FIS Injury Surveillance System

Video analysis of 4 ACL injuries

2012/13 World Cup season

Oslo Sports Trauma
RESEARCH CENTER

Introduction

Injury recording through the FIS Injury Surveillance System (FIS ISS) revealed that there were four anterior cruciate ligament (ACL) injuries during World Cup competitions throughout the 2012/13 season. After the end of the 2012/13 season, FIS enquired the help of the Oslo Sports Trauma Research Center (OSTRC) to perform video analyses of these four injury situations.

Tone Bere (PT PhD), Tron Krosshaug (PhD) and Roald Bahr (MD PhD) reviewed the four injury situations. Previously designed analysis forms were used to assist the reviewers in identifying the time of injury (index frame), the circumstances of injury, the skiing situation, skier behaviour, and estimates of joint angles and limb positions where this was possible. It was not possible to estimate joint angles and limb positions in cases where there were inadequate camera views or insufficient views of the injured limb.

The video analysis revealed that of the four ACL injuries, two were atypical slip-catch injury mechanisms, one injury was a valgus collapse and one injury was a landing back weighted injury mechanism.

Case summaries were compiled for each of the four injuries and are presented in this report.

Oslo, September 2013

Sophie Steenstrup
Tone Bere
Tron Krosshaug
Roald Bahr

Injury Case 1

Table 1. Injury information

Gender	Injured knee	Discipline	Circumstances	Additional injury	Index frame
Female	Left	Giant Slalom	WC competition		C(162, view 1)

Table 2. Weather and course conditions

Weather condition	Visibility	Snow condition	Piste condition	Type of terrain
Clear	Reduced (flat light)	Icy	Smooth	Medium steep

Landing back weighted

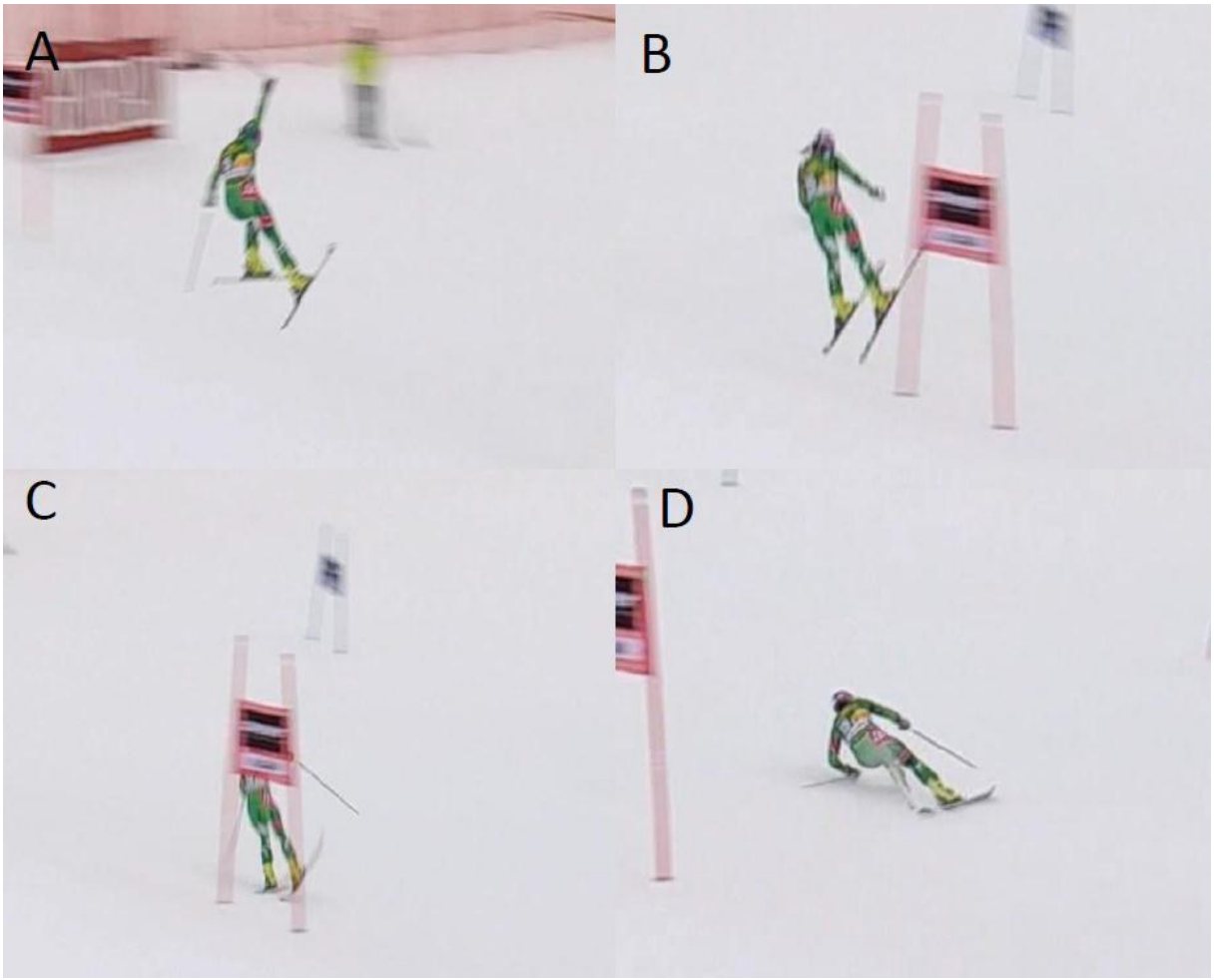

Figure 1. **A** (-240ms) The skier takes too much air and is off balance backwards and to the left during a jump. **B** (- 120ms) The skier lands on the ski tails (mainly left) after the jump. **C** (index frame) The weight distribution is mainly on the left ski. **D (**+280 ms) the skier falls inward over her left side. There is no binding release.

Skiing situation (prior to injury):

The skier is in uncontrolled flight after a jump in a left hand turn. She is out of balance backward and to the left, with the weight distribution mainly on her left ski. Both skis are going straight forward.

Injury mechanism (at the time of injury):

This injury can be classified as a "Landing back weighted" injury mechanism. The skier lands on the ski tails (mainly the left tail) after a jump. The injury is believed to result from a compression and a boot-induced anterior drawer of her left knee combined with quadriceps contraction. Both knees and hips of the injured and uninjured side move towards a flexed position, but no knee valgus is observed (difficult to observe from the camera angle). The hips remain in a static position. Her arms are in a forward flexed and abducted position.

Table 3. Knee and hip positions at the time of injury.

	Knee flexion		**Hip flexion**	
	Angle	**Movement**	**Angle**	**Movement**
Injured leg	25º	Towards flex.	30º	Towards flex.
Non injured leg	5º	Towards flex.	20º	Towards flex.

After the injury situation, the skier falls. There is no binding release on either side during the injury situation.

Injury Case 2

Table 1. Injury information

Gender	Injured knee	Discipline	Circumstances	Additional injury	Index frame
Male	Left	Super-G	WSC competition	Bone bruise	C (78, version 1, short)

Table 2. Weather and course conditions

Weather condition	Visibility	Snow condition	Piste condition	Type of terrain
Clear	Reduced (flat light)	Hard	Rough/bumpy	Medium steep

Atypical slip-catch

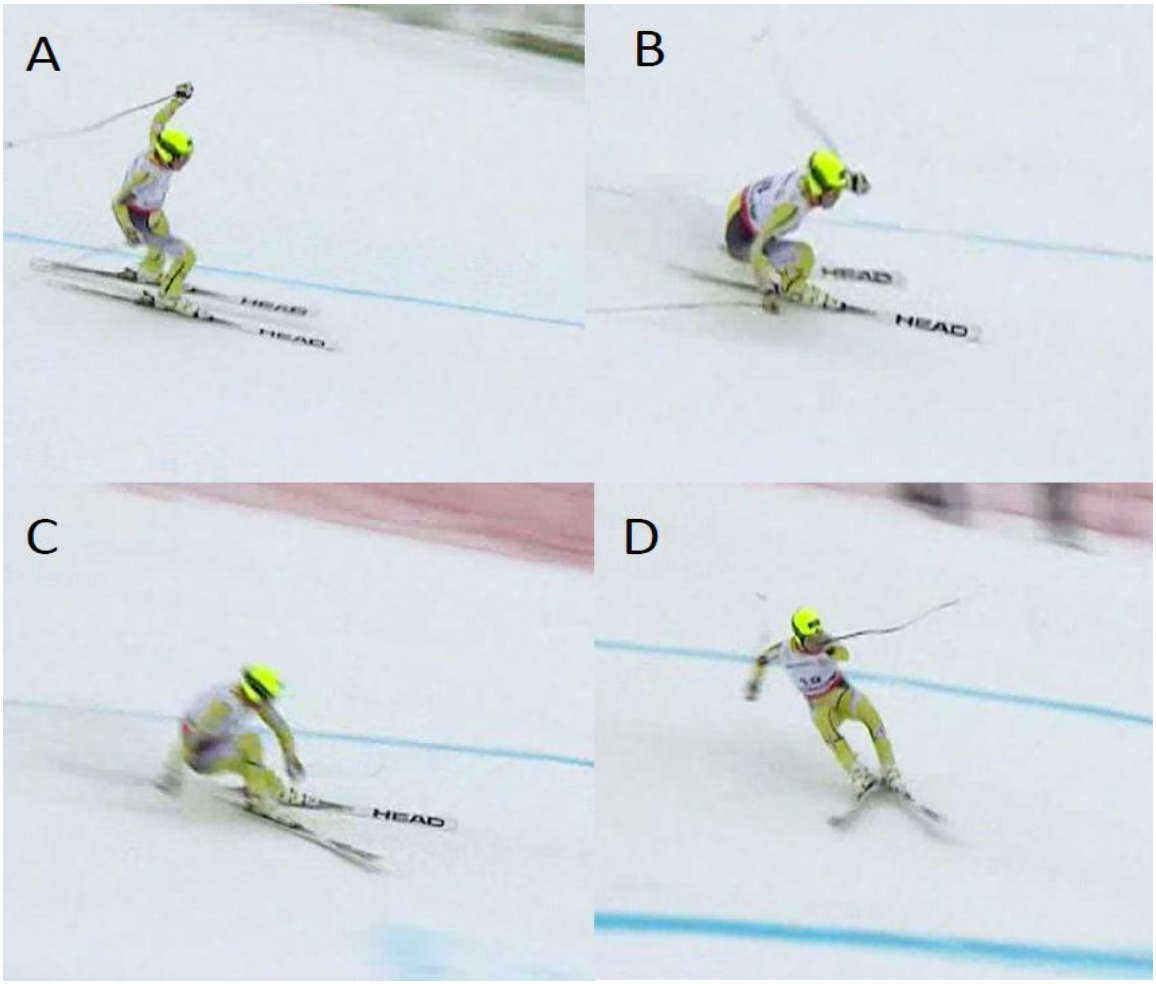

Figure 1. **A** (-640ms) The skier is passive and has too much weight on the inner ski. **B** (-240ms) The skier loses pressure on the outer ski. **C** (index frame) With his weight on the inner ski, the outer ski catches the snow (slip catch). The inner ski leads to the skier over rotating towards the right. **D** (+ 320ms) The skier rotates and falls.

Skiing situation (prior to injury):

The skier is too passive into a compression and goes into a left hand turn where he is late on the line. The conditions are bumpy and the skier leans too much inwards and backwards(the weight distribution is not enough over his outer ski). He has a back-weighted position out of the compression and is therefore in an unbalanced position when starting the following right hand turn.

Injury mechanism (at the time of injury):

This injury can be classified as an atypical slip-catch injury mechanism. In an unbalanced position backward/inward, the outer ski slides away from the body's centre of mass in a right hand turn. Abruptly, the ski tail catches the snow surface, while the skier is in a low position. The outer ski does not catch/carve in, as in a typical slip-catch situation (the left and right ski tails touch).

Table 3. Knee and hip positions (estimates) at the time of injury.

	Knee flexion		**Hip flexion**	
	Angle	**Movement**	**Angle**	**Movement**
Injured leg	20º	Towards flex.	30º	Towards flex.
Non injured leg	100º	Towards flex.	130º	Towards flex.

After the assumed moment of injury, the skier over-rotates his torso and falls. There is no binding release on either side.

Injury Case 3

Table 1. Injury information

Gender	Injured knee	Discipline	Circumstances	Additional injury	Index frame
Female	Right	Super-G	WSC competition	Tibia plateau fracture + MCL rupture	C (98, short version 1)

Table 2. Weather and course conditions

Weather condition	Visibility	Snow condition	Piste condition	Type of terrain
Clear	Good	Hard	Smooth	Medium steep

Valgus collapse

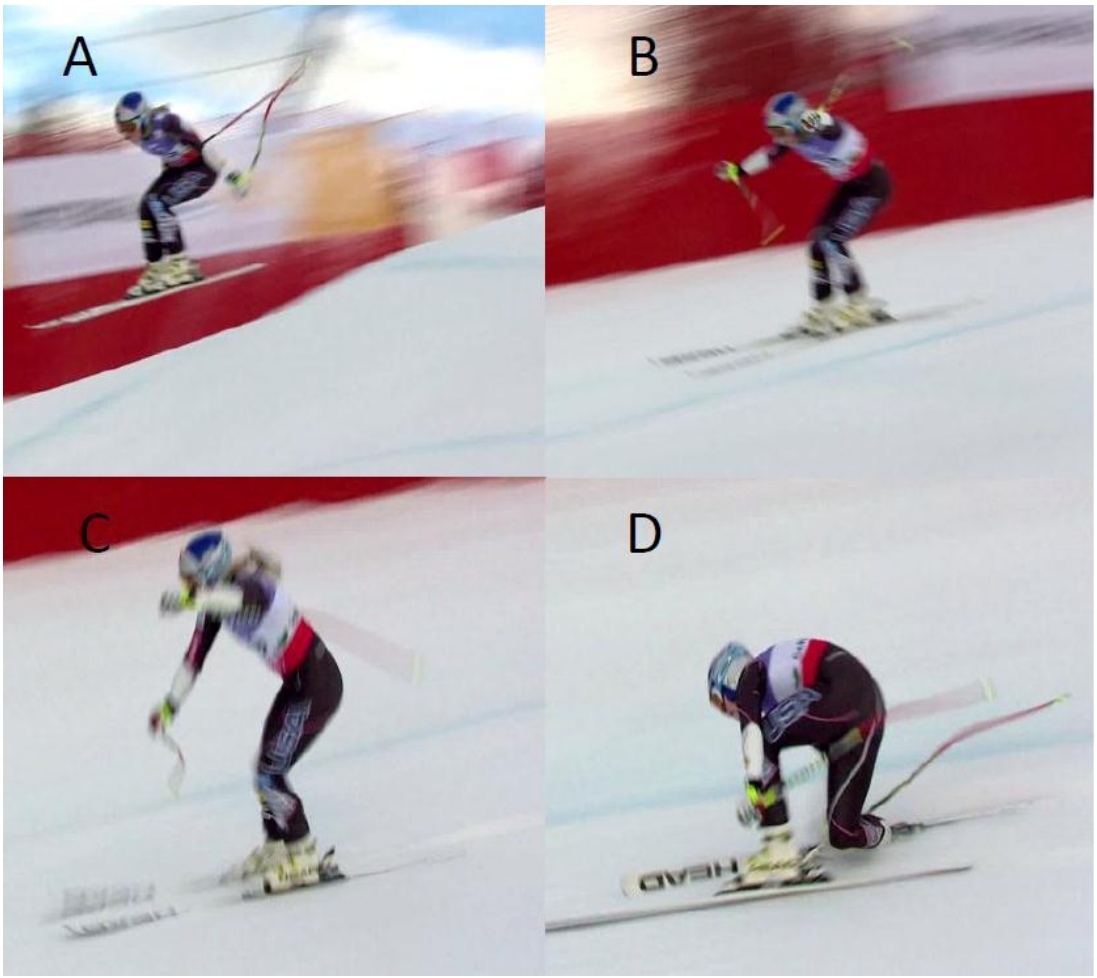

Figure 1. **A** (-480ms) The skier takes a too direct line going into and over the jump in relation to the following gate. **B** (- 200ms) The skier tries to correct her line and position in landing. **C** (index frame) On landing, the right knee is weighted and assumes a valgus collapse position. **D** (+280 ms) The right knee has collapsed in a valgus direction and the skier falls immediately.

Skiing situation (prior to injury):
The skier takes a too direct (aggressive) line into the jump, which leads to her having to initiate the following left-hand turn in flight and during landing.

Injury mechanism (at the time of injury):
The injury mechanism is a valgus collapse on landing. The skier lands with the weight distribution mainly on the right leg, which leads to an immediate valgus collapse. Her arms are both in a forward (flexion) and outward (abduction) position.

Table 3. Knee and hip positions (estimates) at the time of injury.

	Knee flexion		**Hip flexion**	
	Angle	**Movement**	**Angle**	**Movement**
Injured leg	30º	Toward flex.	70º	Towards flex.
Non injured leg	60º	Towards flex.	90º	Static

After the assumed moment of injury (upon landing), the skier falls immediately. There is no binding release on the injured side, while the binding releases after the presumed time of injury on the uninjured side.

Injury Case 4

Table 1. Injury information

Gender	Injured knee	Discipline	Circumstances	Additional injury	Index frame
Male	Left	DH-SC	WSC competition	Meniscus injury	C (156, short version)

Table 2. Weather and course conditions

Weather condition	Visibility	Snow condition	Piste condition	Type of terrain
Clear	Reduced (flat light)	Hard	Smooth	Medium

Atypical slip-catch

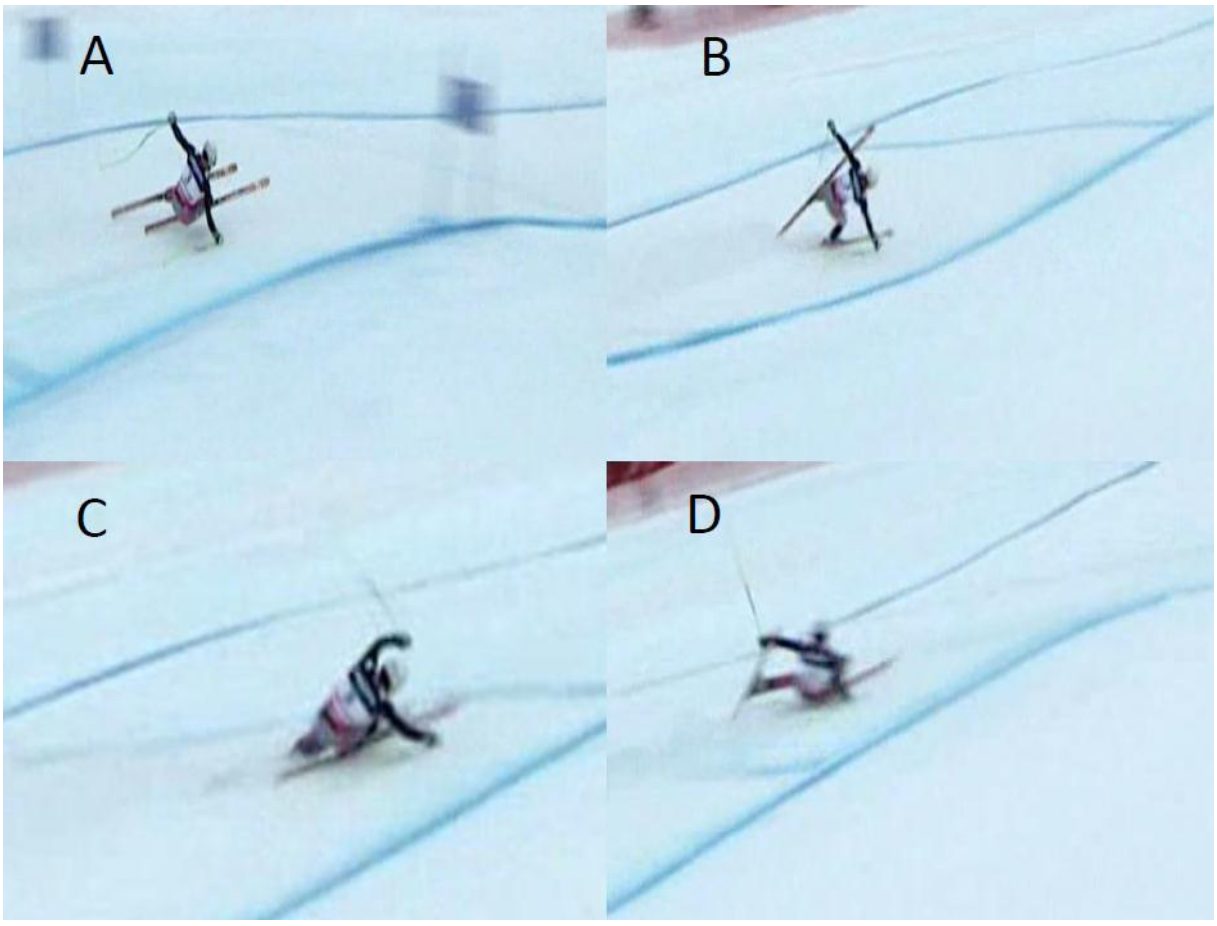

Figure 1. **A** (-760ms) The skier is out of balance backwards and inwards over a bump and loses contact between the skis and the snow. **B** (-240 ms) The skier has all weight on his inner ski, while his outer ski is in the air. **C** (index frame) The outer ski (left) catches the snow abruptly and releases immediately, without carving. **D** (+200 ms) The left ski tip is in the air while the tail is in contact with the snow. The skier regains balance.

Skiing situation (prior to injury):
The skier is too passive out of a compression and leans too much backward/inward in a right hand turn (into a traverse) while passing a bump in the terrain. He loses contact between the skis and the snow and lands on the right (inner) ski only, into the traverse.

Injury mechanism (at the time of injury):
This is an atypical slip-catch injury mechanism. The skier is out of balance backwards and inwards without snow contact on the left (outer) ski. The outer ski then catches the snow abruptly and releases immediately (without carving). The left arm is in a forward position (shoulder flexion), while the right arm is outward (abducted).

Table 3. Knee and hip positions (estimates) at the time of injury.

	Knee flexion		**Hip flexion**	
	Angle	**Movement**	**Angle**	**Movement**
Injured leg	Unsure	Toward flex.	Unsure	Towards flex.
Non injured leg	Unsure	Towards flex.	Unsure	Towards flex.

After the assumed moment of injury, the skier does not fall but regains balance and manages to turn and stop. There is no binding release on either side.

DJO has generously supported the International Ski Federation Injury Surveillance System

FIS

Oslo Sports Trauma
RESEARCH CENTER

DJO