The Irish Association of Snowsports Instructors

David Murrie

Former Head of Department of Coaching & Exercise Sciences (England & Scotland)

Professor of Sports Biomechanics & Physical Education (USA) and

Principal Lecturer in Sports Science & Conditioning, School of Physiotherapy (England)

www.iasisnowsports.ie

Biomechanics - "*Know it, Use it*":
For safer & more effective, teaching & coaching

Prevent knee and back injury and enhance performance

Slick Science

Population: 4.5 million

Capital: Dublin

Language: Irish & English

Snow in Ireland

Corran Tuathail / Carrauntoohil
The highest mountain in Ireland
1,038m

Ireland`s Indoor ski club & school

Tamsen McGarry

(35th Slalom, Salt Lake City 2002)

Kirsty McGarry

(32nd GS, Torino 2006)

Skiing in Ireland

Night Skiing!

Powder day!

Ireland`s ski centre:
Kilternan (opened 1974)

2008 – awarded the title
“National Snowsports Centre for Ireland”

Shane O`Connor (46th Slalom, Are 2007, World Championships) is the first Irish Olympic skier to have developed `at home`, The Ski Club of Ireland (formed in 1964), with limited access to snow.

FIS recognised races since 1992

Ireland`s Best Olympic Results

Thomas Foley (31st GS Torino, 2006
and Europa Cup, 9th place Skier Cross 2009)

Patrick-Paul Schwarzacher-Joyce
(15th Combined & 27th Downhill, Nagano 1998)

Our Association

Formed 1988

Transferring knowledge into practice

Currently 147 members, Including 12 level 4, 17 ISIA level 3, 13 IVSI race coaches & 11 snowboard instructors.

(Working in Dublin, Chamonix, Whistler, Swiss resorts including Verbier, NZ & in the Eastern USA).

Biomechanics

"…use it" - in injury prevention

knee and spine hazard management

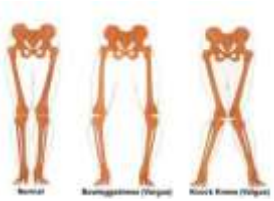
Health & Performance

(occupational hazard - chronic knee & back injuries)

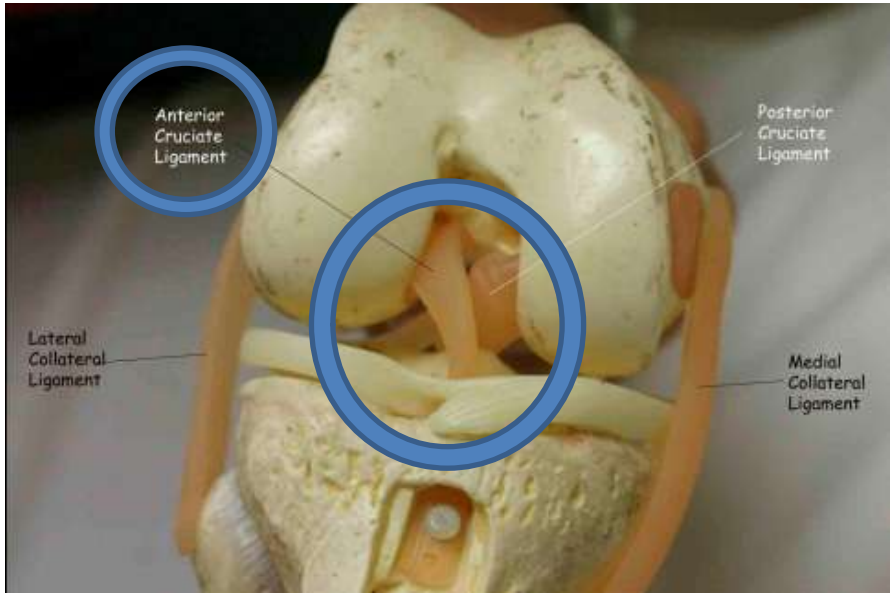
The knee remains the predominant injury location
(e.g. accounting for more than 50% of all injuries in female skiers)

12 days after torn ACL

14th January 2011



Main ACL Injury Mechanisms



Phantom foot: knee flexion internal rotation ; Usually at low speed or stopped, backward twisting fall (often in children and beginners and intermediate level skiers).

Anterior drawer – heavy impact, legs extended on tail of ski. The `Boot Induced` Anterior Drawer (BIAD) mechanism e.g. in jumps or moguls (or hit from behind).

Valgus external rotation – e.g. ski hitting gate, or in forward ski split fall.

`Slip-catch` recovery in racing .

Pete Gillespie

Cartilage (meniscus) tear with a slack anterior cruciate ligament substantially alters cartilage contact pressures.

Which worsens cartilage degeneration and progression of osteoarthritis.

With a ruptured ligament and more significant tears of the menisci, even a reconstructed knee will have altered mechanics compared with the uninjured limb, further contributing to the risk of post-injury, knee osteoarthritis.

20% reinjure the ACL and 40% require additional surgery…

Returning to sports involving dynamic loading contributes to accelerated joint degeneration.

TODAY`S MESSAGE:
Save the ACL !

ACL: a structure unique to the Knee

In 96% of ligament Injuries the bindings don't release. Statistically, more vulnerable are recreational females aged 14 to 59 years.

Along with preparatory plyometric strength and proprioceptive training annual binding adjustments should help to reduce knee injuries in female carving skiers. (Some studies advocate a 15% reduction in setting).

The MCL is also injured in 30% of ACL injuries. The MCL is attached to the medial meniscus and remember when cartilage is damaged this leads to early onset arthritis particularly in those who return to dynamic sport.

KEY MESSAGE -

The ACL and MCL, as well as the supporting muscles, have proprioceptors -

– so they can `feel` , and so they can `learn`! - and so teach them !!

Asymmetry : Dominant side

High prevalence of left ACL injury observed in other sports.

& left ACL injury with right turning was the most prevalent suffered by alpine skiers (additional rotation of the dominant side).

Most alpine skiers with no history of ACL injury show limited laterality in knee strengths, reaction time, and knee movements.

But, people with recent injuries show differences (due to limitations of surgery, inadequate rehabilitation, lack of objective functional evaluation).

In rehabilitation, and in training, planning, and functional evaluation of people is very important.

Children

Increased ACL injury rates in girls have seen at age 12 peaking at 16 in other sports.

Children with medial sided knee pain should have stress radiographs of the knee to identify common bone growth injuries. Note, with increased intensity of competitive sport in children, some studies have shown that bone growth injuries are frequently associated with ligament injuries.

ACL

Injury Prevention Strategy & Programs

….as part of instructor and skier, teaching

Proven Results in Decreasing ACL Injuries:

Football, Handball, Basketball, Volleyball, Female Athletes generally, Ski Patrol, Ski Instructors
(http://www.vermontskisafety.com/kneefriendly.php)

BY 41%-72%

Risk Factors

Previous injury - quadriceps extensor lag, hamstring (graft) lag. Tendon / Ligament damage (joint laxity) can, take months if not years, to recover.

Lack of coordination and balance!

Poor alignment / lateral imbalances in loading (e.g. aligning to knees over the second toes)

Dynamic knee stability (e.g., quadriceps muscles, VMO, hamstrings, gastrocnemius)

Higher speeds (males 16-25)

Being Female? (4-7 times greater in other activities). Females return slower and return less to skiing after an ACL injury.

(Higher and stiffer boots)

Bindings!

Reducing the risk: Multi-components

Risk Awareness (US Ski Patrol and Ski Instructors).

`FEEL IT`: Balance and perturbation training (reaction and co-contraction): Increased sensitivity of the muscle spindles for a higher state of "readiness" to respond to forces applied to the joint, which in turn, improves joint stability.

`DO IT`: Muscle (balanced) Strengthening – using closed kinetic chain.

`FEEL IT`: Alignment Motor Control - Fundamental step &jump movements (avoiding internal torque). Injury prevention pre-activation/coordination (in boot) - in `warm up`.

`DO IT`: Agility training.

`DO IT`: Plyometrics: neural, muscular and tendon training with eccentric loading.

`DO IT`: Recovery (hydration, refuelling, rest, contrast baths, compression wear).

`DO IT`: Quality and variety in training NOT repetitive volume (e.g. not all day/days in gates).

Proprioception (`feel it`)
– balance, agility & coordination

Stork standing

Change from conscious to unconscious – e.g. ball catch

2 footed squat jumps, 180 degrees and hold

Hops:
- Forward back, lateral, cross pattern, line, side.
- 4 corners of square clockwise & anticlockwise
- Round a `clock face, hop and hold.

`Slide board

`W` formation running

Agility run

Box jumps (lateral)

Take home messages –

`Do` additional exercises in your ski boots - for earlier and more powerful stabilisation.
`Do` direction change hopping with `quiet` landings - to absorb the landing by better controlled eccentric muscle work.

Performance-based measures of knee function

1. A single hop for distance

2. A triple crossover hop for distance in which the skier crosses over a 15-cm wide `gap` with each consecutive hop

3. A straight triple hop for distance

4. A timed hop in which the skier hops a distance of 25m as fast as possible

- appear also to reflect `impairment`.

(The tests are all single-limb hop tests).

Ingemar Stenmark:
Progressive Skill Ski-in

Pre-ski - Controlled Boot exercises

Single leg squats

Side slipping. Slow medium radius parallel steering (accuracy).

Vary the radius of turns, types of turns, changing stance height, ski with separation, short series of short radius, (racers going from short progressively through to longer skis)

Monitor alignment, posture and weight transference.

Flat & groomed to start and building up to more demanding runs.

Often skiers have rehabilitated well in the gym and then just go straight out onto snow and hammer down runs– **this phase and warm up / `ski-in` has to be controlled and must be gradual** otherwise there is risk of (further) injury as the body has to adapt and (re)learn in order to cope with the forces and demands of being on snow.

Back Issues

The human spine is inherently unstable without its musculature.

& Importantly Low Back Pain leads to reduced muscle strength and recruitment of the key deep stabilisers.

Low Back Pain

Poor postural control leaves the spine vulnerable to injury.

Combination of compression, spinal flexion & twist is particularly harmful to the lumbar spine

Posture

Good posture allows range of movement minimises muscular work AND minimises joint loading.

Key message –

Learn to identify lumbar neutral & control pelvic tilt.

Tilt of the pelvis largely dictates spinal posture

Example drills:

– check for pelvis dipping instead of lifting when lifting one ski.

– one legged squats.

(Note: Tight hamstrings limit pelvic tilt)

Avoid prolonged flexion!

Prolonged flexed posture (20mins) imparts significant strain on the lumbar spine that can take up to 7hrs to recover from!

MOVE ! and VARY the movement, posture and stance.

Lumbar Control

Neutral spine practice.

`At Risk` Isometric Muscular Endurance Test (secs)

	M	W
Lateral bridge (both sides)	100	80
Prone back (extensors)	160	185
55 degree `V sit` (flexors)	135	135

Recommendations

Warm-up - Recall accurate, coordinated movement. ..

Dynamic stability & neuromuscular co-ordination for joint protection.

Skill Sensitivity: Positional awareness, movement sense and spinal bracing.

Edging in ski boots on wobble board; double and single

Stepping F/B lateral and diagonal

Lunge, squat, plié

Step up, step down, lateral step-up & down

Single leg multidirectional hopping

Bench hop downs

Single leg squats

Agility figure 8 runs

Plyometrics (e.g. bounding)

Post-ski stretching particularly foot, ankle, lumbar spine & hip flexors.

Flexibility training to reduce one-sided-ness.

Generalised Age Related Factors

Biochemical, mechanical and postural changes are gradual - in the composition, stiffness, structure and control of tissues.

Typically; muscle and tendon becomes `plastic` and less elastic. Bone`s mineral content reduces and osteoporosis develops. Ligaments and tendon are less durable to stresses, more prone to tear and repair slower & less well. Knee Injury points tend to move higher from children to adults.

Offsetting Age Related Factors

Function starts to diminish at approximately 35yrs & typically noticeable post 45yrs:

E.g. The ability of the spine to cope with compression declines by about 30% in middle-age, with decreased motor control & `feed-forward` and consequently decreased stability of lumber spine. For females 10 years immediately post menopause has greatest loss).

Post 60yrs - 15% strength loss per decade.

`Take home` messages

-Train it or lose it !

(& Don't forget your hamstrings & glutes)

ACL and Back injuries are serious and a serious problem in skiers and ski instructors.

ACL and Back injuries and problems can be significantly reduced.

BY: regular practice of high quality dynamic neuromuscular control.

And the same safety practice and training is also performance enhancing.

Acknowledgments

Die Ublichen Verdachtigen

The Members of
The Irish Association of Snowsports Instructors

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Derek Tate	**(Head of Training)**
Pete Gillespie	**(Trainer)**
Toby Fischel	**(Trainer)**

The Original Researchers

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Columbia

Parallel Dreams

Hemel Snow Centre

In Homage to “Hannes” Schneider, Stefan Kruckenhauser & `the cradle of alpine skiing`

- Thank you.