in with ball | 3-8-15 reps          |

Jump/landing: Make jump with soft landing; stay briefly in landing position

| Level A                   | Stand on one leg with knee slightly bent and hands on hips; make short forward jump and land on same foot; jump backwards to starting position | 3-8-15 reps          |
| Level B                   | Stand on two legs shoulder-wide apart with hands on back; make sideways jump and land on one foot; alternate sides | 3-8-15 reps          |
| Level C                   | Take a few quick steps on same spot and make short jump straight forward landing on one foot | 3-5 reps             |
| Level D                   | Same as level C, but change direction and jump to one side (90° turn); alternate sides | 3-5 reps             |
| Pair exercise             | Teammate stands in front of you approximately 5 m away; make two legged jump while heading football and land on two legs | 3-8-15 reps          |

Figure 3: Knäkontroll (Waldén et al12).
### The 11+

**PART 1: RUNNING EXERCISES - 8 MINUTES**

1. **RUNNING STRAIGHT AHEAD**
2. **RUNNING HIP OUT**
3. **RUNNING HIP IN**
4. **RUNNING CIRCLING**
5. **RUNNING RUNNING & JUMPING**
6. **RUNNING QUICK RUN**

**PART 2: STRENGTH - PLYOMETRICS - BALANCE - 10 MINUTES**

**LEVEL 1**

1. **PLANK BOTH LEGS - 1 min**
2. **PLANK STATIC - 1 min on each side**
3. **PLANK DYNAMIC - 2 sets on each side**
4. **HAMSTRINGS - NORDIC HAMSTRINGS - 1 set**
5. **SQUATS WITH TOE RAISE - 3 sets**
6. **SQUATS - 3 sets**
7. **JUMPING VERTICAL JUMPS - 2 sets**

**LEVEL 2**

1. **PLANK ALTERNATE LEGS - 3 sets**
2. **PLANK WITH LEG LIFT - 2 sets on each side**
3. **HAMSTRINGS - NORDIC HAMSTRINGS - 1 set**
4. **SQUATS - 3 sets**
5. **JUMPING LATERAL JUMPS - 2 sets**

**LEVEL 3**

1. **PLANK ONE LEG LIFT - 3 sets**
2. **PLANK WITH LEG LIFT - 2 sets on each side**
3. **HAMSTRINGS - NORDIC HAMSTRINGS - 1 set**
4. **SQUATS - 3 sets**
5. **JUMPING BOX JUMPS - 2 sets**

**PART 3: RUNNING EXERCISES - 2 MINUTES**

1. **RUNNING OVER THE PITCH**
2. **RUNNING OVER THE PITCH**
3. **RUNNING ROUNDING RUN**
4. **RUNNING RUNNING & CUTTING**

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*Figure 4: FIFA 11+ (Soligard et al)*
Who should be targeted?

Most prevention programmes today are created as ‘one-size fits all’ package to be performed by all athletes. Perhaps future studies will give more specific knowledge about which type of exercises different sports and different athletes should perform. Further evidence is needed to determine whether a pre-season functional test e.g. by a drop-jump or single-leg squad test, can be used to identify athletes with higher risk. A study by Soligard et al showed that across different skill attributes, players with high levels of football skills were at greater risk of sustaining injuries than their less skilled teammates. In other words, there are direct and indirect performance benefits from keeping players free of injury.

The Coach is the key!

Winning and performance are the key factors for coaches and players. Therefore, motivating coaches and players to follow exercise programmes is easier if they do not only to prevent injuries but also is provide direct performance benefit. It might be expected that by implementing a 15 to 20 minute injury prevention programme, physical performance should also improve. However, there is limited research on this with conflicting outcomes.

Coach education is the key. Well-trained coaches can deliver a new exercise programme in the correct way. Knowledge of sports injuries, injury prevention, attitudes and beliefs to the importance of injury prevention training is quite varied among coaches. Without doubt, injury prevention should be mandatory as part of the coach education and certification at all levels.

TAKE HOME MESSAGE

It is possible to prevent ACL injuries, however, much research is still needed to make the current programmes even better and maybe more athlete-specific. We know that exercise programmes need to include a combination of balance, co-ordination, lower limb and core strength, plyometric and agility exercises. A better understanding of ACL injury risk factors and mechanisms will help us to optimise current injury prevention programmes. In the meantime, our best recommendation is to establish warm-up routines and put the existing knowledge on ACL injury prevention into practice. Spread this knowledge and convince coaches and athletes that ACL prevention works!

Figure 3: Knäkontroll (knee control) (Page 182)

The neuromuscular warm-up program “Knäkontroll” (“knee control”) significantly reduces the rate of ACL injuries among adolescent female football players (Waldén et al). “Knäkontroll” contains of exercises focusing on knee control and core stability similar to other programs in, for example, handball. The 6 exercises are one-legged knee squat, pelvic lift, two-legged knee squat, the bench, lunge, and exercises on jump/landing technique. Each exercise is subdivided into 4 steps of progressive difficulty and a pair exercise (Table 1). The exercises are to be preceded by 5 minutes of low intensity running and take about 15 minutes to complete after familiarisation. In the project, the teams were instructed to conduct the exercises during the warm-up at 2 training sessions a week throughout the whole season. All players started on the first level of difficulty and proceeded to the next level when exercises were performed with good control as assessed by the coach.

Figure 4: The FIFA 11+ (Page 183)

In a randomised controlled study by Soligard et al, the objective was to examine the effect of a comprehensive warm-up program designed to reduce the risk of lower extremity injuries among female soccer players. Approximately 1900 players participated in the study. The 15-20 min warm-up program, called “The FIFA 11+” includes exercises to improve lower extremity and core strength, awareness and neuromuscular control during static and dynamic movements. After 8 months of training, the intervention group had a significantly lower risk of injuries overall (32%), of overuse injuries (53%) and of severe injuries (45%) compared with the controls. The “11+” exercises, as in many of the other neuromuscular exercise programs, compose a multifaceted program, provide variation and progression of exercises, and address many training components that are thought to be related to ACL and lower extremity injury risk.

Key Aspects of Successful Injury Prevention Programmes

Multi-component warm-up programmes, including a combination of balance/co-ordination, technique, lower limb and core strength, plyometric and agility exercises.

Focus on technique:
- two-leg landings.
- a more narrow cutting technique.
- proper balance with hip, knee and toe in line.

Include a variety of exercises with a progression from easy to more difficult to continually pose a challenge to athletes (important for motivation).
Include exercises in pairs to make training more fun, but also to maximise movement quality.
Include ball exercises when basic exercises are well-established.
players with high levels of football skills are at greater risk of sustaining injuries

References


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