ENGLISH INSTITUTE OF SPORT

A Major Educational Event for all Professionals involved in the Training, Performance and Rehabilitation of Runners

professional events

Running 2015

Prevention & Management of Traumatic Sports Knee Injury

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Rehabilitation from ACL Reconstruction

Ian Horsley PhD, MCSP

Lee Herrington PhD, MCSP

ACL Injury

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Post op

ACL Injury

- Monitoring
- Daily:
- Athlete reports numeric rating scale of pain (0-10) post each rehabilitation session along with score at end of day & in morning on first weight bearing
- Athlete rates stiffness of knee on first mobilising in morning
  - Score 0= free movement 1=some restriction to movement 2=significant restriction 3= unable move to painfully restricted
- Athlete measures knee circumference (around patella) on waking (1st hour of day) & in evening

Patient scores		Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
NRS Pain	am							
	post rehab							
	pm							
Stiffness	squat							
	stairs							
Swelling	am							
	pm							

ACL Injury

- Monitoring
- Weekly (biweekly):

- Knee range of movement
  - Supine, sitting & prone
- Patella mobility
  - medial glide & tilt, inferior glide (20 degrees knee flexion)
  - scoring: free; restriction; significantly limited
- Quadriceps strength (handheld dynamometer) 90deg flexion
- QASLS score (appropriate task to phase)

ACL Injury

- Monitoring
- QASLS: drop jump test
- QASLS: unilateral tests
  - Single leg squat
  - Single leg land
  - Single hop for distance
- Tuck jump test

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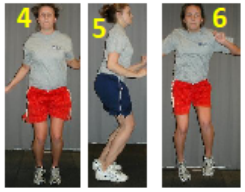
Tuck jump test scoring criteria

Marking criteria
If the participant fails to meet the criteria below then they score 1, if they meet the criteria they score 0 for the respective category.

Knee & Thigh Motion
1. Knee valgus on landing
   - Hip, knee and foot aligned, no collapse of the knee inwards
2. Thighs not reaching parallel (peak of jump)
3. Thighs not equal side to side (during flight)

Foot position during landing
4. Foot placement not shoulder width apart
   - Inside of tape marks
5. Foot placement not parallel (front to back)
6. Foot contact timing not equal
   - Asymmetrical landing
7. Does not land in same foot print
   - Consistent point of landing
8. Excessive landing contact noise

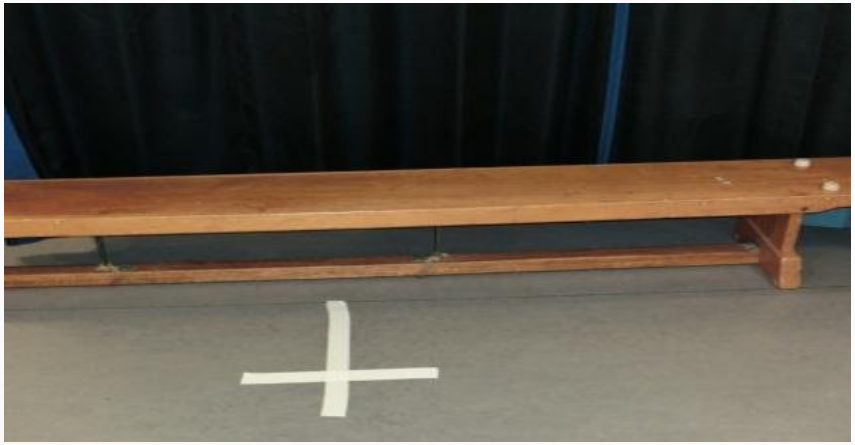


Plyometric technique
9. Pause between jumps
10. Technique declines prior to 10seconds

Name:	Score
Knee & thigh motion	
Knee valgus on landing	
Thighs not reaching parallel (peak of jump)	
Thighs not equal side to side (during flight)	
Foot position during landing	
Foot placement not shoulder width apart	
Foot placement not parallel (front to back)	
Foot contact timing not equal	
Does not land in same foot print	
Excessive landing contact noise	
Plyometric technique	
Pause between jumps	
Technique declines prior to 10 seconds	
Total Score	

DROP JUMP LANDING

- Participant stands on a 30cm box
- Jump two footed off the box landing with feet either side of a line 30cm from the box
- Immediately attempt to undertake a maximum vertical jump reaching up to touch a target held above the line



SINGLE LEG STEP DOWN

- Participant stands on a 30cm box
- Instructed to step off the box onto a mark, 30cm from the box and 5cm on the contra-lateral side to the mid line

SINGLE LEG HOP FOR DISTANCE

- Participant stands on mark at side of standard tape measure
- Hands resting on iliac crests
- Attempts to hop as far as possible staying parallel to the tape.

General notes

- All landings for single leg step down and single leg hop for distance must be held for 3 seconds, emphasis during task instruction must be placed on this
- Evaluate all landings using the QASLS scoring system
- For single leg hop for distance also include the distance hopped and the leg length
- Position camera a minimum of 2m from the landing position, zoom in to maximise the size of the subject within the frame
- Allow the subject a minimum of two practice attempts (continuing until they are able to do tasks appropriately) then record a single attempt after this

- Monitoring
- Single leg squat
  - Step up, side lowe
- QASLS score
- Squat 1

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Qualitative analysis of single leg loading

Date: **Patient:**

Condition: **Left** **Right** **Bilateral**

QASLS	Task: Single leg squat Single leg step down Single leg hop for dist	Left	Right
Arm strategy	Excessive arm movement to balance		
Trunk alignment	Leaning in any direction		
Pelvic plane	Loss of horizontal plane		
	Excessive tilt or rotation		
Thigh motion	WB thigh moves into hip adduction		
	NWB thigh not held in neutral		
Knee position	Patella pointing towards 2nd toe (noticeable valgus)		
	Patella pointing past inside of foot (significant valgus)		
Steady stance	Touches down with NWB foot		
	Stance leg wobbles noticeably		
	Total		

- Monitoring
- Drop jump vertica
- Modified LESS scc
- Drop

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Qualitative analysis of drop jump landing

Date: **Athlete:**

Condition: **Left** **Right** **Bilateral**

		Left	Right
Trunk alignment	Leaning in any direction from midline		
Foot on Landing	Initial foot contact not symmetrical (timing)		
	Initial foot contact not symmetrical (foot landing away from mark)		
	Significant ground contact time		
	Foot not neutrally aligned (facing forwards)		
	Failure to land on mid foot		
Limb on landing	Thigh pelvis angle <90deg		
	Stiff upright landing		
	Patella pointing towards 2nd toe (noticeable valgus)		
	Patella pointing past inside of foot significant valgus)		
	Total		

AC

- Monitoring
- Step off, hop off, sing
- QASLS score
- Step 1
- Hop 1

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Qualitative analysis of single leg loading

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Steady stance	Touches down with NWB foot		
	Stance leg wobbles noticeably		
	Total		

TUCK JUMP TEST

- Subjects stand in a 30cm box marked on floor
- Undertake tuck jump continuously for 10 seconds
- Must attempt to raise the knees above the hips each time and land and take off within the box

- Monitoring
- Tuck jump test
- Tuck S1

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Tuck jump test

Date: **Patient:**

Condition: **Left** **Right** **Bilateral**

Name:	Score
Knee & thigh motion	
1.Knee valgus on landing	
2.Thighs not reaching parallel (peak of jump)	
3.Thighs not equal side to side (during flight)	
Foot position during landing	
4.Foot placement not shoulder width apart	
5.Foot placement not parallel (front to back)	
6.Foot contact timing not equal	
7.Does not land in same foot print	
8.Excessive landing contact noise	
Plyometric technique	
9.Pause between jumps	
10.Technique declines prior to 10 seconds	
Total Score	

Subject 1

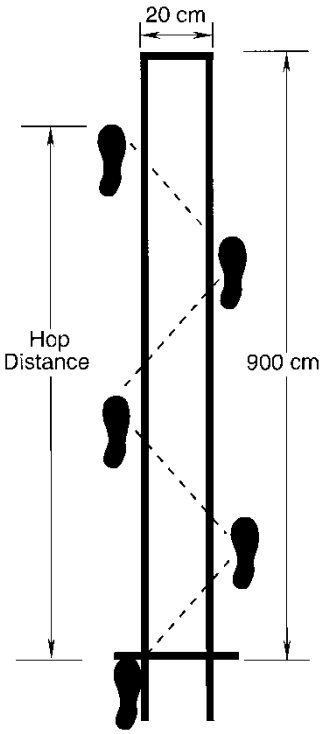
Subject 2

CROSS OVER HOP TEST

- Subject stands by two parallel lines 20cm apart extending at least 5m
- Undertakes four consecutive hops without pause crossing the grid lines each time.

ACL Injury

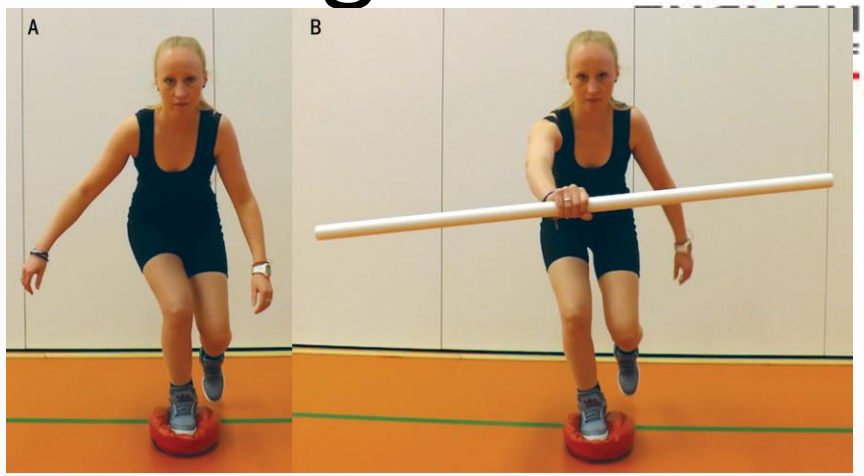
- Monitoring
- Hop tests
- One leg hop for distance
  - 80-90% height (males)
  - 70-80% height (females) (Ellenbecker 2001)
- Cross over hop; 4 hops
  - mean 4.5m (Goh & Boyle, 1997, Hopper et al 2003; Munro & Herrington, 2009; Reid et al 2007)

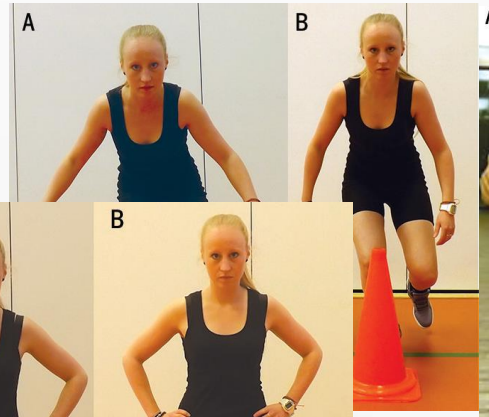


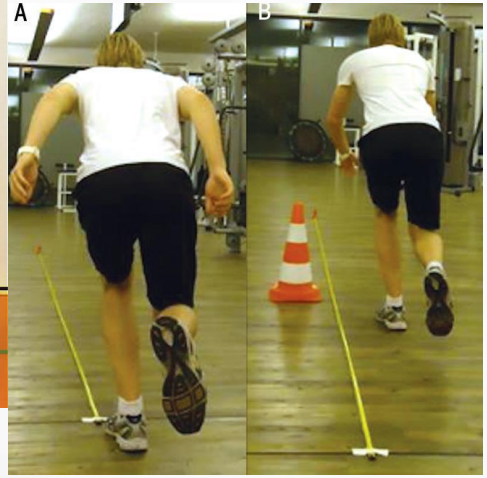
Hop type	Male (% leg length)	Female (% leg length)
Single hop	188.9 (+/-17.9)	157.2 (+/-17.7)
four hop	584.8 (+/-60.7)	505.3 (+/-51.8)
Cross-over hop	554.5 (+/-56.5)	479.9 (+/-54.7)

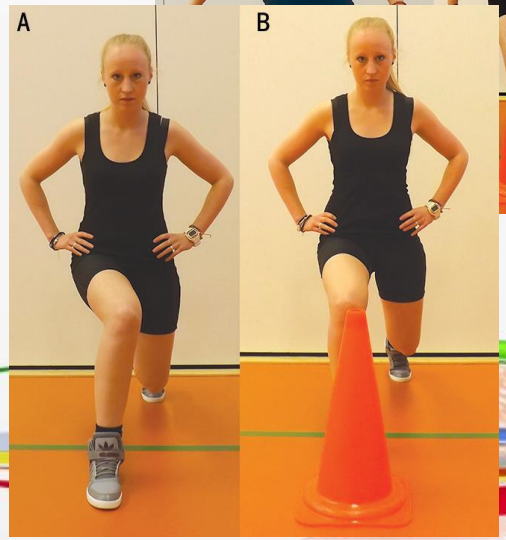
Motor Learning

- Single-leg stance on unstable platform
- Single-leg squat
- Single-leg hop for distance
- (Walking) lunges
- Double-leg squat







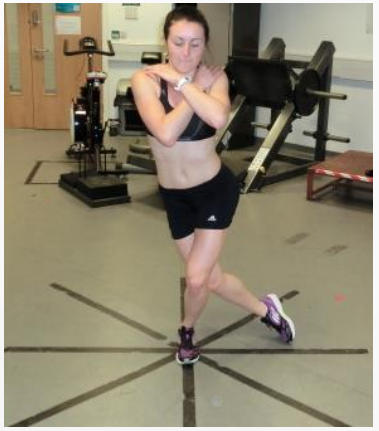


STAR EXCURSION BALANCE TEST

- Subject stands on leg to be tested in centre of star
- Instructed to reach as far as possible down the line without taking undue support from the reaching leg or stepping over onto that leg
- 4 practices then test 5 repetitions

ACL Injury

- Monitoring
- Star excursion balance test (SEBT)
- Directions:
  - Anterior (quads)
  - Posterior (hams)
  - Medial & lateral (ACL)



Direction	Reach Distance (% leg length)	
	Male	Female
Anterior	80-92	73-92
Antero-medial	82-91	82-91
Medial	87 91	87 91
Postero-medial	87-107	87-99
Posterior	85-88	85-88
Postero-lateral	81-106	81-93
Lateral	71-76	71-76
Antero-lateral	73-78	73-78

ACL Injury

Block 1:

Post op recovery phase

ACL Injury

- Post op recovery phase
- Aims:
- overcome the effects of the operation
- regain range of movement
- regain muscle activation
- control effusion
- achieve normal walking gait

ACL Injury

- Post op recovery phase
- Typical activities
- Effusion control
  - Compression, game ready etc
- Muscle activation
  - Compex & superimposed twitch
- Range of movement
  - Patella & tibiofemoral
- Gait re-education
- Limb loading

ACL Injury

- Target criteria to be achieved prior to progression to progressive limb loading activity

- Full quadriceps activation (SLR no lag x10)
- Range of movement 0-120 degrees (minimum)
- Minimal am effusion (<1cm patella)
  - Minimal change effusion with activity (<1cm patella)
- Bilateral squat to parallel (thighs relative to floor) even weight bearing
- Gluteal activation
  - Bilateral short lever bridge
    - X10 reps to neutral hip extension
- Hamstring activation
  - 0-90 deg knee flexion in standing on the uninjured limb
  - Bilateral long lever (straight leg bridge on chair:30cm)
    - X10 reps to neutral hip extension
- Function:
  - Normal symmetrical gait
  - Static cycling

ACL Injury

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Block 2:

Progressive limb loading activities

ACL Injury

- Progressive limb loading activity
- Aims:
- progressing athlete from bilateral weight bearing activities to full unilateral weight bearing activities
- undertake limited load acceptance activities (bilateral landing & jogging)

➢ both in closed skill block practice manner.

- progress strength training & work capacity of key lower limb muscles.

Load comparisons in single leg and double leg squats: a theoretical model

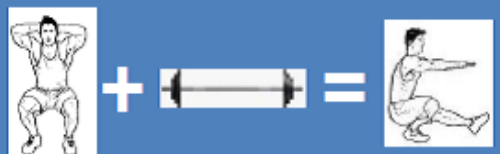
Graham-Smith. P., Natera. A., and Jarvis. M

BM = 100 kg

Both legs support 60.28% of BM collectively (i.e. 60kg from the upper body) (Zatsiorsky et al., 1990)

Each leg individually supports 30.14% of BM (i.e. 30kg on L and 30kg on R)

In single leg stance 80.14% of BM is supported (i.e. 80kg [60kg from the upper body + 20kg from the other leg])



Add 1.0 x BM or a 100kg barbell to the DL BM Squat to get the same loading as in the SL BM Squat

100kg divided by 2 legs = 50kg on each leg plus the 30kg of the mass each leg already supports = 80kg

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SL Squat + 0.5 x BM added load = **130kg**
(i.e. 80kg of BM + 50kg of external load = 130kg)

Given that each leg in double leg stance supports 30% of BM and then shares any additional load 50/50... What load would equate to the equivalent loading in each leg versus the SL Squat with +0.5 x BW?

If 2.0 x BM additional load (i.e. 200kg) is used each leg will share this load 50/50. Therefore 100kg external load plus the 30kg BM load will effectively be lifted by each leg. Total load per leg = **130kg**

DeLeva, P (1996). Adjustments to Zatsiorsky-Seluyanov's segment inertia parameters. Journal of Biomechanics, v.29 (9), pp.1223-1230.

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ACL Injury

- Progressive limb loading activity
- Typical activities
- Muscle strengthening & work capacity training
  - Leg press (squat), mid thigh pull, heel raisers
  - Open chain quads (120-60 degree) & hamstrings
  - Bridging; extended & flexed knee
- Static movement dissociation
  - Static balance; multi-angle & vestibular
  - Movement dissociation; T drills, SEBT
- Dynamic movement control (closed chain)
  - SLS, step up/down, forward & side lower, lunge
  - Closed skill block practice

ACL Injury

- Progressive limb loading activity
- Typical activities
- Bilateral load acceptance
  - Closed skill block practice
    - ❖ Criteria bilateral leg press-squat 1.5BW
    - ❖ Single leg balance stability challenge 60deg flex
- Cardiovascular training
  - Cycle, cross trainer, jog (alterG-treadmill)

ACL Injury

- Target criteria to be achieved prior to progression to unilateral load acceptance activity
- Single leg squat to 90° (alignment control x10 reps; QASLS score 0-1)
- Single leg stand 5, 45 & 90° knee flexion (10 second hold) on airex pad
- SEBT
  - Ant & Post symmetrical
  - Med & Lat <15% LSI
- Single leg press 1-1.5BW (10RM) – 0 to 90 deg knee flexion
- Bilateral drop jump test [QASLS score 0-1] from 30cm box
- Tuck jump test (score <3)
- Gluteal muscle work capacity
  - Unilateral short lever bridge on box (hip 45deg) (x25+ each leg no greater than 5 rep difference between sides)
- Hamstring muscle work capacity
  - Unilateral long lever on box (hip 45deg) (x25+ each leg no greater than 5 rep difference between sides)
- Calf muscle work capacity
  - Unilateral heel raise (x25+ no greater 5 rep difference between sides)
- Full range of movement
- Minimal activity related effusion (<1cm change patella)
- Function
  - Straight line jogging treadmill (8-10min/mile)
  - Straight line running (6-8min/mile)
  - Stair ascent & descent (30cm); alignment control symmetry

ACL Injury

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Block 3:

Unilateral load acceptance activity

ACL Injury

- Unilateral load acceptance activity
- Aim
- progress athlete from bilateral load acceptance activities to full unilateral load acceptance activities in multiple planes of movement
  - Including combination of closed & open skill practice
- progress strength & force development training & work capacity of key lower limb muscles

ACL Injury

- Unilateral load acceptance activity
- Typical activities
- Muscle strengthening & work capacity training
- Unilateral load acceptance activities in multiple planes & reactive landings situations
- Bilateral multi-plane & unilateral single plane plyometric activities

ACL Injury

- Target criteria to be achieved prior to progression to sport specific task training activities
- SEBT symmetry & within norms
- Single leg (hop) land (alignment control; QASLS score 0-1)
  - Single leg hop for distance
  - Forward & side hop from 30cm box
- 10 RM Single leg press > 2.0BW – 0 to 90 deg knee ROM
  - 10 rep leg press to 90 degrees within 5-10% of contralateral leg
  - PBs no more than 5-10% down on pre injury level 3-6 RM of selected lower limb exercises, e.g. If previous PB Squat = 150 kg x 5, then 140 kg Squat x 5 with good form is a pass.
- Tuck jump test (score 0-1)
- Cross over hop LSI <5%
- Isokinetic extensors 300%BW total work 60deg/sec (average over 5 rep)
- Isokinetic Peak Eccentric F > 120-130% of Peak Concentric F at 60 deg/sec
  - No breaks in Isokinetic Curve during 60 deg / sec ROM
- Rate of force development; eg vertical hop test (Myer et al 2012 Am J Sports Med) LSI <5%

ACL Injury

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Block 4:

Sport specific task training activities

ACL Injury

- Sport specific task training activities
- Aim
- Improving athlete's work capacity in ability to undertake unilateral load acceptance activities in multiple planes of movement with a reactive random element
- Develop athlete's ability to carry out specific multi-directional running & landing tasks which are aligned to needs of their sport, along with any other sport skill based tasks

ACL Injury

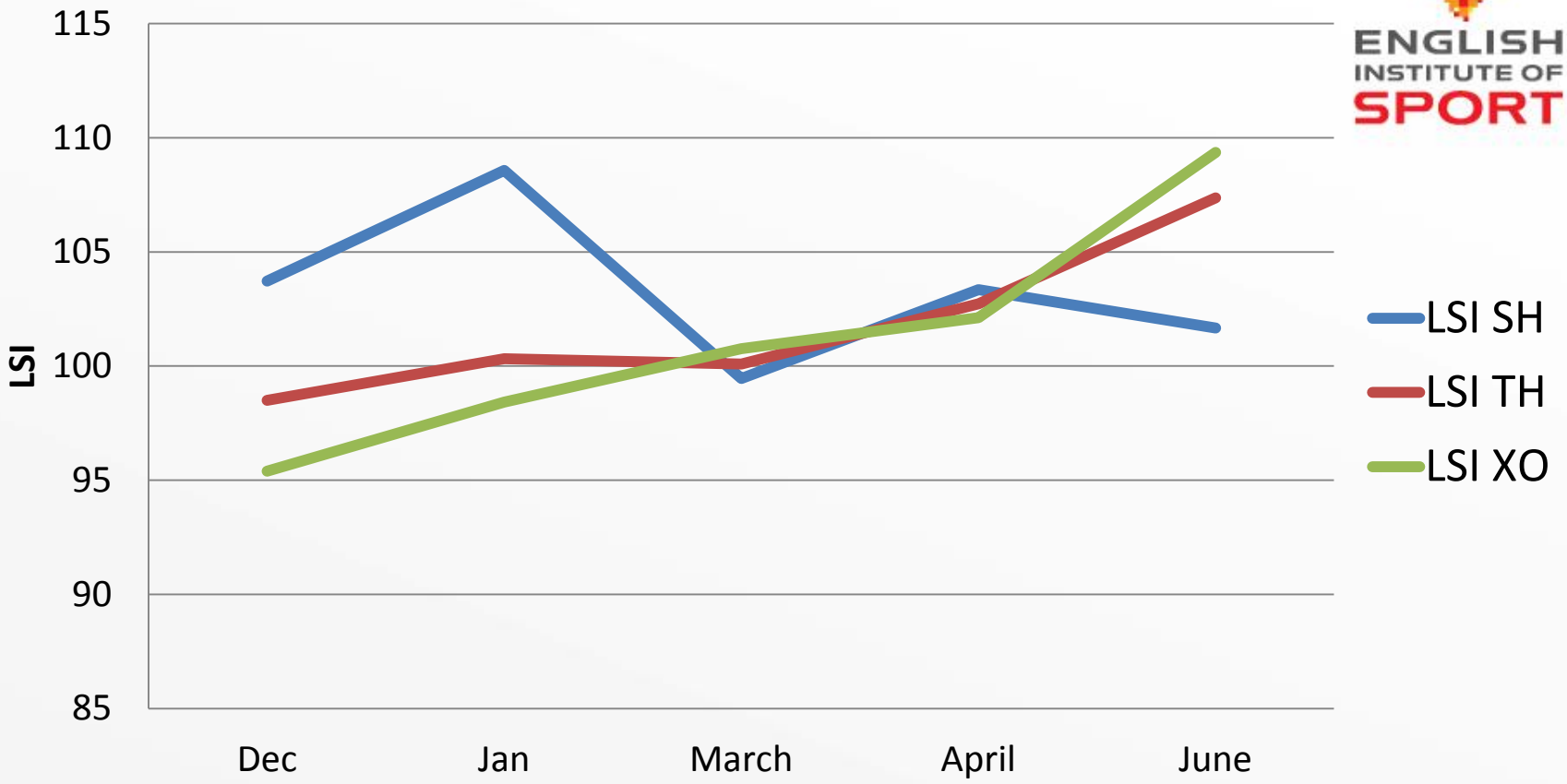
- Sport specific task training activities
- Typical activities
- Muscle strengthening & work capacity training
- Unilateral load acceptance activities in multiple planes & reactive landings situations (with fatigue element)
- Sports specific aligned running agility tasks
- Sports specific aligned skill tasks

ACL Injury

- Target criteria to be achieved prior to progression to unrestricted sport specific training
- Following fatiguing task (sport specific intensity-duration)
  - SEBT symmetry & within norms
  - Single leg (hop) land (alignment control; QASLS score 0-1)
    - Single leg hop for distance (LSI < 5%, & <5% pre op score)
    - Forward & side hop from 30cm box (alignment control; QASLS score 0-1)
- Running speed
  - flying run (10m) through Optojump system & [illegible] side symmetry of contact and flight times wit
  - Agility run time symmetrical (modified T or al specific) < 10% preop time
- Function
  - sport specific tasks with alignment control under random practice & fatigue scenarios (video analysis)

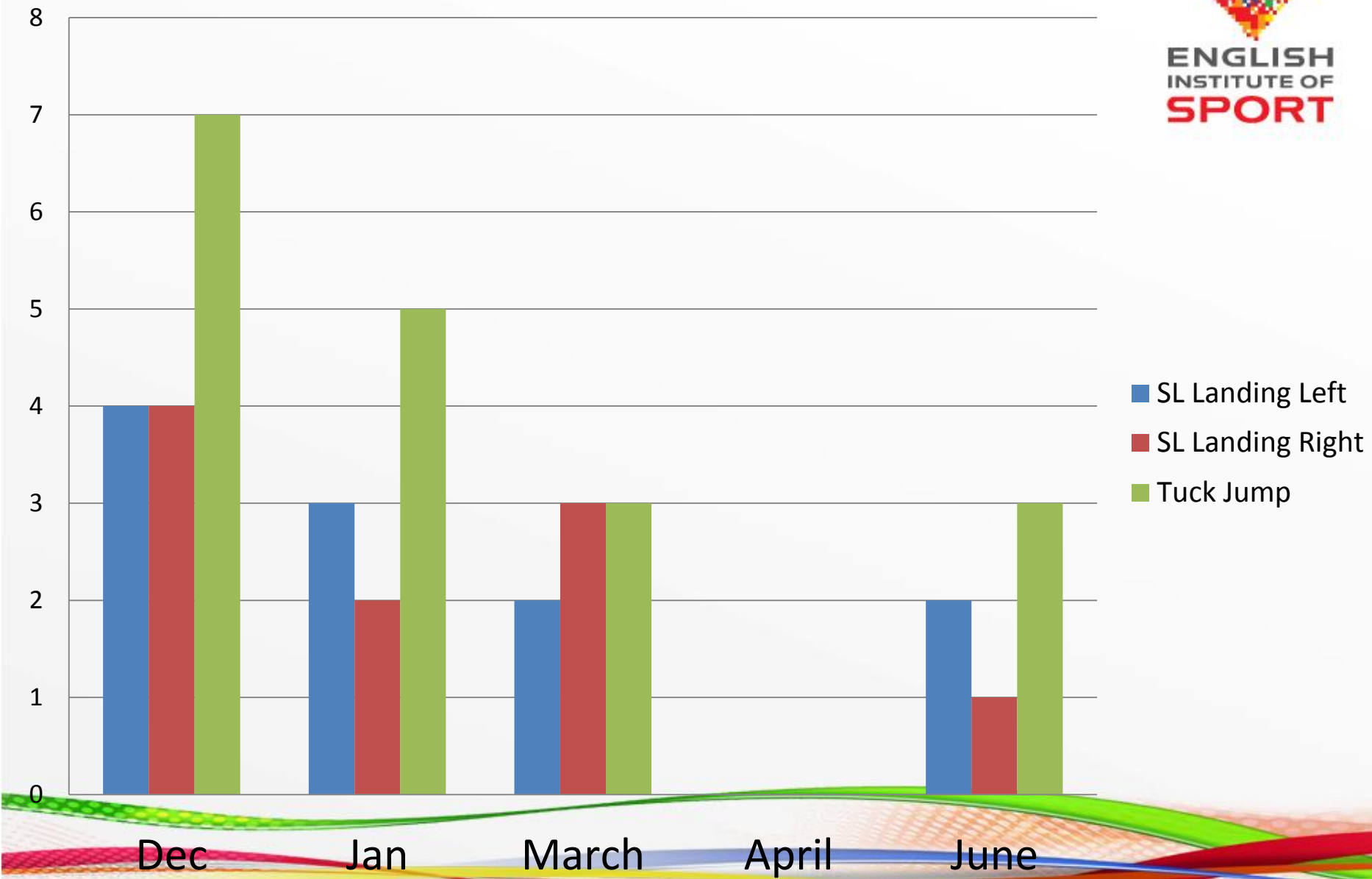
Case study – Back to Performance

LSI for Hop Tests



LSI = Injured or Non Dominant Limb Score
Non-Injured or Dominant Leg Score x 100

Tuck Jump & QASL Scores



Tuck Jumps

December 2013

June 2014

On Court – Technical Coach Led within Physio Restrictions

ACL Injury

Unrestricted sport specific training

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Masterclass

Task based rehabilitation protocol for elite athletes following Anterior Cruciate ligament reconstruction: a clinical commentary

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Thank you

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Physio matters Podcast