SKIER'S KNEE: Mechanism of injuries and treatment options

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ΚΑΣΠΙΑ ΘΑΛΑΣΣΑ
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Α. Ιαξάρτης
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ΙΝΔΙΚΟΣ ΩΚΕΑΝΟΣ
Η περσική αυτοκρατορία

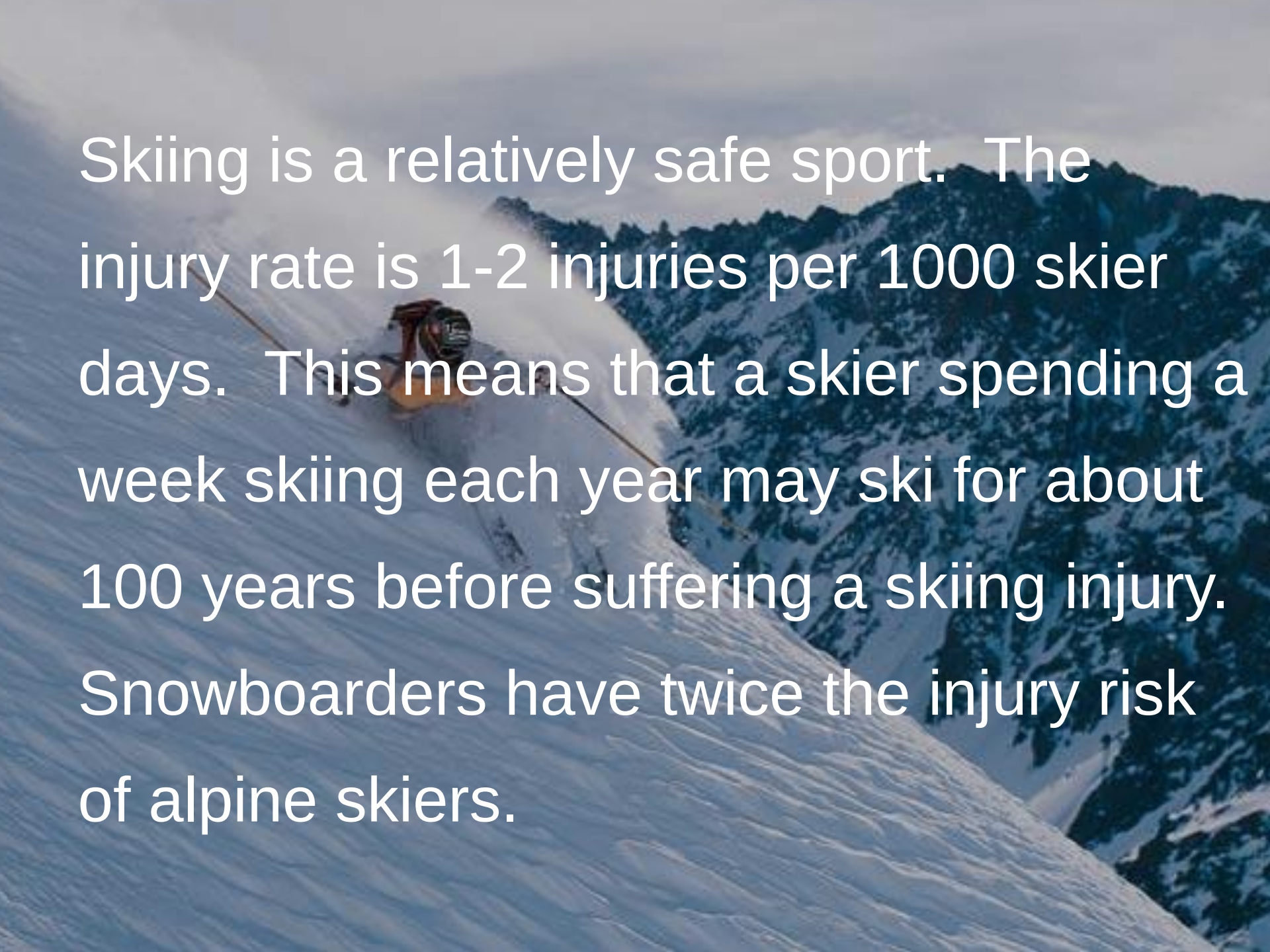
Essential Histories

The Greek and Persian Wars 499–386 BC

Philip de Souza

Why in Skiing?

- Different epidemiology
- Different injury mechanism
- Different prevention
- Different treatment?



Skiing is a relatively safe sport. The injury rate is 1-2 injuries per 1000 skier days. This means that a skier spending a week skiing each year may ski for about 100 years before suffering a skiing injury. Snowboarders have twice the injury risk of alpine skiers.

Injury rates

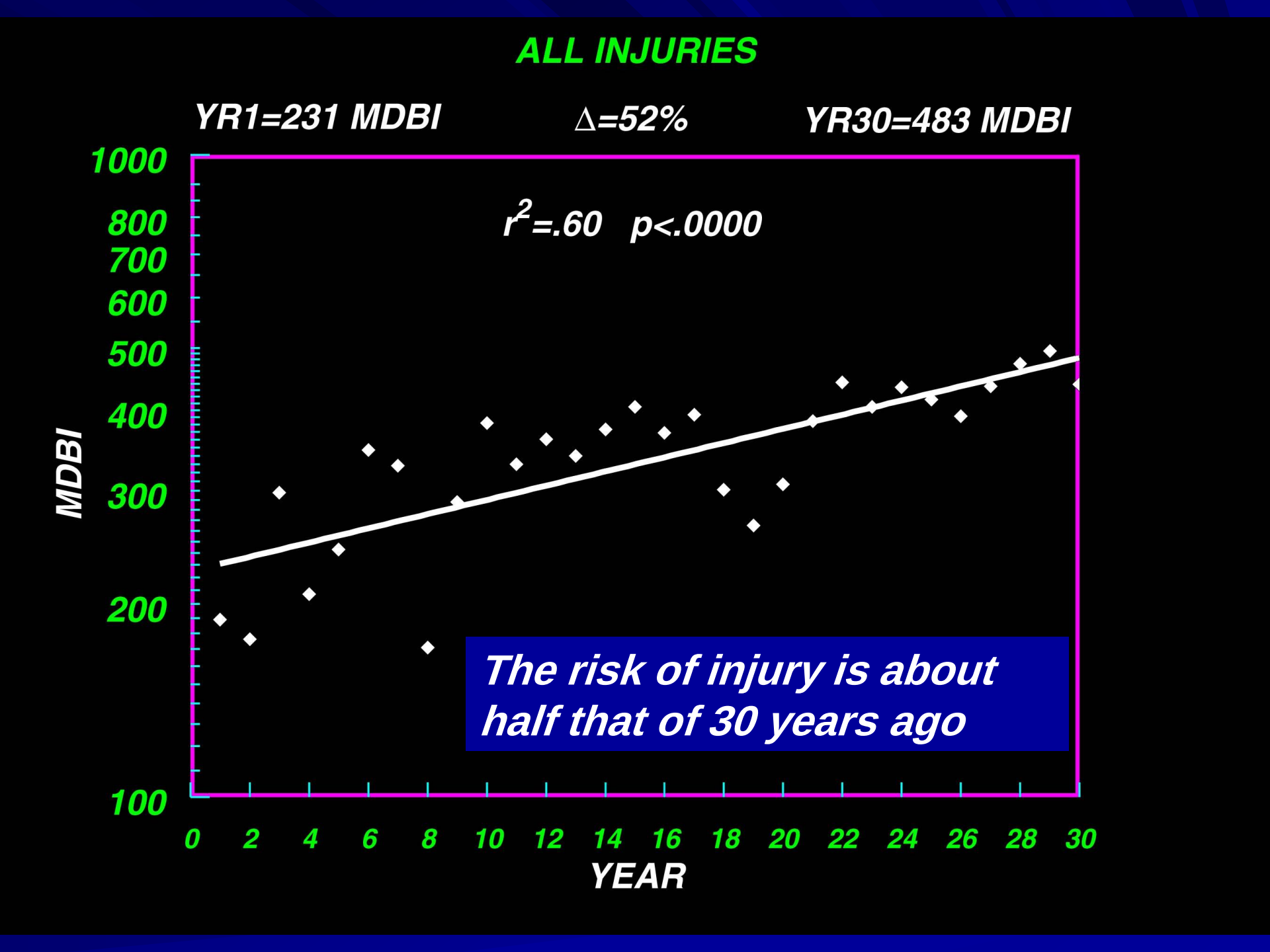
Sweden:	**Alpine skiing**	**1 injury per 1000 skier days** **Made & Elmqvisr 2004**
Norway:	**Alpine skiing**	**1.1 injuries per 1000 skier days** **Ekeland et al. 2005**
USA:	**Alpine skiing**	**2.3 injuries per 1000 skier days** **Johnson et al. 2000**
France:	**Alpine skiing**	**2.5 injuries per 1000 skier days** **Laporte et al. 2000**
Scotland:	**All skiing/ boarding**	**3.7 injuries per 1000 skier days** **Langran & Selvaraj 2000**
Greece:	**Skiing/ snowboarding**	**4.1 injuries per 1000 skier days** **Zacharopoulos et al. 2014**

Injury Rate Decline in ALL Injuries

52%

1972	2002
231 MDBI	483 MDBI

$R^2 > .60$; $P < .01$


ALL INJURIES
YR1=231 MDBI
Δ=52%
YR30=483 MDBI
r^2=.60 p<.0000
MDBI
1000
800
700
600
500
400
300
200
100
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
YEAR
The risk of injury is about half that of 30 years ago

Injury Rate Decline in Lower Leg Injuries

83%

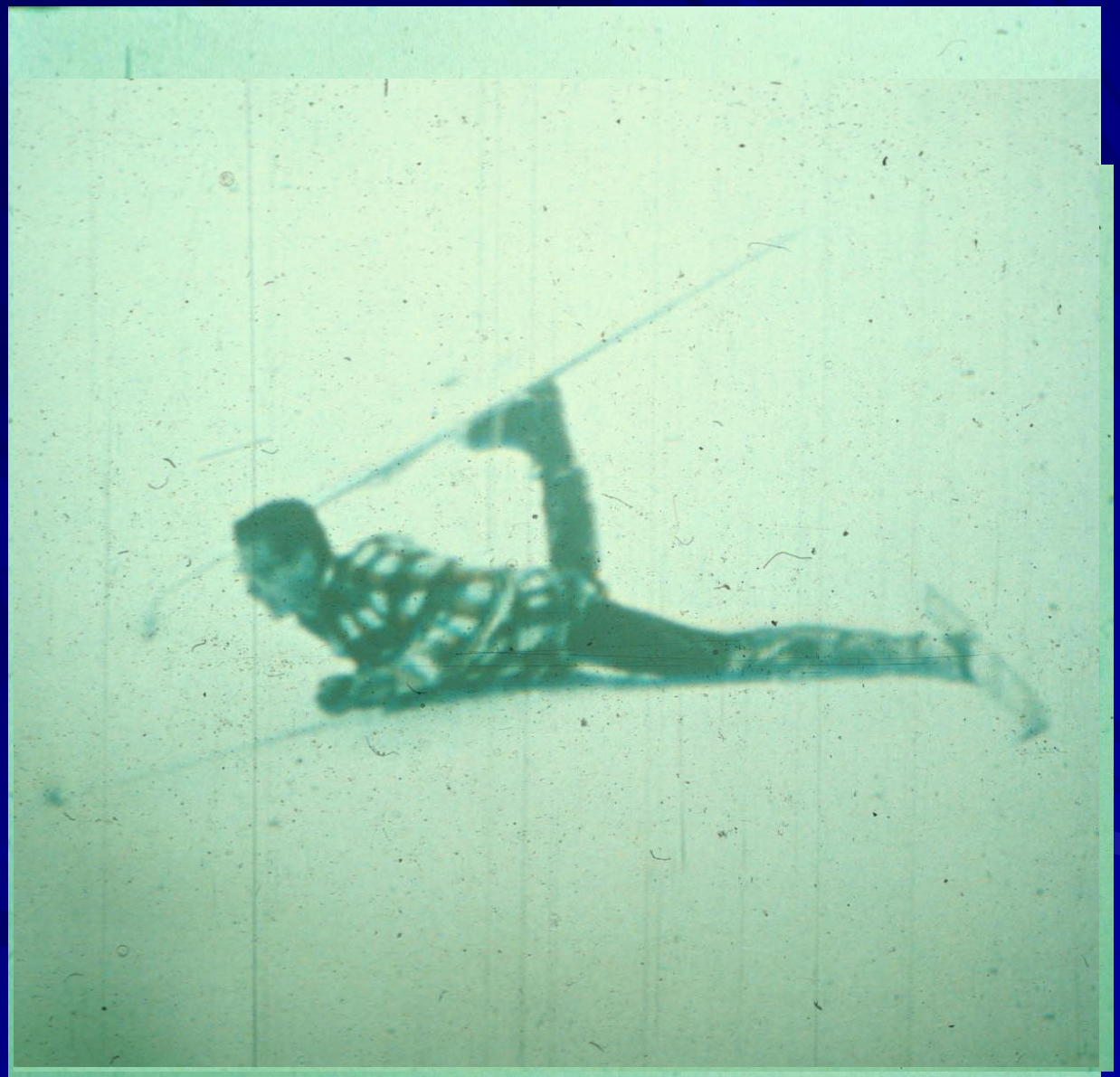
1972	2002
1069 MDBI	6255 MDBI

$R^2 > 0.74$; $P < .01$

Factors which may have influenced the improvement in lower leg injuries in years 1–17 (1972-1988)

- Reduction in friction between boot and ski
- Improved binding performance under combined loads
- Lower release settings
- Better equipment maintenance
- Improved boot design
- Improved boot fitting
- Increasing skier experience
- Improved trail grooming

Knee Injuries in Skiing



Injury Rate
Decline in Knee Sprains

22%

1972	2002
1,169 MDBI	1,503 MDBI

R^2 NS; PNS

Injury Rate
Decline in Grade I & II
Knee Sprains

70%

1972	2002
1,463 MDBI	4,837 MDBI

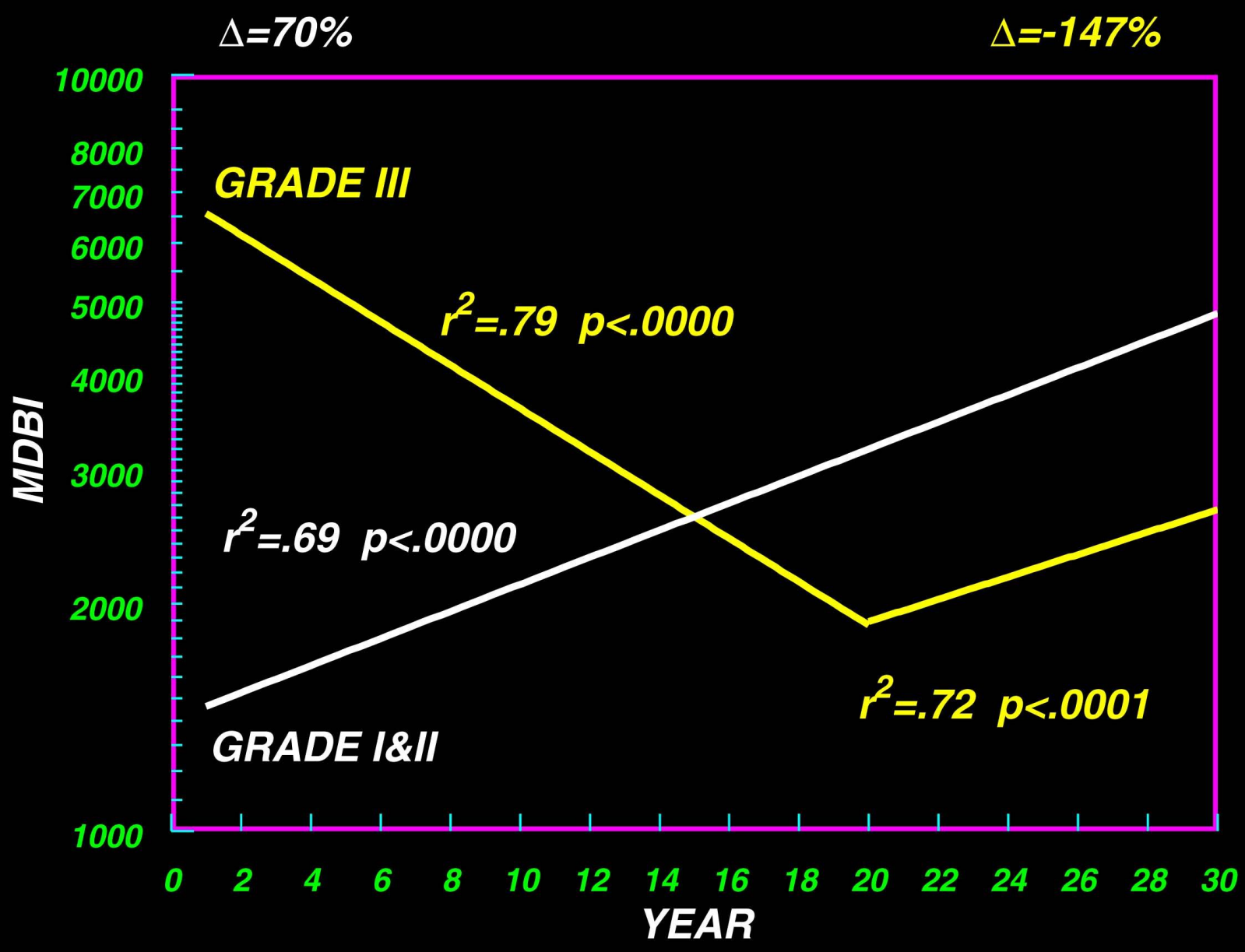
$R^2 > .69$; $P < .01$

Injury Rate **Increase** in Grade III Knee Sprains

196%

1972	2002
5,222 MDBI	1,765 MDBI

$R^2 > .62$; $P < .01$

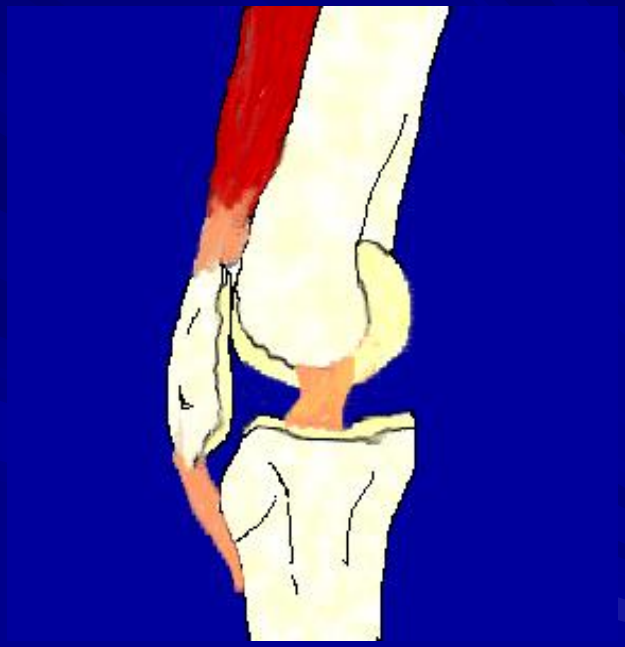

GRADE I&II/GRADE III KNEE SPRAINS
Δ=70%
Δ=-147%
10000
8000
7000
6000
5000
4000
3000
2000
1000
MDBI
GRADE III
r2=.79 p<.0000
r2=.69 p<.0000
r2=.72 p<.0001
GRADE I&II
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
YEAR

1972-2004
32 Year Ski Injury Study - 17,967
Knee Injuries – 6,127

	#	% of All Injuries
Sprains	4648	25.9
Contusions	730	4.1
Meniscus	308	1.7
Patella Soft Tissue	222	1.2
Knee Lacerations	98	0.5
Tibia Plateau	97	0.5
Patella Fracture	24	0.1
	6127	34.0

ACL Injuries

The main problem in skiing

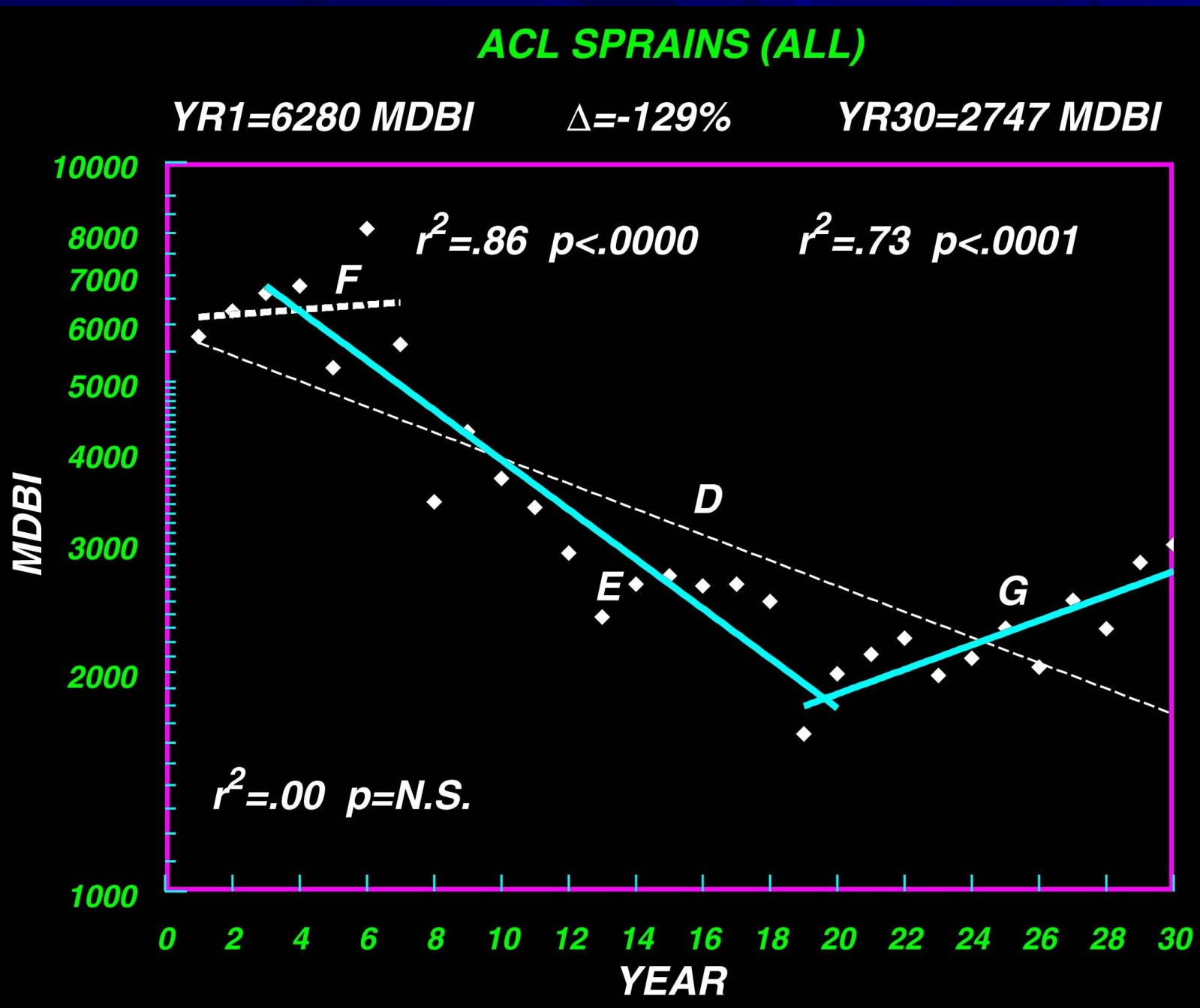


ACL Injuries 1972-1973 through 2003-2004
32 Years

4 Year Groups	% of All Injuries
1973-76	3.3
1977-80	4.3
1981-84	10.3
1985-88	14.4
1989-92	14.5
1993-96	19.9
1997-00	18.4
2001-04	16.8

The risk of sustaining a knee sprain involving the ACL **increased** by **231%** over the period from year 3 (1974) to year 20 (1991).

Since year 20 (1991) there has been a 34% decrease in the risk of ACL injury.


ACL SPRAINS (ALL)
YR1=6280 MDBI
Δ=-129%
YR30=2747 MDBI
10000
8000
7000
6000
5000
4000
3000
2000
1000
MDBI
r2=.86 p<.0000
r2=.73 p<.0001
F
D
E
G
r2=.00 p=N.S.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
YEAR

Possible Reasons for the Increase in ACL Sprains over years 3 – 20 (1974-1991)

- Increased boot stiffness in backward lean making the “Phantom Foot” injuries mechanism more likely
- Changes in ski design that improves turning
- Increasing age of the skiing population

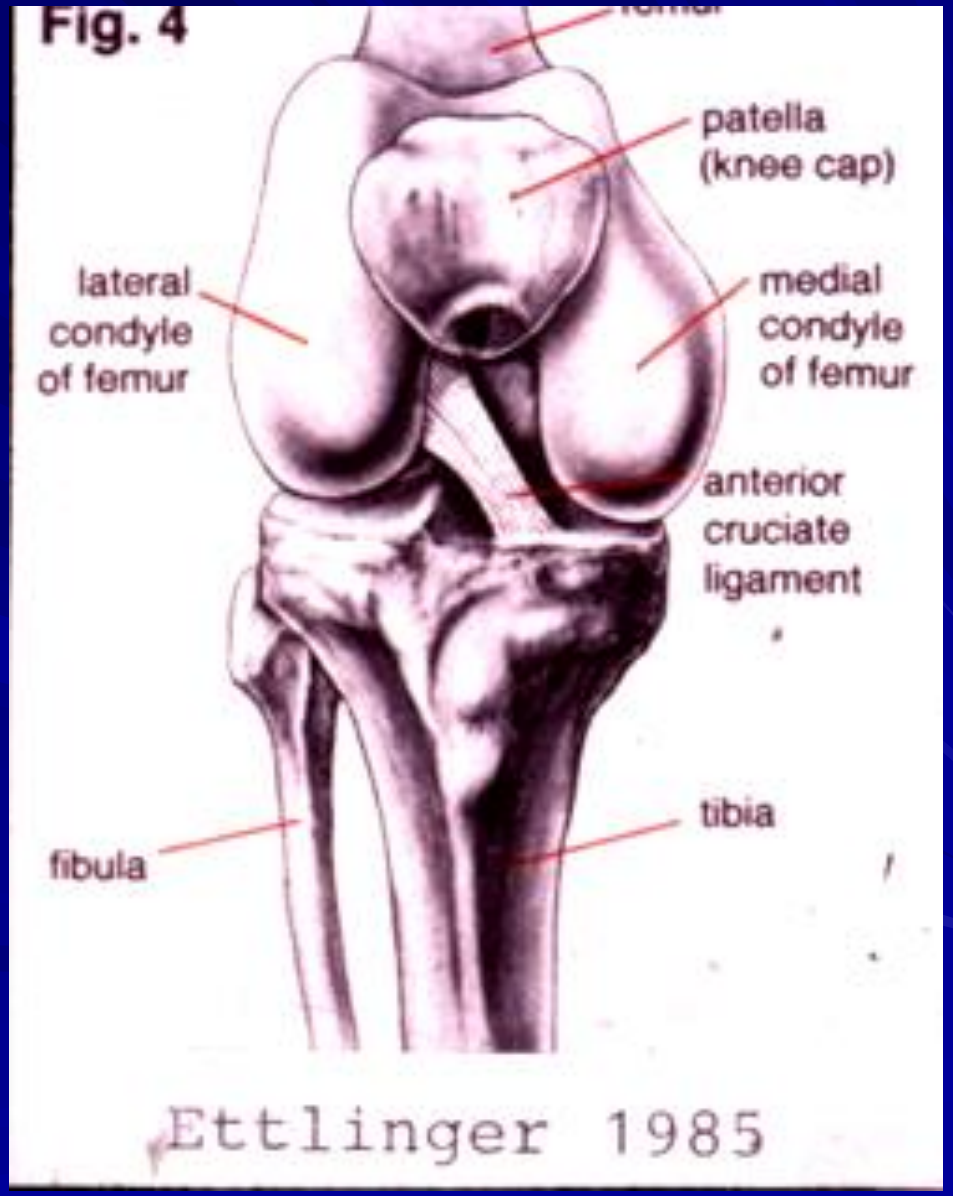
Possible Reasons for the Decrease in ACL Sprains over years 20–30 (1991-2002)

- Modification in skier behavior
- Changes in skiing technique
- Shorter skis
- More experienced skiing population
- Reduced number of falls per day

ACL injuries

Account for about 20% of alpine ski injuries and about 40% of alpine knee injuries.

Johnson et al. 2012



ACL injuries in competitions

About 30% of alpine and freestyle World cup and Olympic racers have suffered an ACL injury

Heir et al. 2003

Bere et al. 2011

ACL Injuries

ACL injured skiers are shorter, lighter, older, more likely to be female, and less skilled and experienced than controls.

Females are 40% of the control population but suffer 63% of the ACL sprains.

ACL Injuries

ACL injury unlikely if ski length is less than 75% of the skier's height.

ACL Injuries

Patients with ACL injuries have similar binding release torques as uninjured skiers, and modern release bindings do not protect against ACL injuries.

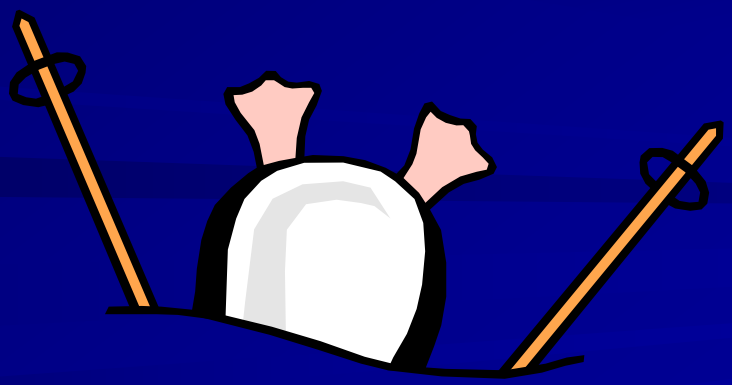
Ettinger et al. 1995

Diebert et al. 1998

Johnson et al. 2003

ACL Injuries

ACL injured skiers have very different fall profiles than skiers sustaining lower leg injuries.



ACL Injuries

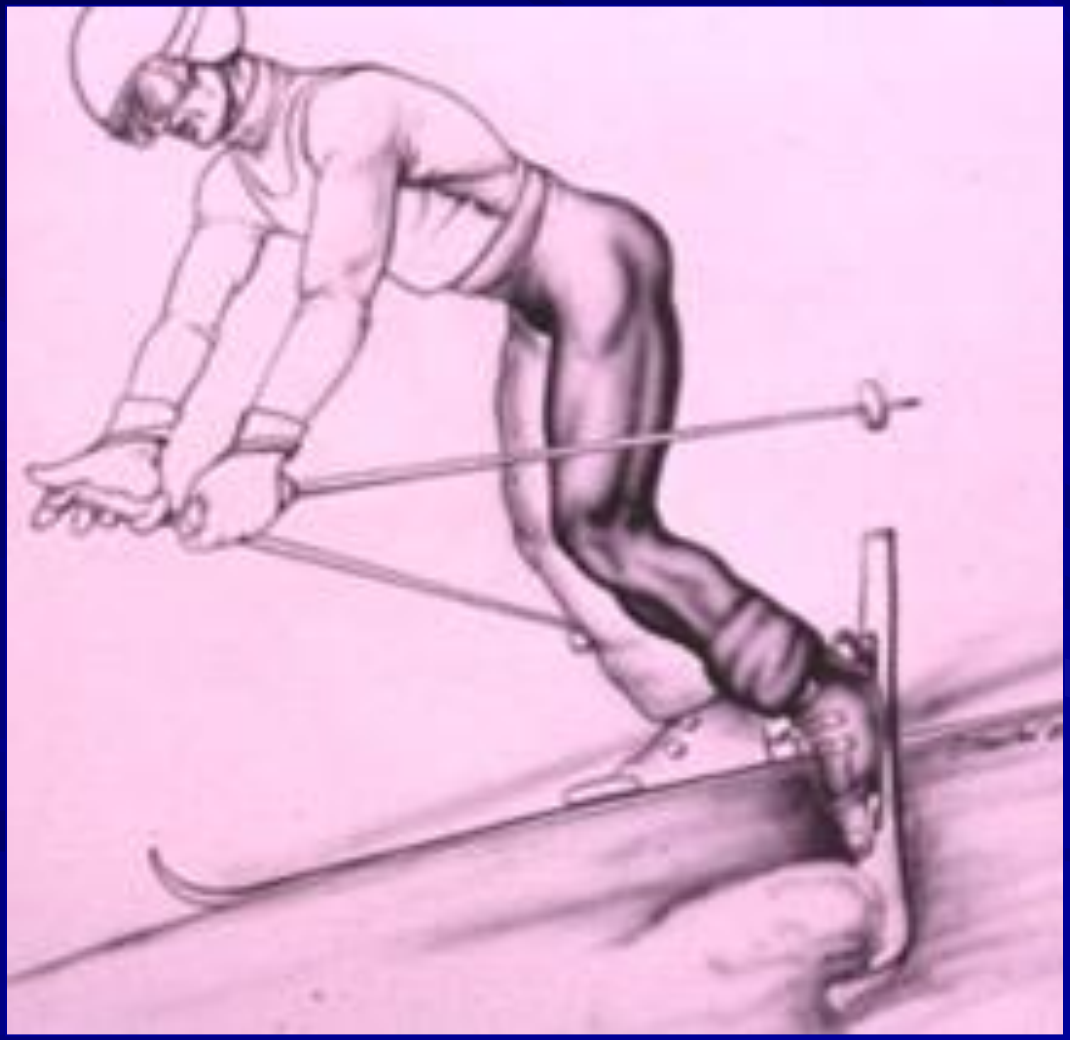
skiers could not reliably recall:

- Direction of fall relative to body
- Direction of fall relative to fall line
- Whether leg injured was weight bearing

Friden T, KSSTA 1995

Krosshug T, Br J Spor tMed 2005

Injury Mechanisms of ACL injuries



ACL Injuries in Skiing

ACL injury situation

Bacward Twisting Fall

”Flexion-Internal Rotation” or ”phantom foot”

Injured racer

Phantom foot mechanism

Phantom foot

Phantom Foot mechanism is considered as the most common cause of ACL injury

Injury often occurs before the skier is aware that anything is wrong.

Ettlinger et al. 1995

Phantom foot

This is true with the traditional skis (70% of the cases)

(Johnson RJ, 2005
Beynnon BD, 2009)

But what about carving skis?

Forward Twisting Fall

"Valgus-external rotation"

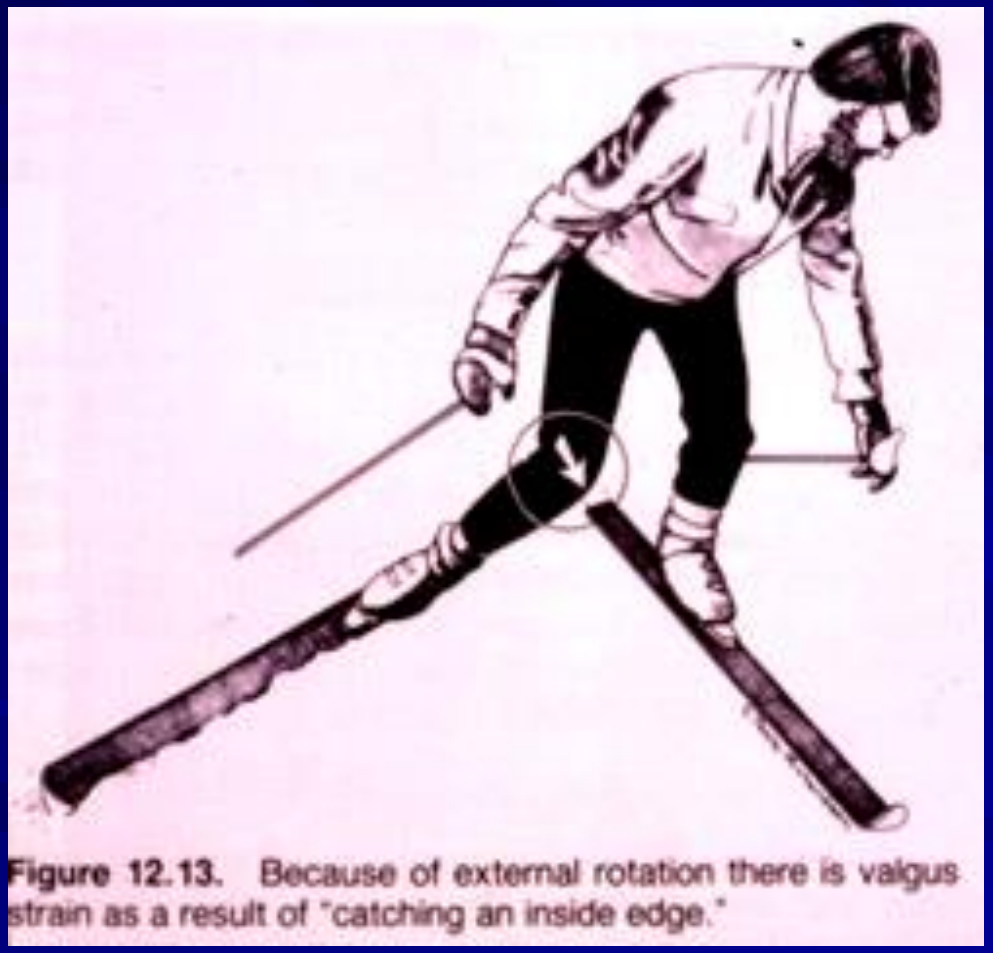
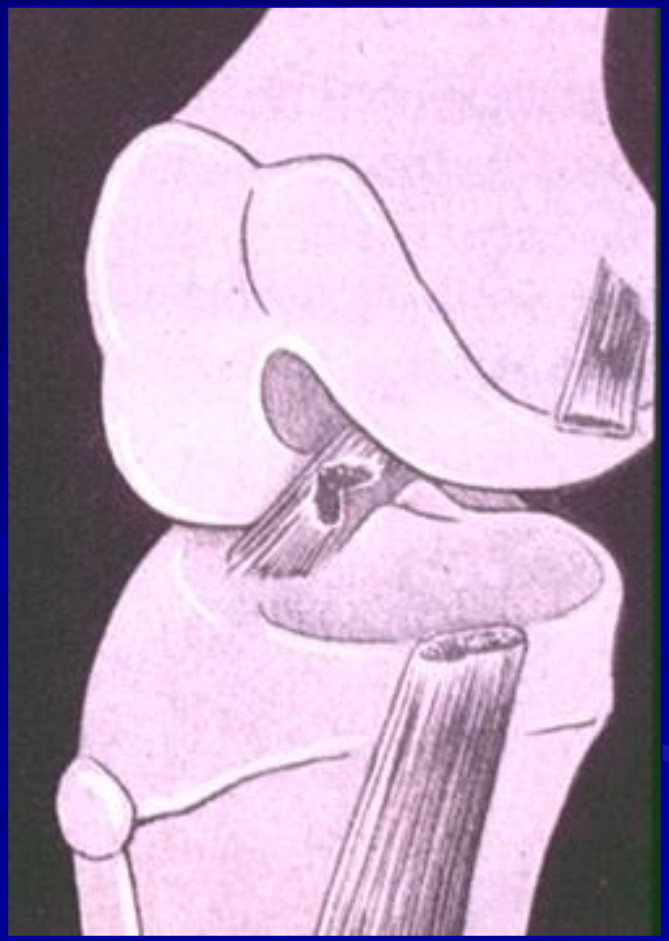


Figure 12.13. Because of external rotation there is valgus strain as a result of "catching an inside edge."



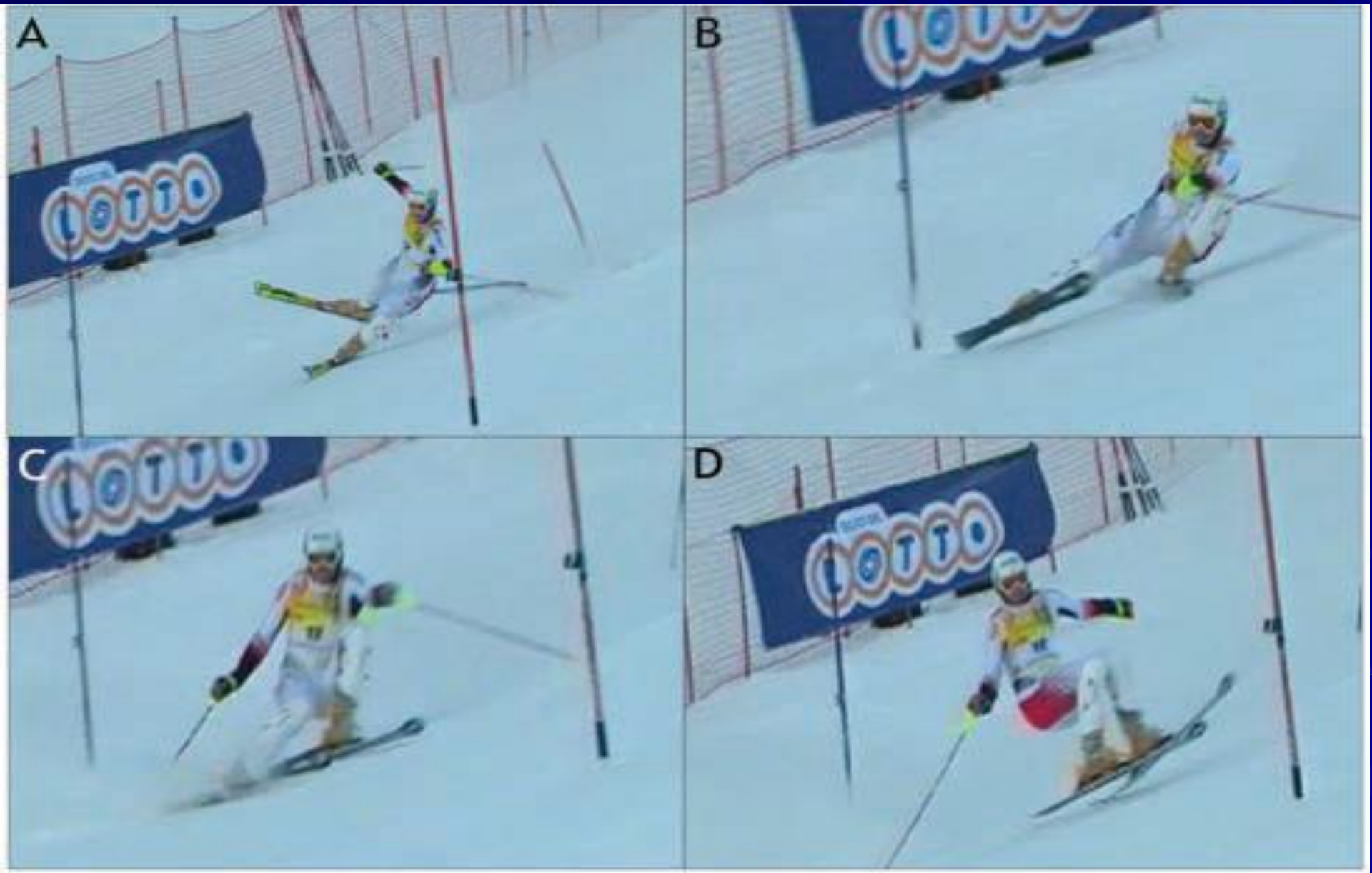
Clancy & McConkey 1985

Forward Twisting Fall "Valgus-external rotation"

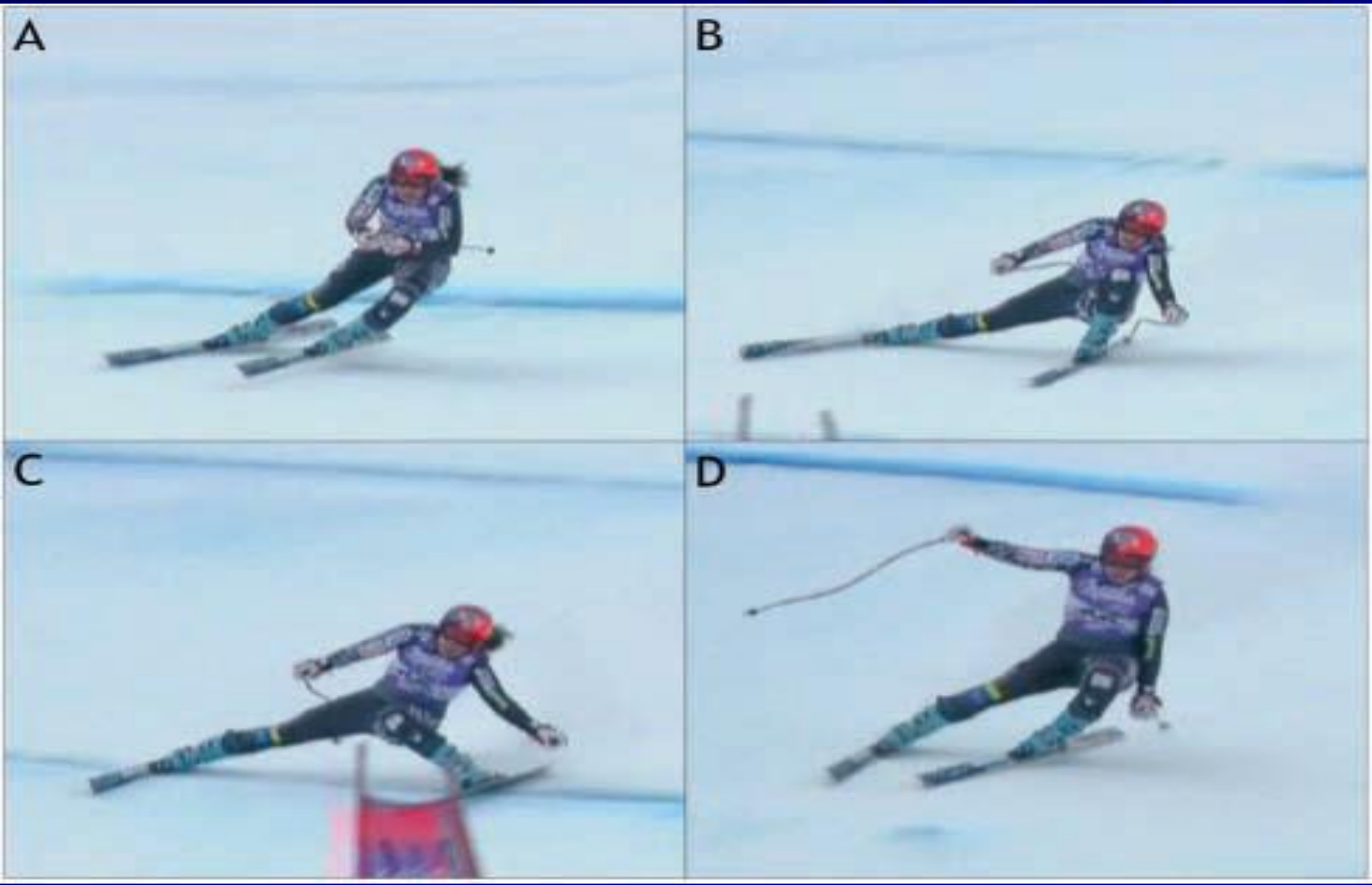
- Ruedl G. et al (KSSTA 2009, Int J Spots Med 2011) suggest that the main mechanism has changed from the backward twisting fall (phantom foot) to the forward twisting fall, (51% vs 29%) with the use of the carving skis

- But the objection came soon from Norway (Bere t. et al, Am J Sports Med 2011)

“slip-catch situation”



“dynamic snowplow”



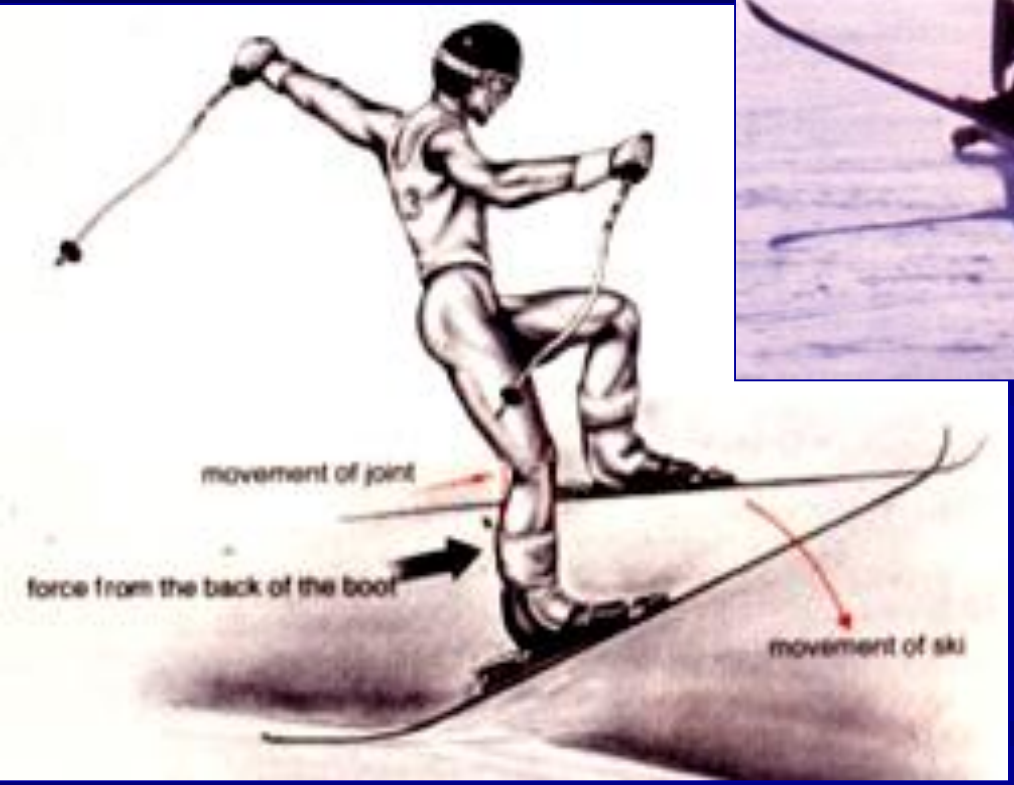
Internal Rotation

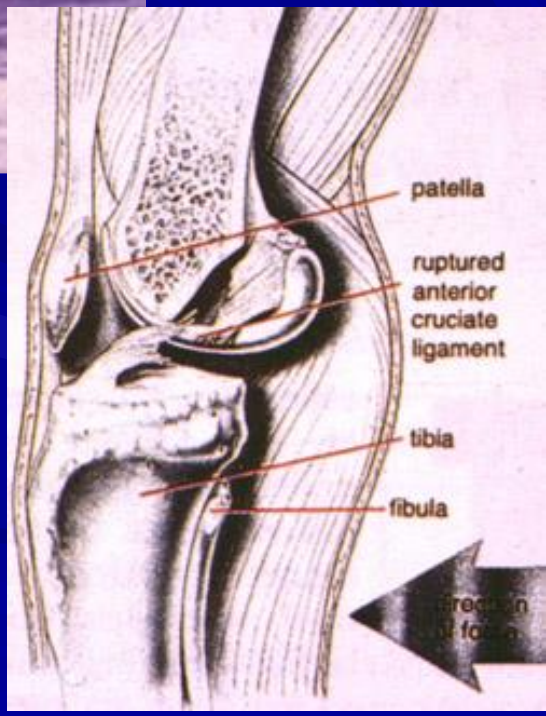
+ flexion

+ valgus

The main mechanism of injuries in skiing

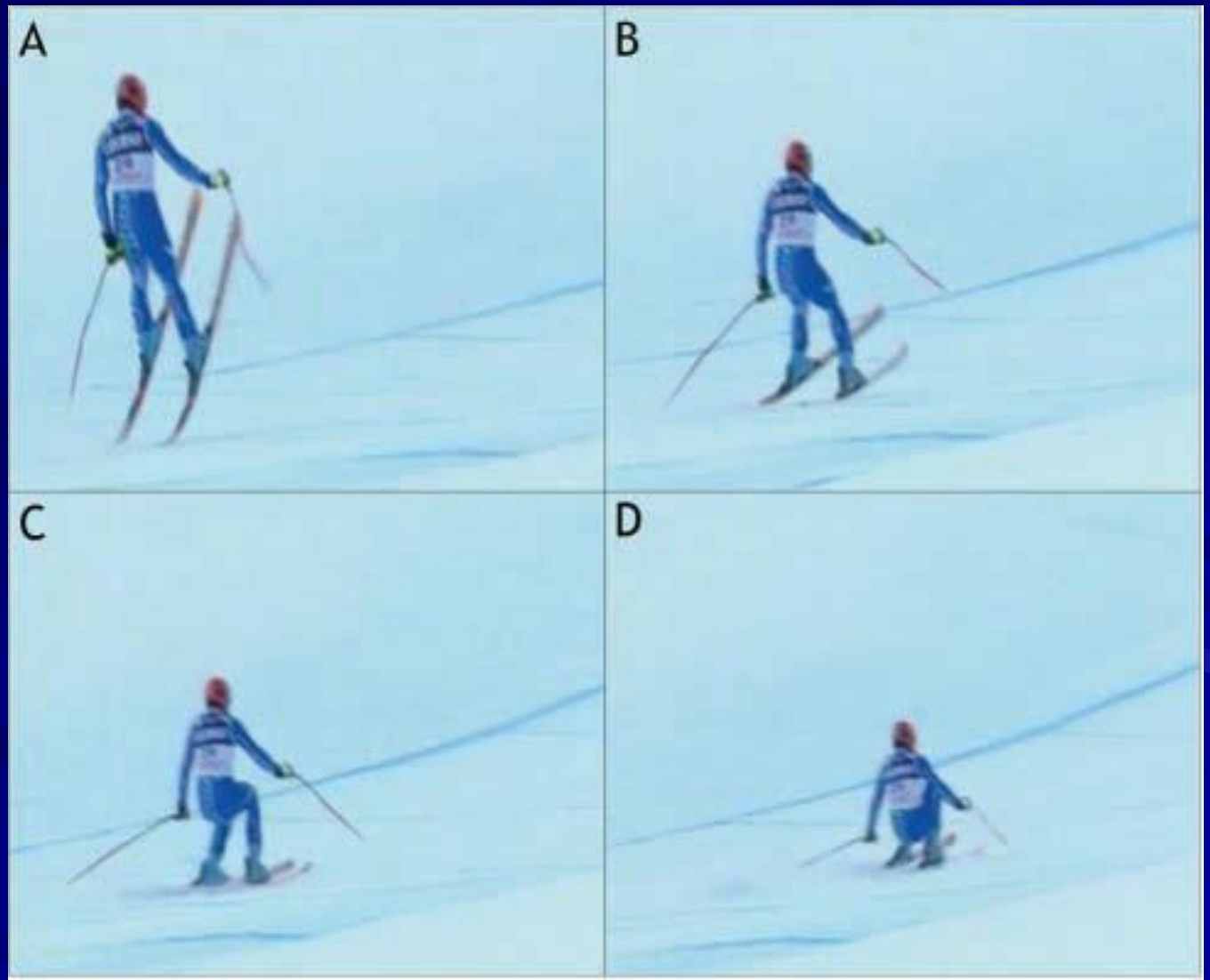
Boot induced anterior drawer





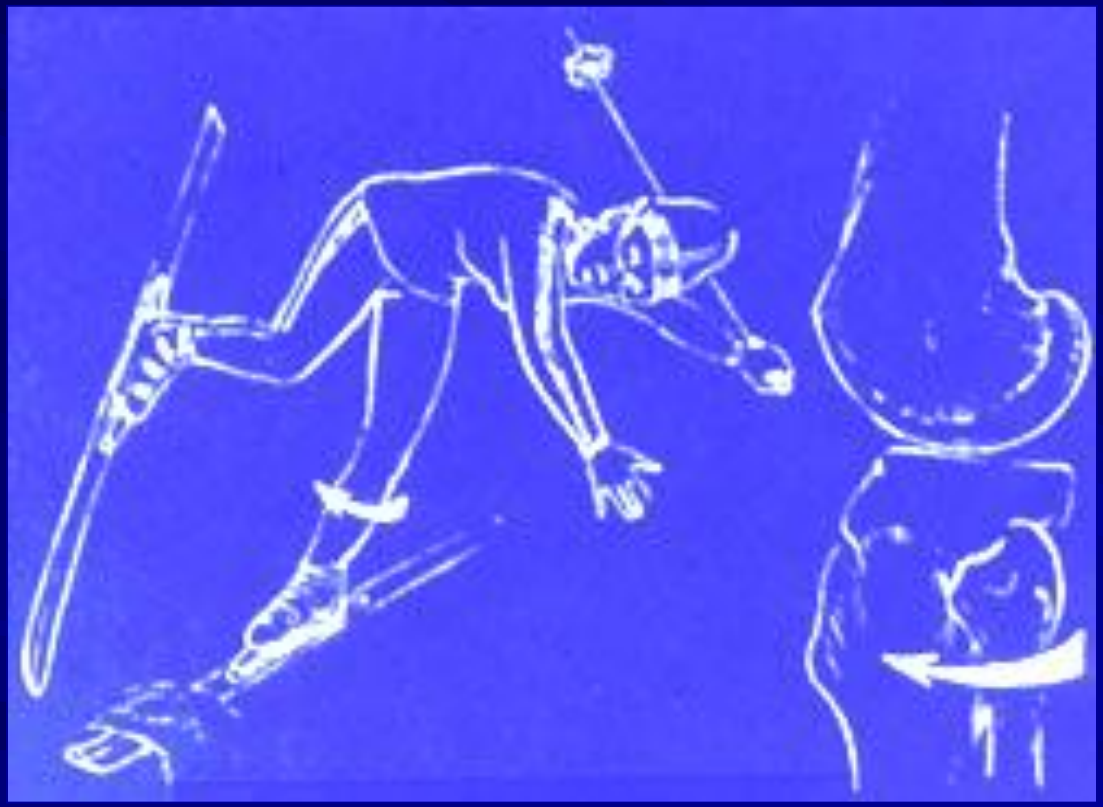
Ettlinger & Johnson 1995

Boot induced anterior drawer

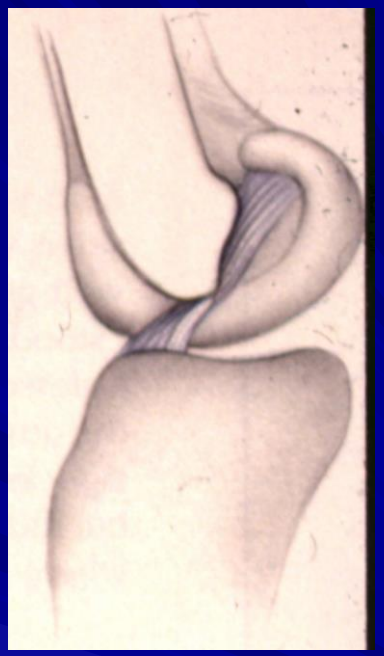


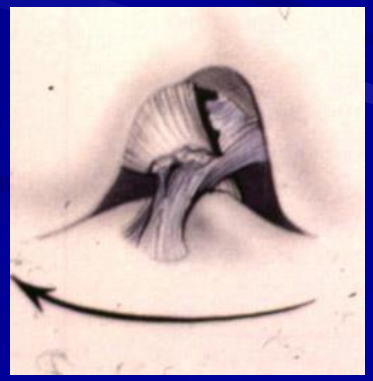
Hyperextension

Pure hyperextension or combined with internal tibial rotation

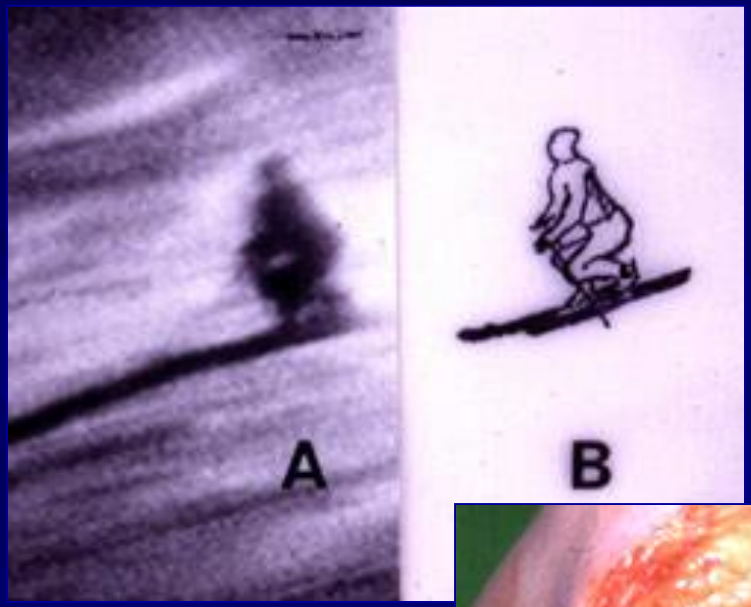


Kennedy et al. 1974





Hyperflexion

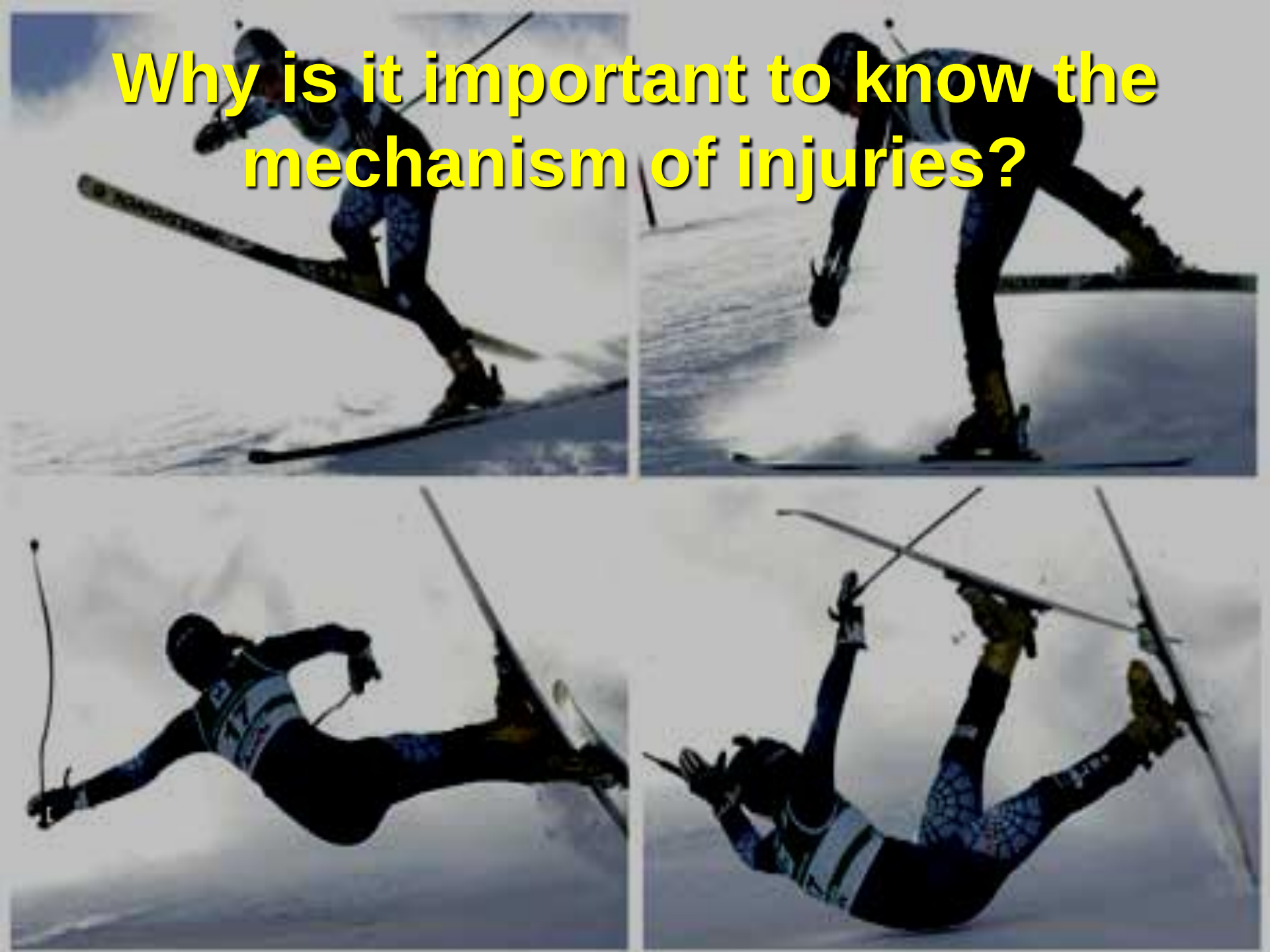


Ekeland & Thoresen 1985

Forceful quadriceps contraction

McConkey 1985 Garret et al. 2002

Why is it important to know the mechanism of injuries?



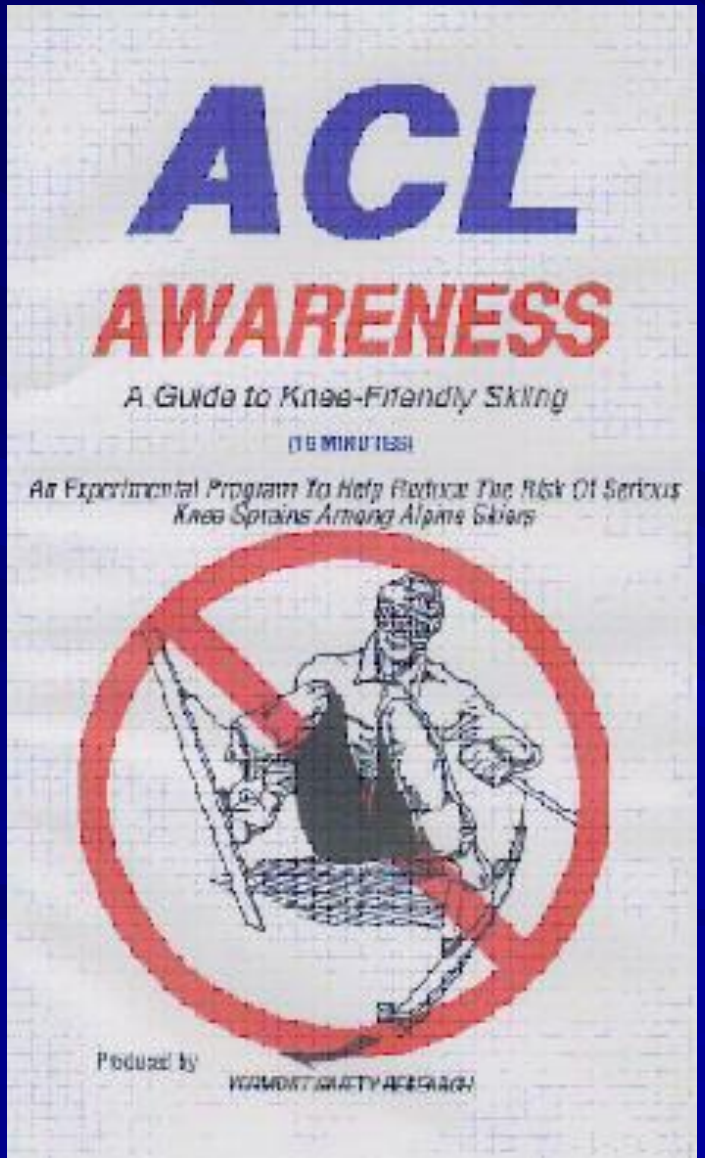

Means of Prevention of ACL Injuries
There are not exist!!!

Means of Prevention of ACL Injuries

There are not exist!!!

- Present equipment is not capable of protecting the ACL.
- There is no evidence that anything presently on the market is going to improve the present situation.

Prophylactic measures



(Ettinger et al. 1995)

Prophylactic measures

- Provides description of situations which lead to the Phantom Foot “syndrome”,
- Describes the Phantom Foot mechanism and
- the means to prevent it

Prophylactic measures

Do’s and dont’s

1) Don’t straighten your legs when you fall. Keep your knees flexed.
2) Don’t try to get up until you’ve stopped sliding. When you’re down-stay down.
3) Don’t land on your hand.
4) Don’t jump unless you know where and how to land. Land on both feet and keep your knees flexed.

Prophylactic measures

ACL awareness training reduced ACL injuries 60% among American ski patrollers.

(Ettinger et al. 1995)

Prophylactic measures

but what about the recreational skiers??

Treatment

Controversies on:

- Graft selection
- Rehabilitation program
- After treatment use of braces

Graft selection

Steadman's group in Vail, CO, reported that the medial hamstrings play a significant role in internal rotation of the knee joint.

In downhill skiing internal rotation is important and protects the skier from letting the ski slip away outwards.

Therefore, their advice is to avoid the hamstrings for ACL-reconstructions in downhill skiers.

Graft selection

- Segawa et al (2002) noted persistent weakness in internal rotation after harvest of the ST and gracilis tendons and suggested that STG removal would compromised dynamic stability, especially under rotational loads

(Segawa H, Arthroscopy 2002)

- Nakamura et al (2002) reported loss of knee flexor strength following the harvest of the hamstring tendons

(Nakamura N, Arthroscopy 2002)

Graft selection

Adachi et al suggest that ACL- reconstruction with a hamstring graft should be avoided in athletes that participate in sports requiring deep and powerful knee flexions.

(Adachi et al, 2003)

Graft selection

- Fukubayashi et al concluded that gracilis compensates for ST function, and it should be preserved during ACLR.

(Fukubayashi KSSTA 2006)

- Gobbi suggest avoiding removing the gracilis and proposed a 4ST technique on some sports (ski, karate, ballet etc)

(Gobbi A et all, Arthroscopy 2003, 2005
Sports med Arthrosc Rev 2010)

Graft selection

- Even if the weakness resulted from hamstrings harvest is little don’t forget that an elite skier needs 100% of his strength in order to return to his pre injury level.

Think to change your preferable method of ACLR

(allograft, BPTB, 4ST ?)

Graft selection

For the other skiers speak with them

Identify:

- preoperative function
- concurrent intra-articular injury
- physiologic and pathologic joint laxity
- anatomy of the knee
- preinjury activity
- patients expectations
- psychological status etc

Graft selection

But don't forget that skiing has no limitations on age and ability

Rehabilitation

Emphasis to:

- Proprioception
- Balance exercises

Rehabilitation

Criteria for returning to sport

- A stable knee joint and absence of giving-way
- Full range of motion
- Thigh muscle strength ≥ 90 % of the contralateral leg
- Good results in knee related functional tests
- No pain or swelling in connection with physical activity/sport

DON'T BE HURRY

After treatment

- The use of a knee brace is recommended for the ACL reconstruded skiers

(Sterett WI et al, Am J Sports Med. 2006)

Conclusion

The knee is at risk in skiing, and ACL injury is the main problem.

Knowledge about injury mechanisms may prevent some of the injuries.

Different treatment options should be considered

خيليممنون