

# Jumping Injuries: Their Cause, Possible Prevention and Rehabilitation

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## Introduction

The main task for any level of field event coach is to construct and direct a training program that will ensure continual progression of an athlete whilst avoiding injury. This is especially the case with athletes who have had several training years behind them. To improve these athletes in particular, progressive overload in terms of volume and intensity is required.

Jumping ability may be improved via specific strength exercises such as bounding, hopping and box plyometrics. These exercises are stressful on the body due to the short contact times and high ground reaction forces involved. Coaches will know from their practical experience that the specific preparation period is when most injuries occur as both the volume and intensity of training are at a high level.

The coach dictates to a large degree what an athlete does whilst in training, however, it is difficult to dictate everything that an athlete does outside of training as the athlete may pursue an activity or occupation which is stressful on the body. In junior coaching, injuries are not usually frequent as there should be sufficient variety in training and the emphasis should be primarily on enjoyment. Variety is important at this age and repetitive high stress activity to a particular area may cause an overuse type injury. As the athlete progresses into the teenage years, the possibility of injury increases as the training volume increases and the body is growing, so anatomical structures such as bones, tendons and ligaments are vulnerable. As the athlete progresses into a high performance program such as an Institute or Academy of Sport, this is where overuse type injuries typically begin, as the desire by the coach and athlete is to attain the best possible results.

At each of these levels the coach has the most contact with the athletes, hence, coaches should be the first line of defence against injuries. Therefore, it makes sense that the field event coach should have a sound knowledge of what causes jumping injuries and if the desire is elite performance, preventative and rehabilitation exercises should be understood and prescribed in training.

There are many types of jumping injuries which may cause the athlete pain, and these could include (but is by no means an exhaustive):

- \* Stress fracture of feet or shins - the most common sites are the navicular bone in the foot and the tibia (Figure 1)

- \* Achilles tendinitis - the achilles tendon (heel cord) begins to inflame and degenerate (Figure 2)

- \* Plantar fasciitis - inflammatory condition of the plantar fascia accompanied by a sharp pain in the underside of the foot (Figure 3).

- \* Anterior compartment syndrome - pressure increase within the confined space of the front tibial (shin) muscles (Figure 1)

- \* Medial shin splints - inflammation of the deep fascial medial tibial attachment (Figure 1)
- \* Chondromalacia patella - articular cartilage softening underneath the patella (Figure 1).
- \* Patella tendinitis - degeneration and inflammation of the patella tendon (Figure 1)
- \* Spondylolysis - unilateral or bilateral fracture of the pars interarticularis of the vertebrae (Figures 4 and 5)
- \* Spondylolisthesis - vertebral body is displaced anteriorly on the vertebral body below often caused by a bilateral spondylolysis (Figures 4 and 5)
- \* Annular bulge - Outside portion of the intervertebral disc extending beyond the margin of the vertebrae possibly imposing on the sciatic nerve (Figures 4 and 5).

The cause of these injuries in field event athletes and their possible prevention and rehabilitation is the focus of this article. This article is not meant to replace the role of a sports physician or physiotherapist, rather to educate the coach.

### **The Cause of Jumping Injuries**

Most jumping injuries are usually caused by a combination of one or more of the following factors; high ground reaction forces, overuse (especially in elite athletes), poor physical preparation (especially in novice athletes), poor technique and anatomical predisposition (Figure 6). Each one of these factors will be discussed below in turn.

**High Ground Reaction Forces:** As discussed in a previous article on the Coaches Information Service web site (*The Biomechanics of Jumping: The Relevance to Field Event Athletes*), ground reaction forces are high in jumping activities and will be even higher on artificial surfaces (Nigg and Yeadon, 1987). This will cause anatomical structures such as fascia, ligaments, tendons and bones to bear the load during high stress activities such as jumping. Whilst the efficient use of higher ground reaction forces are useful in a performance aspect, in an injury prevention viewpoint, excessive amounts of jumping on a hard surface will eventually lead to injury. The degree of anatomical resilience of an elite level athlete will determine when this happens.

Wearing adequate footwear during jump training is a must to ensure that the ankle joint is stable (does not pronate excessively - see later section for explanation and figure) in addition to absorbing the high ground reaction forces. Athletes need to consult a podiatrist to consider what is best for them.

Throwers should probably not do high volumes of single leg plyometric work due to the fact that these athletes are typically heavier than jumpers. Ground reaction forces will be higher automatically because of their increased weight, therefore, exposing the body to increased risk of injury.

**Overuse:** To get an athlete to perform at the highest level, it is a common coaching practice that high intensity jumping activities are performed in high volume, for example in triple jumpers (Kreyer, 1981). This is especially the case in horizontal jumpers and the high jump where jumping ability is being specifically tested by the measuring tape. It is well known that these jumpers carry injuries throughout their careers.

**Poor Physical Preparation:** The novice athlete is at an increased risk of developing jumping related injuries, as their conditioning level is typically too low for frequent high intensity jumping. There are many novice jumpers that have made an appointment to see the sports physician or physiotherapist a few weeks after commencement of this form of training.

At the other extreme, elite athletes may have specific areas of the body that are conditioned far less than other areas of the body. One area that I have observed this case is the lower leg. High level athletes condition the power generating muscles (such as the quadriceps and gluteals) diligently but, the lower limb muscles such as those that cross the ankle joint in the triple jumper or high jumper are not conditioned until injury halts their desire to perform high volumes of specific training. With this in mind, the volume of high intensity jumping to be performed prohibits the elite performer to be complacent regarding their flexibility and specific muscle conditioning. Prevention, if possible, is inherently better than the cure

**Poor Technique:** Landing on a flat foot in most jumping exercises is essential to avoid injury. You may have already noticed however, that the athlete has shorter contact times when landing on the ball of the foot during a depth jump, but doing this type of jump with any volume will cause injury. For this reason, it is imperative that the coach ensures that good technique is used before a large number of repetitions are attempted. For example, alternate leg bounding is an activity which beginners find difficult to master, especially the reach and paw technique that assists the athlete in positioning the foot flat on the ground. Novices find the action of hopping and repeat double leg jumps far more natural and thus an increased number of repetitions can be performed in these exercises whilst alternate leg bounding is being mastered. Once technique has stabilised then you should proceed with higher volumes of these particular exercises.

**Anatomical Predisposition:** Some athletes may have a particular anatomical structure, muscle imbalance or inflexibility that will predispose them to injury. For example, an athlete may have a congenitally fused intervertebral disc that will tend to cause back problems, or an athlete may have some form of foot structure which may predispose the athlete to a navicular stress fracture. The first a coach usually knows about these problems is when an athlete gets injured with relatively low training loads. More commonly however lower limb injuries are due to problems such as leg length discrepancy (legs are of unequal length), excessive pronation, excessive pelvic drop (Figure 8) and achilles tendon inflexibility (Kibler et al., 1991; Fredricson, 1996).

A leg length discrepancy can either be anatomical (a true difference between leg lengths) or functional (for example, caused by pelvic dysfunction). These are major problems as a functional scoliosis (change of the normal spine alignment) is caused a stresses on the body are subsequently not equal. These are

usually corrected by a lift placed in the shoe to level the pelvic base. A leg length discrepancy can usually be seen in an athlete who drops a shoulder whilst running.

A lot of confusion exists regarding pronation. Pronation is a normal part of foot mechanics and is a movement that occurs at the ankle joint after the foot strikes the ground. It is the excessive amount of this movement that causes a lot of the problems. When a foot pronates, the foot rolls outwards (everts) the lower leg moves forward over the foot (dorsiflexes), and the foot moves away from the midline (abducts) (Figure 7). Supination occurs after pronation and consists of the opposite movements to pronation ie. foot rolls inwards (inverts), ankle joint extends (plantarflexes) and the foot moves towards the midline (adduction) (Figure 8). Pronation has been linked to most of the abovementioned lower limb injuries, therefore if present should be corrected by an orthotic.

In single limb stance such as that occurring in running or jumping, when one leg is in contact with the ground, if the middle gluteal muscles (the muscles which sits directly beneath the large gluteal muscle which is essentially the buttock), are weak and/or lack control there will be a large pelvic drop on the side opposite to the stance leg (Figure 9). This is a problem which physiotherapists pay great attention to in rehabilitation from most lower limb injuries.

A majority of knee problems are due to abnormal patella (kneecap) tracking. The vastus medialis oblique (the teardrop shaped muscle on the inner quadricep - VMO) is the only muscle on the medial side of patella, whereas there are many muscles on the lateral side of the patella which pull on the kneecap. A weak VMO will result in the patella being pulled laterally especially the last 20 degree of extension during the stance phase of running or jumping (Fredricson, 1996).

Achilles tendon inflexibility can be a major cause of lower limb problems in jumping athletes. A tight achilles tendon can result in excessive pronation as a compensatory mechanism, which in turn may cause many lower limb injuries as discussed above.

### **Prevention and Rehabilitation of Jumpers Injuries**

What happens to the human body under high loads is not predictable and no two people are the same, therefore, two athletes of similar level may not be able tolerate the same training load. Coaching is sometimes a science and sometimes an art. A lot of good decisions are made on 'gut feeling' and experience (the art) backed up by a sound knowledge of biomechanics and anatomy (the science). I will try and add some science to your coaching via the following discussion of exercises to possibly prevent injury. The fact a lot of these types of exercises are prescribed when an athlete is injured leads me to believe they should probably be part of a regular training program to delay, or prevent injury.

Feet: Mann et al. (1986) examined the activity of the intrinsic muscles in the foot during running found that these muscles are active during the stance phase of running to maintain the structural integrity of the foot. The intrinsic muscles of the foot can be conditioned via towel scrunches, barefoot running and by continuously picking up objects like marbles and pencils with the toes.

Ankle: These muscles may seem insignificant at first glance but the jumping athlete is only as strong as their weakest link and in a lot of cases, the weak link is the lower limb. My gut feeling is a lot of injuries (especially so in novice athletes) could be avoided by spending time doing the following exercises:

- \* Using theratubing to perform ankle inversion, eversion and dorsiflexion exercises
- \* Using an ankle board to perform various exercises
- \* Walking sideways across a hill
- \* Walking on the toes, heels, inside and outside of the feet
- \* Stretching the achilles tendon and strengthening the plantarflexors

These exercises are necessary as the muscles of the lower limb such as soleus and tibialis posterior have a function to control pronation (Reber et al., 1993; Feltner et al., 1994). Furthermore, tibialis anterior is a muscle responsible for approximately 85% of the gait cycle of which 25% is during the stance phase (Mann et al., 1986). These muscles therefore can fatigue easily in high intensity exercise and their true function may be compromised.

Knee: From examining some of the scientific literature on squatting, it is not just a strength building exercise, but it could be an injury prevention exercise as well. By controlling the downward (eccentric) phase of the squat the patella tendon is strengthened. Tendons and ligaments adapt to greater loads by getting larger and getting stronger for their size (Butler et al., 1978; Tipton et al., 1975). Further, the transition region between the ligament or tendon and bone strengthens.

Also in the squats favour is research by Anderson et al., (1998) that the VMO activity is increased by squatting to around parallel. Further, Wilk et al. (1996) found that the muscle activity of the quadriceps was greatest in a section below parallel to slightly above parallel. There has been much controversy amongst strength and conditioning specialists and sports physicians and physiotherapists that deep squatting should be avoided as the stress on the knees is high. From my coaching experience, I think there is more benefits and drawbacks if executed correctly.

Hip and Back: Hip Abductors, that is the middle gluteal muscles (gluteus medius and minimus) act to stabilise the pelvis against excessive lateral pelvic whilst in single limb weight bearing as discussed above. For example, in bounding and hopping or box plyometrics, when a single leg strikes the ground the opposite hip will drop. Hip abduction exercises using theraband and maybe even pulleys in the gym will exercise these muscles.

To prevent back injuries such as spondylolysis, spondylolisthesis and annular bulge the back and abdominals musculature needs to be well conditioned. Previous research (eg. Garhammer, 1978) has identified Olympic lifting as an activity which produces very high power levels, based on the weight of the bar and the speed in which it travels.

Correct technique in the Olympic lifts is of paramount importance to maximise power output to the desired musculature. Further, good technique demands that the low back adopt a neutral, or lordotic posture, whilst the bar is being pulled to hip level. Enoka (1979) reported that the first pull of the Olympic lifts was the most demanding on the lower back. Further, Cholewicki et al. (1991) reported that the average compressive load on the L4/L5 intervertebral joint during such a lift was 17,192N (an equivalent of approximately 1754kg). It is thought that raising the bar above the head, such as which occurs in the jerk, will recruit the abdominal muscles to stiffen the trunk.

### **A Case for Musculoskeletal Screening of Jumpers**

Musculoskeletal variations such as an anatomical leg length discrepancy and excessive pronation which the non-athlete would never be bothered by, or would be effected later in life, can cause injury to athletes, and especially elite athletes, because of the internal forces and the volume of training involved. Musculoskeletal screening is a process whereby potential problems are identified so that they can be corrected by a variety of sports medicine professionals. For example, an anatomical leg length discrepancy of 10mm may be detected by a radiologist in cohorts with a sports physician and then may be corrected by a podiatrist placing a lift of partial difference in the shoe, thus placing the pelvis level. Screening does not guarantee that the athlete will not get injured, but it will more than likely decrease the probability.

Prior to undertaking serious jumps training a sports physician should be consulted to screen a potential jumper so that the abovementioned problems may be identified. The coach should start paying attention to typical problem areas with the above exercises.

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