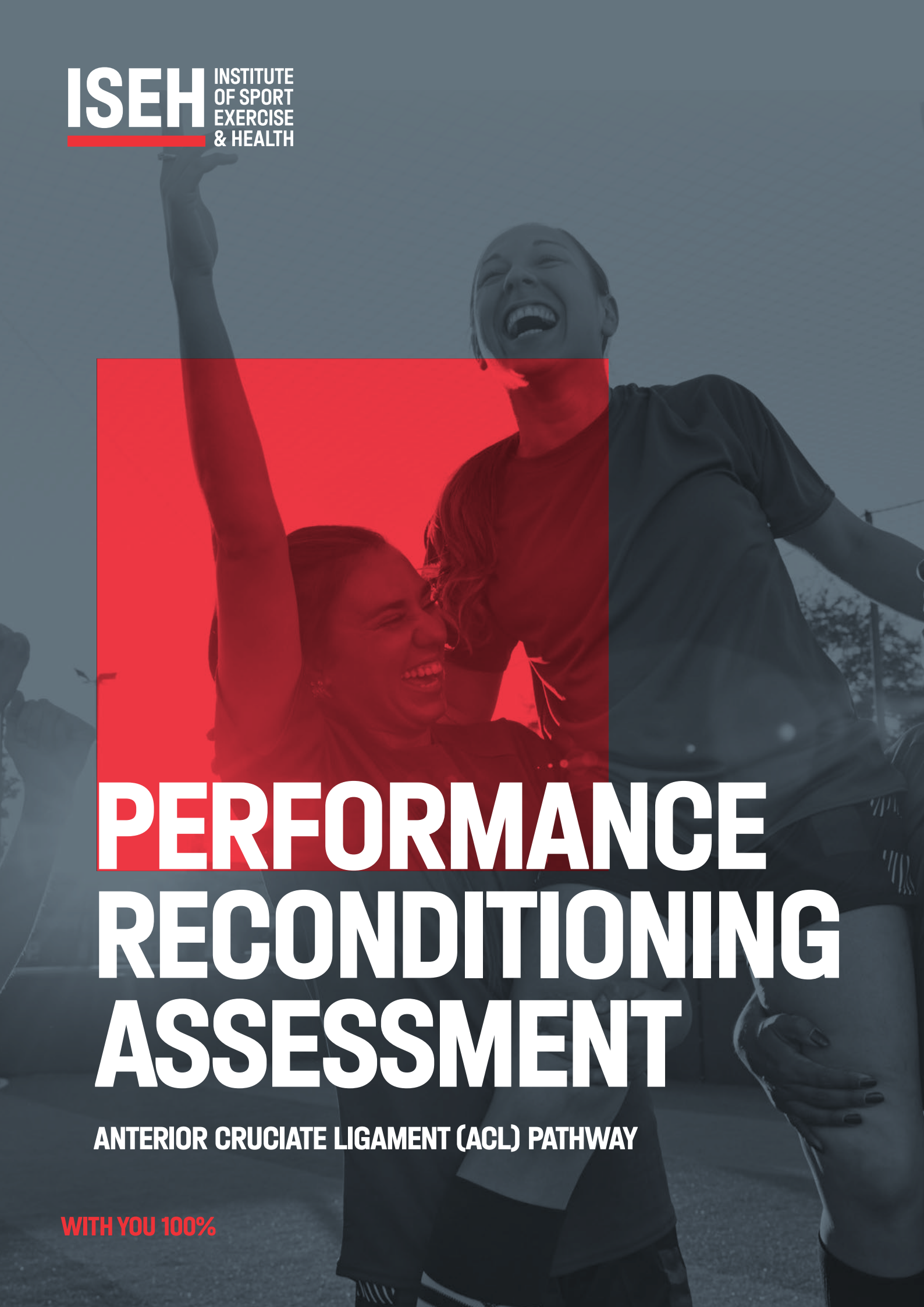
ISEH INSTITUTE OF SPORT EXERCISE & HEALTH



PERFORMANCE RECONDITIONING ASSESSMENT

ANTERIOR CRUCIATE LIGAMENT (ACL) PATHWAY

WITH YOU 100%

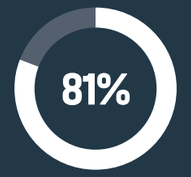
SUMMARY

1. The knee joint is one of the most commonly injured areas of the body, resulting in significant time loss from competitive sport and substantial economic implications.
2. High rates of secondary injury post-surgery are also of concern. This may in part be due to residual deficits in function and altered movement strategies that predispose athletes to greater risk.
3. Individuals are required to pass a battery of tests in the final stages of rehabilitation. However, the evidence suggests that traditional clinician-friendly assessments including hop tests are not sensitive enough to identify between-limb differences, highlighting a need for more comprehensive modes of analysis.
4. Longitudinal monitoring is also required to more accurately capture the 'patients' journey' at important milestones during rehabilitation and return to sport.
5. The Institute of Sport, Exercise & Health (ISEH) has developed a comprehensive, evidence-based assessment pathway to determine rates of progression for the purpose of guiding rehabilitation and subsequent clinical decision making.

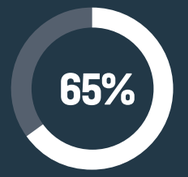
BACKGROUND AND RATIONALE

The knee is one of the most commonly injured joints and a leading cause of sport-related surgeries. Injuries to the anterior cruciate ligament (ACL) have a high economic cost, due to the extensive rehabilitation process and the athlete's subsequent absence from competitive sport. Time loss following a complete ACL rupture is variable (generally between 6-12 months of rehabilitation); however evidence indicates that a minimum of nine months is required to reduce the risk of re-injury following return to sport (Grindem et al., 2016). The rate of re-injury following a return to sports involving rapid decelerations and changes of direction can be as high as 1/3 athletes, suggesting the importance of restoring function as close as possible to pre-injury values (Montalvo et al., 2019).

Only 81% of individuals return to their chosen sport.
Zaffagnini et al., 2014



But only 65% achieve their pre-injury level of competition.
Sepulveda et al. 2017



Of further concern, a recent study of professional football players showed that only 65% remained at the top-level of competition 3 years post injury (Waldén et al., 2016). The reasons for this are likely multi-factorial, but it has been suggested that frequent monitoring and targeted rehabilitation linked to the outcomes of objective assessment can assist in minimising residual deficits that may result in reductions in performance and increased injury risk.

POST-SURGICAL FINDINGS

Following ACL reconstruction, deficiencies in strength, altered movement mechanics and loading patterns during athletic activities such as landing, squatting, and cutting have been indicated to increase risk. Asymmetry in landing mechanics has been proposed as a major risk factor for both primary and secondary ACL injury (Hughes et al., 2020). These residual between-limb deficits appear to not be related to time since surgery (Myer et al., 2012); thus early and continuous assessment at specific time-points throughout rehabilitation is required to monitor progress and individualise the re-conditioning process. For example, functional capacity of the knee at 6 months' post-surgical reconstruction is highly correlated with function at 12 and 24 months (Nawaareh et al., 2017). Similarly, return to pre-injury activity level after 12/24 months was higher among those who passed return-to-activity criteria at their 6 months' assessment (Nawasreh et al., 2017).

THE KNEE IS ONE OF THE MOST COMMONLY INJURED JOINTS AND A LEADING CAUSE OF SPORT-RELATED SURGERIES

THE INSTITUTE OF SPORT, EXERCISE AND HEALTH

The Institute of Sport, Exercise and Health (ISEH) opened in 2013 as a legacy project of the 2021 London Olympic Games and is one of three locations forming the National Centre for Sport and Exercise Medicine (NCSEM). Our vision is to become the world's leading institute for sports and exercise medicine by 2030, supporting excellence in elite sports performance through our dedication to injury prevention and management and world-class research, teaching, training and clinical expertise in sport and exercise medicine.

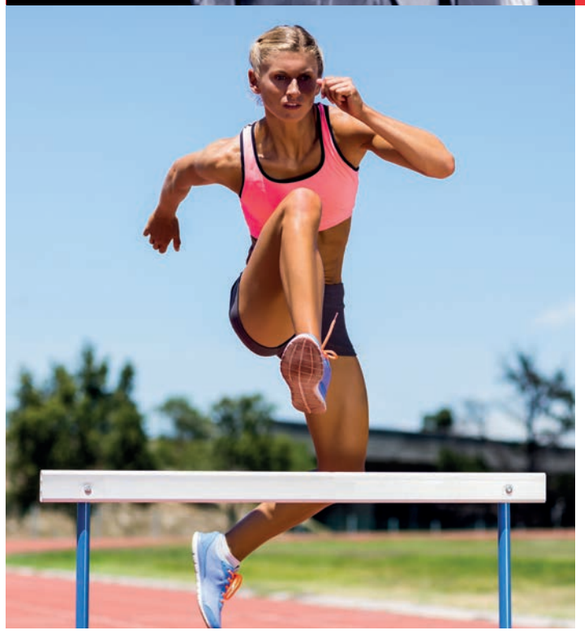
WORLD-RENOWED SPECIALISTS IN SPORT AND EXERCISE MEDICINE

AT THE FOREFRONT OF OUTSTANDING CARE

Following a £10 million investment by the Department of Health, we are able to provide a dedicated state-of-the-art facility in central London to a range of client groups, and take great pride in improving the health of the nation by helping to bridge the gap between elite sport, amateur sports and exercise prescription.

The ISEH is a partnership between UCLH (University College London Hospitals, NHS Foundation Trust), HCA Healthcare UK, UCL, the English Institute of Sport and the British Olympic Association For further details, please visit **www.iseh.co.uk**

WE OFFER COMPREHENSIVE, EVIDENCE-BASED TESTS TO ACL PATIENTS



ISEH: GLOBAL LEADERS IN SPORTS MEDICINE RESEARCH

At the Institute of Sport, Exercise and Health (ISEH), we have developed an independent assessment unit that includes a comprehensive, evidence-based battery of tests for athletes post-ACL reconstruction to identify physiological, biomechanical and psychological deficits that will inform clinicians and help guide rehabilitation. The aim is to improve return to sport rates and reduce the risk of re-injury.

Objective data are captured including a range of metrics to assist in generating a report to identify current performance levels, with consideration of normative data according to age, gender, sport and stage of rehabilitation. This gives clinicians further insight into the recovery of their athlete compared with similar populations. With this approach, clinicians will be able to tailor rehabilitation programs, improving an athlete's chance of a successful return to sport, reducing their risk of secondary injury and long-term degeneration caused by altered loading mechanics.

AIMS AND OBJECTIVES OF THE PERFORMANCE ASSESSMENT UNIT

To ensure athletic individuals achieve their maximum performance and full potential following ACL reconstruction, regular assessment is required to support clinicians and guide decision making throughout the rehabilitation process. This involves a multi-mode and multidisciplinary approach from injury and pre-operation through to return to sport. Routine follow up is also an important component so that patient outcomes can be examined.

The aims and objectives of the assessment process are as follows:

- To assist the multidisciplinary team in delivering individualised athlete management and rehabilitation programs.
- Provide comprehensive progress reports for all patients at multiple time points post-injury and operatively.
- Seek ways of improving the athlete management and rehabilitation service by reflecting on clinical outcomes through data collected within the assessment unit.
- Implement research projects using objective data collected within the assessment unit to reflect the status of the ISEH as a recognised Centre of Excellence for Sports and Exercise Medicine.
- Produce high quality and impactful research publications in leading journals and presentations at international conference proceedings to disseminate findings within the scientific community.
- To contribute to the ISEH vision of becoming a global leader in Sports and Exercise Medicine.

CONTINUOUSLY ASSESSING PATIENT OUTCOMES THROUGHOUT THE REHABILITATION PROCESS

TAKING A MULTIDISCIPLINARY APPROACH FROM INJURY AND PRE-OPERATION THROUGH TO RETURN TO SPORT

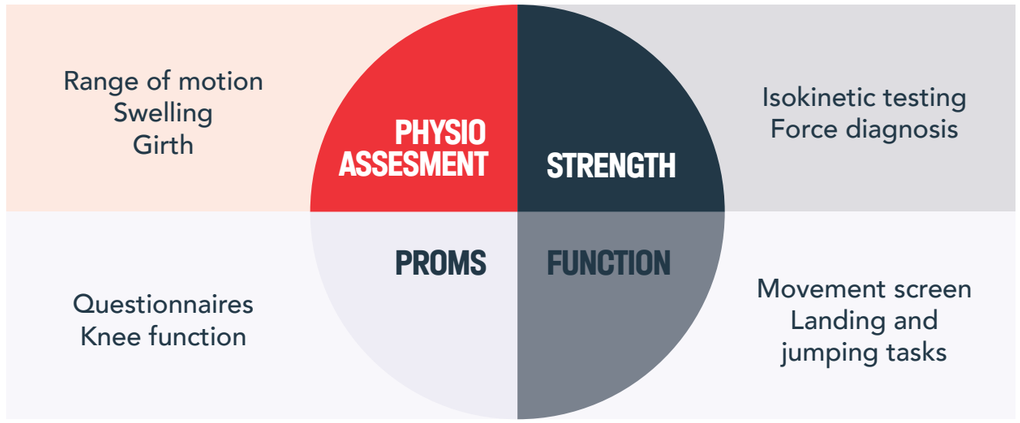
COMPONENTS OF THE PERFORMANCE ASSESSMENT UNIT

There are four major components as shown in figure 1:

- Clinical assessment.
- Strength diagnostics.
- Movement screening.
- Subjective rating of patient function.

In addition, a multidisciplinary service is offered to patients who are able to access support from a range of disciplines inclusive of sports medicine, psychology and nutrition. A brief rationale for each of these is outlined in the following sections and the athlete test battery is displayed in appendix Table 1.

Figure 1. Components of the Performance Assessment Unit



CLINICAL ASSESSMENT

Clinical evaluation includes the quantification of patient function, range of motion and stability. Evidence shows that not achieving full knee extension ROM following ACLR has been associated with poorer long-term outcomes. Restricted ROM can also affect performance of functional activities. In addition, minimal swelling and full range of motion have been indicated as pre-requisites for important clinical milestones such as a return to running.

Clinical assessment includes a subjective description of patient function (inclusive of pain, activity levels and stability during different activities) and examination of patella tendon pain (subjective examination, VISA-P, palpation tenderness, single leg squat). Range of motion testing (measures of knee flexion, knee extension, active terminal extension, hip internal/external ROM and ankle dorsiflexion), along with girth measurement and stability tests (Lachman, Pivot Shift) are also included.

STRENGTH DIAGNOSTICS

Muscle strength deficits have been associated with increased risk of future knee injury; thus increasing quadriceps and hamstring strength are key factors for successful return to sport. Isokinetic dynamometry is considered the gold standard method of quantifying muscle strength. The most common isokinetic output variable is not a strength profile, but merely a single peak torque value for each tested joint rotation velocity. However, the torque production and results are affected by the modes of contraction, angular velocity, range of motion, number of repetitions and gravity correction, with wide variation seen and no standardisation of testing protocols within the literature.

USING ADVANCED DATA TECHNIQUES AND CLINICAL ASSESSMENTS TO DELIVER PERSONALISED CARE TO EVERY PATIENT

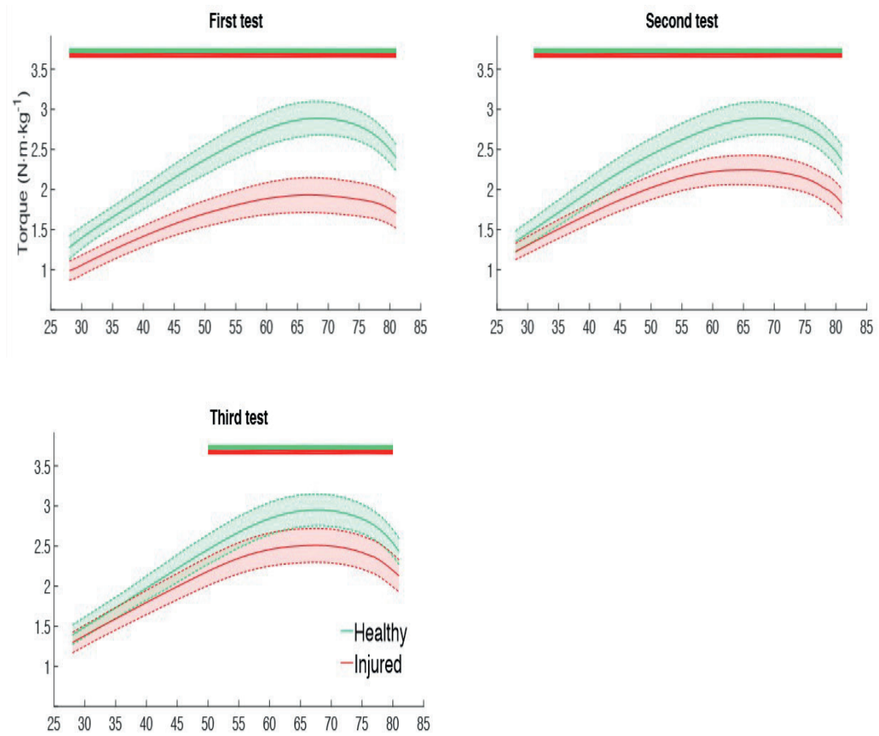
ANTERIOR CRUCIATE LIGAMENT (ACL) PATHWAY

UNDERSTANDING THE DATA AROUND ACL RECONSTRUCTION

An important limitation of these data reductionist approaches (i.e. just looking at peak torque) is that it discards angle-specific moment generating capacity throughout the range of joint motion. This has increased importance following ACL reconstruction as knee ligament injury can introduce angle-specific deficits, which may well remain undetected without evaluation of the entire angle-moment curve. Thus, at the ISEH, a comprehensive strength profile is utilised to determine the effect of joint angle and test position on muscle strength deficits. An example to illustrate this approach is provided in figure 2. The isokinetic torque-angle curve shows that while quadriceps strength deficits reduce at each test, residual deficits are still apparent in the later stages of rehabilitation (third test). Importantly, just observing the peak torque does not indicate at which point in the range of motion these differences are most apparent. This has implications for targeted program design and full restoration of knee function.

Further strength tests are also adopted including handheld dynamometry of muscles at the hip and isometric testing of the ankle plantar flexors using force plate diagnostics. These assessments consider both proximal and distal factors which contribute to knee stability. Measures of global strength capacity (isometric squats) and rate of force development are also included due to their relationships with key athletic tasks such as sprinting, jumping and changing direction.

Figure 2. Torque-angle curve at 3 time points during rehabilitation following ACL reconstruction (test 1 = 18 weeks; test 2 = 26 weeks; test 3 = 34 weeks).



MOVEMENT SCREENING

Abnormal movement patterns or biomechanical asymmetries of the lower limb are hypothesised as risk factors for the development of ACL injuries in athletic populations. Residual deficits and maladaptive movement strategies are also common which can persist for up to two years following surgery. The aim of the movement screening section performed in the assessment unit is to establish the patient's current level of function at different stages of the rehabilitation process to help guide clinical decision making and treatment.

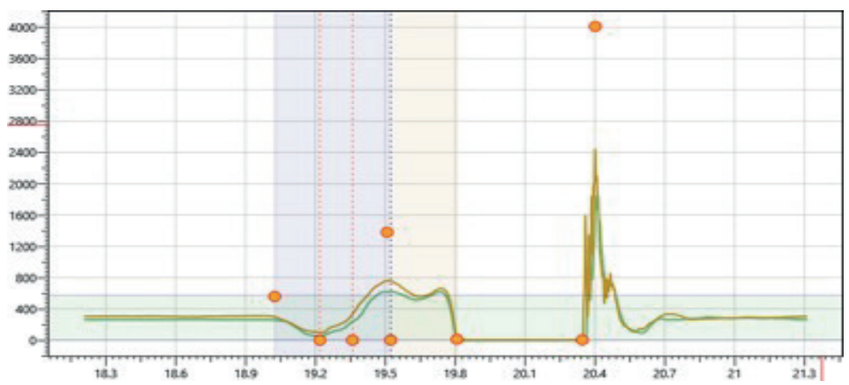
A systematic approach has been adopted which will allow clinicians to subsequently develop individualised programs linked to assessment outcomes. Specifically, this involves the utilisation of assessments that demonstrate appropriate validity and reliability, as well as focus on mechanisms and associated risk factors of ACL injury and are able to detect functional deficits assisting in the early identification of patients at increased risk.

FURTHER ASSESSMENT FINDINGS

A phase-relevant movement screening battery is completed and is representative of time post-surgery, respecting the level of graft maturation and movement capabilities to ensure safe performance. The nature of these assessments are provided in a logical sequence of advancing movement demands within each phase. For example, progression should consider a start point of wider bases of support and slower movement velocities prior to the assessment of tasks which are characterised by higher forces and movement complexities.

A primary mode of assessment includes force plate diagnostics. Figure 3 displays a typical force-time curve for an athlete in the later stages of rehabilitation following ACL reconstruction. Here you can clearly see the inter-limb compensation, whereby the athlete uses an altered force distribution or 'off-loading', with a dominance towards the uninvolved limb. This is magnified through the eccentric phase of the movement which requires the athlete to rapidly decelerate. These deficits can be identified during routine monitoring, with targeted strategies included to reduce asymmetry.

Figure 3. Countermovement jump force-time curve of an athlete in the later stages of rehabilitation following ACL reconstruction



SUBJECTIVE PATIENT-REPORTED OUTCOME MEASURES

The purpose of subjective questionnaires is to examine a range of psychological factors which have the capacity to influence rehabilitation outcomes. Despite their best efforts, many athletes with good knee function do not return to their previous level of sports participation following ACL reconstruction. Psychological disturbances may affect recovery and their ability to return to sport, as well as increase the risk of sustaining a new injury. To successfully transition back to sport after injury, athletes need to be physically as well as psychologically ready.

In order to quantify and assess the influence of psychological factors within the assessment unit, two subjective measures are included: the anterior cruciate ligament return to sport after injury scale (ACL-RSI), and the International Knee Documentation Committee subjective knee evaluation (IKDC) 2000 form. The psychometric properties of these measures are outlined below in Table 1. In addition, a referral service is also available to an experienced sports psychologist at the ISEH if deemed appropriate by the referring consultant/physiotherapist and/or the patient.

Table 1. Psychometric properties of subjective questionnaires used in the assessment unit:

Outcome measure	Description and scoring	Psychometric properties
ACL-RSI: Anterior Cruciate Ligament-Return to Sport after Injury scale	Twelve items evaluate confidence, emotions and risk appraisal Higher score indicates greater psychological readiness to return to sport	High internal consistency (Cronbach's = 0.90). Evidence of known-groups validity (scores discriminated between athletes who returned and did not return to pre-injury sports participation level after ACL reconstruction)
IKDC 2000: International Knee Documentation Committee subjective knee evaluation form	Self-report questionnaire Items evaluate symptoms of pain, giving way, locking/ catching, swelling/stiffness and current knee function (including performance of functional activities) Higher score indicates fewer symptoms and better function	High internal consistency (Cronbach's = 0.92) Excellent test re-test reliability (ICC = 0.93-0.95) Evidence of responsiveness to change in symptoms, function and sports activity.

WE CLOSELY EXAMINE HOW PSYCHOLOGICAL FACTORS CAN AFFECT AN ATHLETE'S RECOVERY

GAIT ASSESSMENT

A range of gait parameters may be altered following ACL reconstruction. These include kinematics (joint angles), spatiotemporal factors (step length or ground contact time) and kinetics (ground reaction forces). The cumulative body of evidence has most frequently utilised walking and slower speed running. Less is known about the strategies displayed at faster running speeds more akin to those required by athletes who are returning to sport. Gait assessments are performed using a force-instrumented treadmill. This process is continued throughout rehabilitation and on their return to sport. Athletes incrementally progress to higher running speeds (from self-selected to 10, 16 and 18 km/hr) as appropriate at each time point based on a number of key factors such as minimal swelling, full range of motion, time post-surgery, and clinician recommendations. Maximum vertical ground reaction force, contact time, step length, and asymmetry are routinely measured although other variables are available.

AEROBIC CAPACITY

Aerobic performance of team sport athletes is a key determinant and can be protective of re-injury due to heightened recovery following training and competition in those who display elevated aerobic capacity. The gold standard protocol is an incremental test on a bike/treadmill in combination with an assessment of V02 max via direct gas analysis. This assessment mode can be included on request to provide a comprehensive analysis of physiological function.

NUTRITION SUPPORT FOR LONG-TERM INJURIES

Long-term injuries can lead to immobilisation of the injured limb and a prolonged decrease in activity. This results in loss of muscle mass, strength and function. Inappropriate nutritional intake will impede recovery from injury, in particular protein and energy malnutrition that exacerbates the inflammatory response and slows the recovery process. Nutrition interventions that focus on attenuating muscle losses during injury should be in situ for all athletes. Immobilisation leads to muscle loss through increased negative muscle protein balance; mediated by decreased basal levels of muscle protein synthesis and a decreased response of muscle protein synthesis to nutritional stimuli. The ISEH offers a nutrition pathway to support those with long-term injuries including:

Initial assessment and individualised nutrition plan focusing on the following areas:

- Muscle mass attenuation
- Balancing inflammation
- Energy intake balance
- Avoidance micronutrient deficiencies
- Supplementation advice/provision
- Body composition DXA/kinathropometry

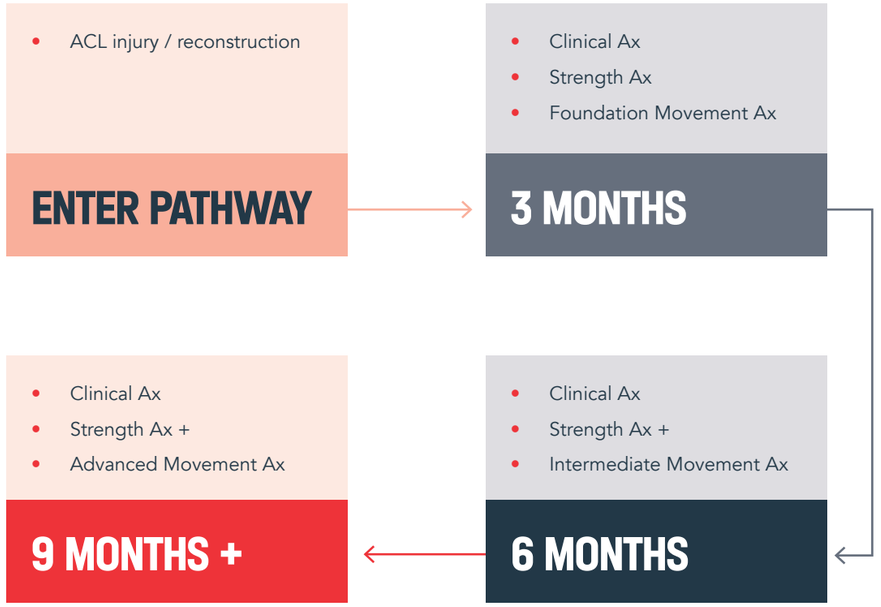
THE PATIENT PATHWAY

The standardised patient pathway is shown below in Figure 4. While the protocols for progression within rehabilitation are criteria-driven, the tests selected have been deemed appropriate for each phase of rehabilitation based on clinical experience and in alignment with the existing literature.

The time points for assessment represent clinical milestones in the patient journey. Specifically, three months after surgery has been indicated as a generalised period when athletes progress to more advanced phases of rehabilitation and may return to running (Rambaud et al., 2018). At six months a number of accelerated rehabilitation protocols aim to complete rehabilitation; and finally, it has been shown that delaying return to sport for up to nine months can reduce the risk of re-injury (Grindem et al., 2016). Including a comprehensive of function at these time points will provide clinicians with a clearer indication of progress and readiness to re-perform after injury/surgery. This places a greater emphasis on a criteria-based approach and captures the athlete's journey, while enhancing the potential for effective shared decision making.

There is also an option to perform further assessments after this point (for example at 12 or 18 months after surgery), allowing for a broader ranging approach for those who may be delayed in their rehabilitation due to a variety of factors, and will also serve as a follow up test to monitor progress in those who may have already returned to sport. This is especially important as risk of re-injury is heightened within the first 6-12 months after discharge from rehabilitation. It should also be noted that patients can enter into the pathway at any point, although longitudinal assessment throughout rehabilitation is recommended.

Figure 4. Patient assessment pathway (+ follow up assessments also available after this point)



THE ISEH OFFERS PATIENTS A RANGE OF EXPERT CARE PACKAGES

PATIENT AND ATHLETE FOLLOW-UP TO DETERMINE SUCCESSFUL OUTCOMES POST INJURY AND SURGERY

In order to assess patient outcomes following injury, surgery and subsequent rehabilitation, performance indicators need to be established. Outcomes are assessed in terms of statistics relating to return to play at the same level of competition, performance and re-rupture rates through routine patient follow up.

In addition, validated patient-reported outcome questionnaires will be used to determine the level of subjective function. Individuals will be monitored remotely on returning to their respective sports. This provides a unique opportunity and allows the exploration of factors associated with successful patient outcomes and best practice approaches to enhance performance.

PACKAGES

It is recommended for athletes to undertake the assessment series as a package (e.g., 3, 6 and 9 months or pre-op, 3, 6 and 9 months, plus return-to-sport follow up) to monitor the progression and the rehabilitation journey; however, one-off assessments can be performed at any time point inclusive of pre-op and the time of return-to sport, or even in the period after return-to sport and competition. Costs include all aspects of assessment outlined in appendix table 1, in addition to a comprehensive report with a follow up consultation with the patient (and referring consultant / physiotherapist) to ensure each aspect is understood and an actionable treatment / training plan can be devised.

A broader assessment can also be offered including quantification of aerobic capacity, referral for nutrition and psychology consultations if required. Prices are available on request and dependent on diagnostics performed.

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WITH YOU 100%

To book an assessment or for further information please contact:

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05/21