Knee Injuries

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Knee Injuries in Female Athletes

It is well established that female athletes, from adolescence onwards, are at greater risk of serious knee injury compared to males. The two most common serious knee injuries are ACL rupture and patellar dislocation. Consider the following telling statistics:

ACL Injury: From the age of 13 years the risk increases dramatically for girls (2), and the rate of ACL reconstructive surgery peaks at age 16 (2). Depending on the sport, females have between 2 to 8 times greater risk than males. The higher risk sports are the pivoting / cutting, and jump and land sports, including gymnastics, soccer, European handball, volleyball, netball, and basketball (2,3). Females are more likely to have the associated risk factors of anterior pelvic tilt*, femoral anteversion**, genu valgum, genu recurvatum, and increased "Q" angle (2). Post ACL-reconstruction, females with known risk factors had a 44% risk of sustaining a second ACL injury (1). Of those who go on to suffer a contralateral ACL rupture, up to 88% will be female (1).

Patellofemoral instability: While figures for male and female rates of instability are similar, in the high risk ages (10-17 years) girls have a 33% greater risk than boys (6,7). Females have a 3 times greater risk for recurrent instability (6). In patients with patellofemoral instability, females are more likely to have the associated risk factors of hypermobility, femoral anteversion, positive "J" sign, trochlear dysplasia, increased "Q" angle, and patella alta (5,6). It has been suggested that girls are at significantly higher risk, and the similar rates statistically are an indication that boys engage in higher risk activities than girls. This is supported by data that show females were more likely to dislocate during "low-risk" and "no-risk" activities, while most dislocations in males occurred during "high-risk pivoting activities" (5) .

Injury Factors:

So what are the main factors that place females at such significantly greater risk? Most of the following information has come from studies of ACL injuries:

1. Compared to males, females do not have a 'neuromuscular spurt' to match their growth spurt, meaning they develop greater size and weight without an accompanying increase in muscle size and strength to help control movement (2). The reasons for this are not entirely clear but may relate to hormonal factors, biomechanical deficiencies and / or training differences (1,2).
2. Females appear to have greater knee laxity, and this laxity may increase cyclically with hormonal changes (2).
3. Females are more likely to have anatomical and biomechanical risk factors. Most of these are mentioned above. Other reported risks include the greater likelihood of females having a smaller femoral intercondylar notch width, & smaller size of the ACL (2). *Anterior pelvic tilt places the hamstrings and gluteals in a lengthened & weakened position, and contributes to greater internal femoral rotation (2). **Internal femoral rotation (due to femoral anteversion, postural dysfunction &/or poor muscle control) places the gluteals and hip

external rotators at a mechanical disadvantage, contributing to strength deficiencies (see point 5 below).

4. Studies of jump / land and pivoting / cutting show that in general, females are much more likely to demonstrate functional "collapse". This is due to a combination of hip adduction and external rotation, knee valgus (27.6° compared to 16.1° for males in one study), and tibial external rotation (2). When landing from a jump, males were found to absorb on average 38% of forces through the hip, compared to only 19% for females (2). Females have a tendency to land on a more extended hip and knee, and to land with the upper body weight further behind the knee. This increases stress on the ACL due to tibial anterior translation, increases ground reaction forces, and contributes to quadriceps dominance (see below) (2).

5. Muscle strength factors: Females are more likely to demonstrate greater imbalances between the quadriceps and hamstrings (quads dominance). Females are also likely to have reduced relative hip abductor and external rotator muscle strength & increased relative flexor / adductor strength (2). These strength imbalances may relate to training, biomechanical and / or postural factors. Overall, female leg muscles exhibit around 20% less resistance to dynamic stretch compared to age and size-matched males (2).

Low Risk Female Sports

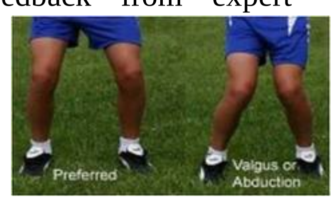
It is very interesting to note that dancers and ice skaters have by far the lowest incidence of ACL injuries amongst all sports. Various theories have been proposed to explain this (2):

- Female dancers had 21% stronger hip abductors compared to other females.
- Dancers demonstrated either normal quads to hamstring ratios, or stronger hamstrings.
- Female dancers had 33% stronger ankle plantar flexors. The calf can contribute to improved knee stability.
- Dancers land on the balls of the feet and on bent knees, promoting effective shock absorption.
- Most forms of dance emphasise hip external rotation, and strong external rotator muscles are required for effective technique. In skating strong abduction and external rotation force is generated by the push-off limb.
- Excellent proprioception and balance is required for these sports.
- Dancers develop their skills gradually, only progressing when certain skills are mastered. In contrast, athletes of junior team sports often attempt movements performed by elite fully developed athletes.

Prevention

Research in the last 15 years has shown that the risks of serious knee injury can be dramatically reduced, through the introduction of specific training programmes. There is good evidence that the neuromuscular spurt can be artificially induced in females, through the implementation of integrative neuromuscular training programmes (3). These programmes result in significant improvements in strength, power and coordination (2,3), and may reduce injury risk to levels equal to that for males (2).

Important components of these integrative programmes are plyometric and strength drills, balance and core stability training, biomechanical analysis and technique feedback from expert trainers. This includes a focus on proper technique and body mechanics, and a "soft" landing at the time of impact. Proper 'athletic position' on landing means that the knees and hips are comfortably flexed, shoulders are back, feet are shoulder width apart, the chest is over the knees, and the body mass is balanced over the balls of the feet (2). Effective single leg balance and landing technique is the ultimate goal.



The prevention programme should be incorporated into the overall sports training regime. One way this has been done successfully has been to integrate it into the training or game-day warm-up. Further recommendations are:

1. The programme should be commenced in pre- and early adolescence. There is evidence that neuromuscular training programmes are more effective the earlier they are introduced. After implementation of such a programme, the risk of ACL injury decreased 72% in pre- or early adolescents, 52% in late teens, and only 16% in over-18's (3).
2. The programme should be commenced pre-season, to avoid the high-risk, early season injury incidence.
3. It needs to be performed a minimum of twice per week for 6 or more weeks.
4. Programmes need to be repetitive, high intensity and progressive, with the aim to train the muscles, connective tissues and nervous system.

The most popular injury prevention programmes have been developed as part of the warm-up routine for soccer in Europe and the U.S. These include:

- The *'PEP' Programme* (Prevent injury & Enhance Performance). This was developed for female soccer players in the U.S., and resulted in a reported reduction in ACL injury incidence of up to 88% (2,4,8,9).
- The FIFA *'11+' Programme*. A study of female soccer players in Europe reported a 30% to 50% reduction in overall injury incidence (not specifically ACL) when this programme was implemented as part of the warm-up (10).

Both programmes are accessible online

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