The EN-KNEE

Isokinetic Testing and Training

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Fontys Paramedische Hogeschool Eindhoven
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Foreword:

This manual is part of a graduation project at The Fontys Paramedische Hogeschool Eindhoven. A video has also been made, as an additional visual aid together with the manual. The students behind this project have followed the English-Stream programme at the department of physiotherapy; this project has been done in the last semester in the fourth year, before the students graduate. Without help and assistance from supervisors and others, the making of the manual and the video would not have been possible. The project group would like to thank supervisors; Marlies Schillings, Annelies Simons and Monica Veeger. Toine Seegers, Sven Sweeden and the staff at the "studielandschap" (library at Fontys Paramedische Hogeschool Eindhoven) has also been very helpful. We would also like to thank John Blankers with family and the former American students for their help and advises.

Knee training.

Summary:

This manual is made to give students and teachers at the Fontys Paramedische Hogeschool Eindhoven knowledge on how to operate the isokinetic testing and training unit the EN-KNEE. The manual also gives an introduction into the subject isokinetics. It gives instructions on how to adjust the EN-KNEE to fit patients with both knee and hip problems, how to make reproducible test protocols, how to analyse test results and make valid comparisons and how you can set up a training programme. Different topics covered in this manual is directly linked to a given time on the accompanying video This manual will together with the video make the student/teacher fully able to operate the EN-KNEE independently.

Hip training.

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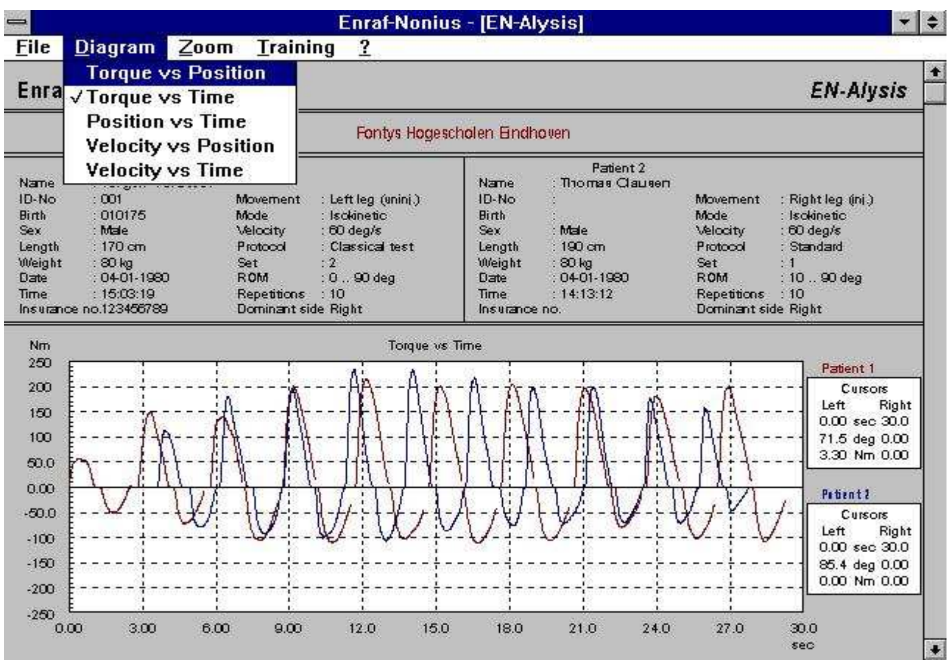
Introduction

During the late sixties and early seventies, a new form of controlled and monitored way of exercise against resistance was developed called Isokinetic moving. Isokinetics is a subject, which has gained increasing interest within the physiotherapy profession during the last two decades (1). In the beginning, the literature consisted primarily of research data and clinical information relating to the knee joint. However, recent advances in equipment have made it possible to use positioning to apply Isokinetics effectively to most other extremity joints, as well as the trunk itself (3).

Resent developments in technology has made it possible to make testing and training units that can make the patients perform quite accurate isokinetic movements. These units monitor and measure the patient’s performance during training. Most of these units offer the possibilities for both concentric and eccentric training. They often also have the possibilities for isometric training, passive moving and constant passive moving (CPM). All information gained from the training can be stored in a computer for comparisons and analysis. At the moment, isokinetic testing is one mean to gain objective and accurate measurements of muscle-power (1).



Computer program for the EN-Knee

The department of physiotherapy at Fontys Paramedische Hogeschool in Eindhoven has implemented isokinetics as a subject in the curriculum for all their students. An isokinetic training and testing unit for the knee called the EN-KNEE has been purchased as an educational tool. There is however, insufficient instruction material to support the students to learn how to work with this unit. This graduation project is done to find out whether it is possible to make better study-materials than what is already being used. The products of this project are a video and a manual.

1. Isokinetics

1.1 History

In the late 1960's the concept of isokinetic exercise was developed by an engineer, James Perrine, and introduced in the scientific literature by Hislop and Perrine in 1967. They were able to introduce this concept thanks to the design of a dynamometer that controls the speed of movement and imposed a maximal and adaptable resistance over the entire range of motion (4).

The technology behind isokinetic dynamometry made a considerable progress owing to the evolution in computer technology.

In the late 1960s, isokinetic devices included a basic or simple computer program capable of comparing bilateral data, updated to enable the computation of total work, power and endurance. This was followed by the introduction of a monitor, which provided immediate feedback to the therapist and the patient alike. More recently, touch-on monitors have been incorporated, with computers capable of more complex tasks, including the computation of fatigue index, displaying progress in the training program, gravity correction and improved data storage capacity. Eccentric mode has been added as an option. Advancements in the provision of accessories have also provided more scope for muscle testing and rehabilitation. It is now possible to test all limbs and recently, a trunk testing facility has become available which allows trunk flexion and extension, rotation and lifting and closed kinetic chain exercise (2).

Rapidly, isokinetic devices became the tools of choice in hundreds of research papers as well as the cornerstone of quantitative muscle performance assessment in the clinical setting (3).

Today's devices are used in larger rehabilitation centres and in some hospitals.

1.2 Evaluation of muscle strength and function

Evaluation of rehabilitation programs with respect to effect, has become an important feature in the physiotherapy practice. Concerning muscular strength, isokinetic test devices are frequently used as evaluation tools. With isokinetic equipment, objective measurements of deficits in muscular performance can be made (1).

The evaluation of function after orthopaedic surgery procedures is of great importance. The patient's functional level is an essential parameter after surgery, and subjective evaluation is not sufficient to document the functional outcome (4). Evaluation tools like functional scoring systems (e.g. Lysholm, Tegner), objective muscle strength measurements (e.g. isokinetics), and functional tests (e.g. triple jump test, walking stairs, squatting) have to be included in the protocols to document the patient's function in a scientific way (11).

1.3 The isokinetic concept

The term "isokinetics" is defined as the dynamic muscular contraction where the velocity of movement is controlled and maintained constant by a special device called dynamometer. With the isokinetic method, if maximum force is applied to the dynamometer over a range of motion (ROM), the resistance of the dynamometer is proportional to the muscular capacity at all joint angles, offering optimal loading of the muscles under dynamic conditions.

Because of this accommodation, the muscle groups tested may be exercised to its maximum potential throughout the total ROM. Isokinetic movements require a device that provides resistance to limb movement so that a limb segment cannot accelerate beyond the machine's pre-set angular velocity. As a result, the machine does not provide resistance, or measure torque, until the limb segment attempts to exceed the pre-set speed (4).

Note: The method gives objective measurements of force production in groups of agonistic muscles, not in one specific muscle.

1.4 Modes of testing muscle strength

1.4.1 Isokinetic Mode

Isokinetic exercise is defined as dynamic muscular contraction when velocity of movement is controlled and held constant by a special isokinetic device. The resistance of the device equals the applied muscular torque throughout the ROM. This is, however, not true at the beginning and at the end of a given motion. Therefore, isokinetic movements require the use of an electromechanical appliance capable of maintaining a constant velocity of movement. Muscle contractions are not themselves isokinetic: concentric and eccentric contractions may be produced by isokinetic exercises, depending on the testing modes of the given apparatus (2).

1.4.2 Isometric Mode

The isometric mode of muscle strength testing involves contraction against a fixed, immovable object. Strength is measured as the peak force or torque developed during a maximal voluntary contraction. A high degree of accuracy is possible with various tension-meters. Like the EN-Knee, most isokinetic devices have this option (2).

1.4.3 Isoinertial or Isotonic Mode

Isoinertial testing involves variable speed of movement with fixed resistance, such as the use of free weights or machines. Isoinertial exercises are composed of concentric and eccentric actions and are commonly known as ”isotonic”. The term ”isoinertial”, however, is more scientifically correct. Isoinertial strength is measured as the heaviest weight which can be lifted once through a given ROM (2).

1.5 Isokinetic training compared to Isoinertial (Isotonic) and Isometric training(2)

	Advantages	Disadvantages
Isometric	Does not aggravate sensitive joint surfaces. Easy to perform and remember. Minimal equipment required Reproducible. Easy to measure Convenient for bed or home exercise Cost effective.	Lack of dynamic functions Not functional. Any improvements are speed and angle specific. Many contraindications. Not efficient in terms of strength. Little objective feedback of strength increase No endurance enhancements.
Isoinertial (Isotonic)	Functional. Includes concentric and eccentric modes Easy to monitor. Minimal equipment needed. Convenient for home exercises. Best strength and endurance enhancements.	Maximal loading only at specific angles. Momentum key factor. Synergists either limit progress or are under trained. Unsafe for (already injured) joints. Highest likelihood of injuries. Gives delayed onset muscle soreness. Many contraindications. Difficult to monitor accurately.
Isokinetic	Maximal loading throughout whole range of motion. Objective, reproducible and easily quantifiable. Muscles easily isolated. Safest form of exercise. Good for early muscle rehabilitation Few contraindications.	Time consuming. Requires a lot of training and skill to use. Costly. Not functional.

Figure 1.

Both methods have advantages and disadvantages.

In isotonic exercises the amount of resistance is limited to the weakest point in ROM, whereas isokinetics provide maximal resistance throughout the ROM. Isokinetics accommodates to fatigue and pain, isotonics have no such accommodation. Isokinetics permit quantification of torque, work and power (see definitions), - isotonics do not. Isokinetic exercises occur primarily from non-weight-bearing open-kinetic-chain (OKC) positions, whereas isotonics are more easily performed from weight-bearing closed-kinetic-chain (CKC) positions. Isotonics may therefore be more transferable and relevant to functional weight-bearing activities of daily living and athletic performance (4). However, muscle testing is just one method of measuring functional performance.

In the past, many clinicians and exercise scientists believed that isokinetic training was a superior method. However, there is considerable scientific evidence that demonstrates isokinetic training does not offer advantages over other forms of resistance training and in most instances may be inferior to other forms of training (9).

Theoretically, an isokinetic device will accommodate force production and maintain a constant velocity; thus a maximum force effort can be made through the complete range of motion. However, according to research there are no commercially available devices, which produce an isokinetic movement throughout a complete range of motion, especially at fast speeds (9).

This is also the case of the EN-Knee, which has controlled stops at end range of motion, so that the end position is not reached at a jolt which increases the comfort for the patient. (3).

This lack of complete isokinetic range of motion is due to acceleration at the beginning and deceleration at the end of the range of motion (9).

Thus, these devices are more properly termed "semi-isokinetic." They are only 100% isokinetic in parts of the ROM.

1.6 Effects of Isokinetic training on muscle strength

Studies and reviews comparing semi-isokinetic and other resistance training modes indicate a high degree of strength specificity. In fact, strength and power gains as a result of free weight training or variable resistance training are not always demonstrable when measured on semi-isokinetic devices (9).

Because movement is rarely performed at a constant velocity through a full range of motion, it may be argued that a freely moving object or device will allow muscle contractions to occur which are more similar to natural motions. A recent comparison of "isotonic" (freely moving leg extension device) versus semi-isokinetic leg extension training indicates that isotonic training is superior in producing both strength and power gains (9).

1.7 Results of Isokinetic training on the functional level

Sceptics claim that isokinetics do not correlate to functional activities, but several authors have documented a positive correlation between isolated isokinetic peak torque results and functional test measures such as running, cutting and hopping (4).

Risberg et al. (1994; 1995) developed a set of functional tests to evaluate functional limitations after ACL-injuries. They showed that there was a statistical significant correlation between the stair hopple test, the triple jump test and the quadriceps strength measured isokinetically (Risberg et al. 1993; 1994). In this context isokinetic equipment was used as a standard in order to find out to what extent muscle strength was related to the patients functional performance. Wilk et al. (1994) concluded that there was a positive correlation between isokinetic quadriceps peak torque at 180º/sec and 300º/sec and functional testing. They also found that subjective self-assessments of knee function compared favourably with the patient's ability to generate knee extension peak torque.

In studies that reported weak correlation between isokinetic performance and functional test results (Reizebos et al. 1983; Anderson et al. 1991; Delitto et al. 1993; Greenberger and Paterno 1995), the testing equipment did not allow reciprocal muscle testing of the knee extensors/flexors. Reciprocal muscle testing allows a stretch-shortening muscular cycle to occur and also allows antagonist muscle activity; both contribute significantly to functional activities (Wilk et al. 1994). The reciprocal testing is crucial to the functional translation of isokinetic testing results (4).

Few studies dealing with modes of training have investigated carryover to aspects of performance other than strength such as sprinting or jumping and none have investigated effects on ergonomic tasks. A few studies have compared free weights and variable resistance machines (Jesse et al., 1988, Silvester et al., 1982; Stone et al., 1979; Wathen, 1980; Wathen and Shutes, 1982) and semi-isokinetic devices (Augustsson et al., 1998) as to their effects on the vertical jump and vertical jump power indices. Four studies (Augustsson et al., 1998; Silvester, 1982; Stone, 1979; Wathen, 1980) found that free weights produce superior results. Two studies (Jesse et al., 1988; Wathen and Shutes, 1982) found statistically equal results. While these studies generally indicate the superiority of free weights in producing a transfer of training effect, they are not definitive (9).

1.8 Open Chain (Leg Extension) vs. Closed Chain (Squat)

Recently the concept of open (OKCE) and closed kinetic chain exercises (CKCE) have received considerable attention in the scientific literature, particularly in terms of injury rehabilitation (9).

A CKCE is one in which the foot or hand is fixed and force (in a weight bearing manner) is transmitted directly through the foot or hand such as a squat or bench press.
An OKCE is one in which the foot or hand is not fixed, such as a leg extension, and the peripheral segment can move freely.

CKCE produce markedly different muscle recruitment and joint motions compared to OKCE (9).

Most isokinetic equipment are OKCE devices and do not likely provide complete specificity for training or for testing strength gained through CKCE training (9).

Literature states that if movement patterns could be made more similar, then results may be more readily comparable. Manufactures have taken this into account and today, the American company producing Cybex now deliver isokinetic equipment with the possibility to also test and train in a closed kinetic chain.

1.9 Reproducibility of isokinetic muscle strength measurements

During the last decade researchers have become far more aware of the crucial significance of reproducibility (or reliability) and validity of isokinetic test measurements. These two aspects have to be fulfilled in order to establish scientific test methods.

Rothstein and Ecternach (1993) use the following definition of reproducibility: "The consistency or repeatability of measurements; the degree to which measurements are error-free and the degree to which measurements will agree". In other words, we evaluate reproducibility by considering the stability (consistency) or agreement between different sets of measurements on equal tests performed on the same individual within a short period of time. The goal is to develop measurement methods that can discover real changes over time.

Nitschke (1992) did a review of studies dealing with reliability of isokinetic torque measurements, and she concluded that there were few studies that established reliable test protocols. The reviewed authors had omitted to report the standard error and confidence intervals for meaningful interpretation of the reliability coefficients. Nitschke' s review stresses the fact that the results in reproducibility studies often are analysed in an inappropriate way, notably by using correlation coefficients. What is really important to evaluate is the level of disagreement. One should care about whether measurements are the same, not whether they are related or associated, because there must be a close relation per se between identical muscle groups when tested repetitively. Better ways to assess variance between measurements are to use intraclass correlation coefficients (ICC's) or coefficient of variance (CV) (4).

1.10 Validity of isokinetic muscle strength measurements

Sim and Arnell (1993) defined measurement validity as: "The extent to which an instrument measures what it is intended to measure and can refer equally to nominal, ordinal, interval or ratio levels of measurement. Validity deals with accuracy of inferences drawn from such measurements".

In the summarising chapter in his book concerning validity, Dvir (1995) concluded that: "Isokinetic test findings are valid for a number of specific dysfunction's, like patello-femoral pain and anterior cruciate ligament (ACL) deficiency (3).

These dysfunctions can be found back in the chapter covering indications and contra-indications.

The most frequent argument used by colleagues that are critical to isokinetic equipment as a valid method of muscle measurements is that muscle strength is tested under non-functional conditions. The trend in the 1990's has been to use closed kinetic chain exercises in the rehabilitation of the patients. Studies suggest that CKC-exercises may offer additional advantages of less stress on the maturing graft in the rehabilitation of ACL-reconstructed patients and the patello-femoral joint. Most functional activities, however, are combined open and closed kinetic chains. In the gait cycle, 65% of the cycle is closed kinetic chain (stance phase) and 35% is open kinetic chain (swing phase). In running almost 70% of the cycle is open chain (2).

Manufacturers of Isokinetic equipment have taken this into account and today there are isokinetic devices that also are suited for testing and training in a closed kinetic chain (Biodex).

Another important factor is that by using functional tests like stair hopple and one leg hop tests to uncover functional disturbances, we need more specific testing tools, e.g. isokinetic equipment, to find out where in the lower extremity the deficit is located. Test measurements can theoretically be grouped according to the World Health Organisation's classification of impairment, disability and handicap (11).

Impairment variables relate to anatomic or physiological structures, whereas disability variables relate to performance of activities. Isokinetic muscle test parameters could be related to the impairment level whereas functional knee tests parameters are more related to the disability level.

Risberg et al. (1994) showed a positive relationship between muscle strength on impairment level and functional tests on disability level, which indicates that muscle strength is an important component of functional knee tests (4).

2. Description of the EN-KNEE

The EN-Knee is a training and testing unit that, in standard set up, is suited for testing and training of the knee and with some adjustments also can be used for the hip.
The EN-Knee offers both the possibilities for isokinetic and isometric training and testing. The resistance of the EN-Knee adjusts itself automatically to the resistance experienced, the lever arm only gives resistance when a force is being exerted on it. The constant velocity of the motion and range of motion can be set. The EN-Knee software offers the possibility to show graphic displays of the measurements on a computer screen. With the measurement data and the graphic displays, differences in the motion data can be recognised and quantified (3).

The EN-Knee unit consists of 4 major parts. The chair, the lever arm, the active dynamometer and the control unit.

The EN-Knee unit

2.1 The chair

The chair is where the patient is seated during training and tests. It consists of a seat that can be adjusted up and down and a back-support that can be adjusted to the front and to the back. The seat and the back support must be adjusted to the correct position to put the knee in the correct position in relation to the equipment axis as will be explained in chapter 4.

2.2 The lever arm

The lever arm forms the interface between the patient and the EN-Knee unit. It transmits the forces from the patient's leg to the active dynamometer. The lever arm has a fixation lock for the lower leg. This fixation lock can slide up and down the lever arm to fit the leg-length of the patient and it can be firmly locked to stay in position during a training session.

2.3 The active dynamometer

The active dynamometer has the attachments of the lever-arm and its centre is what is referred to as the equipment axis of the EN-Knee. In the active dynamometer, the resistance is altered by electronic servomotors to match the patient's force to ensure that constant speed is maintained throughout the movement. There are two attachments for connection of the lever arm and the active dynamometer, one on each side of the chair. The attachment on the right side is for the right foot, - the attachment on the left side is for the left foot.

2.4 The control unit

There is a control-panel on the right side of the chair, which can be used to set the parameters for training. In most cases however, the control unit will be a computer connected to the EN-Knee with a software-program that can set up all the parameters for testing or training and with elaborate analysis possibilities.

2.5 Options

A detailed description of how to make a test protocol and how to choose for the different options in the software program will be given in chapters 5 and 6.

2.5.1 Motion

You can choose the right or the left leg. Often the right and the left leg are tested after each other for comparison purposes. Another possibility is to test the same leg twice in order to check the consistence in various sets and repetitions.

2.5.2 Mode

The mode indicates whether an isokinetic or isometric training programme is being used. The isometric programme offers data about one specific angle. The isokinetic programme produces data about one defined range of motion.

2.5.3 Velocity

The velocity can be adjusted between 30º and 240º in steps of 5º. Low velocities are often used to stimulate strength increase, while higher velocities are often used to train endurance.

2.5.4 Protocol

Here you can define a number of variables, like the number of sets, the range of motion and the interval between sets, depending on the choices from ‘standard’, ‘library’ or ‘individual protocol’. The software makes it possible to put together patient specific testing and training which can be stored in a library to be used more than once.

2.5.5 Set number

Here you must decide the number of sets in your training session.

2.5.6 ROM

The range of motion (ROM) is the excursion, which you would like your patient to perform.

It can be adjusted in degrees between 0º and 90º. It is preferred to make the ROM as large as possible since the actine-myosin coupling in the sarcomeres is optimal, which has a positive effect of the power development (Perrin, 1993).

2.5.7 Repetitions

A repetition consists of one extension and flexion motion. The number of repetitions per set for strength testing purposes must be at least six, as research shows that the peak torque is measured in the first two to six repetitions (Baltzopoulos & Brodie 1989).

2.5.8 Graphics

It is possible to visualise by means of a diagram some five different graphics. Which variables that are shown in the graphics can be seen in the left upper corner and the right lower corner of the graphics block.

By using the cursors it is possible to zoom in into a specific part of the graphics to investigate certain parts more closely. When the graphics are changed, again the part that was zoomed into in the previous graphics will be shown.

3. Preparations   **Time on video: 3min. 50sec**

3.1 Turning on the equipment:

The computer and the EN-Knee together make the EN-Knee unit. The computer is connected to the EN-Knee by a parallel cable. The attachment is located on the reverse side of the EN-Knee.
It is also possible to operate the EN-Knee without the computer. The built-in control panel can then operate the EN-Knee.

First the computer and the monitor are turned on. Turn on the EN-Knee by pushing the on/off button down on the right reverse side, as you are facing the unit from the frontal side.
After turning on the EN-Knee, one must pay attention to the lever arm. The lever arm goes up and down to reset itself. It is important that the lever arm has space to move freely through its range.

3.2 Instructions to the patient:

Before testing and training with the EN-Knee it is important to give good instructions to the patient.

Important issues are:
-The EN-Knee, how it works and what it does.
-Explain what isokinetic concentric action mean and how it feels during a test
-That the patient has to be tied to the chair by fixation belts.
-It is important that the patient tries to move his/her leg as fast as possible through the whole range of motion. The speed of the movement will always stay the same, but by trying to move as fast as possible, the EN-Knee will generate more resistance. Also, clarify the possible after-effects of isokinetic exercise, especially the likelihood of delayed onset of muscle soreness.
It is important to instruct and stimulate the patient to give maximal effort, to ensure reliable and correct data, which is crucial when analysing the results.

There are three main sources of unwanted variability (errors) in measurements: device error, error of the administrator, and human variability (which is not a real error). Since modern isokinetic equipment offer high sensitivity, device error is not a big problem anymore (3).

Concerning the error of the administrator several factors have to be taken into account. It is very important to position and stabilise the patient in a proper way. Positioning and fixation of the body and limb segment must be exactly the same in repeated testing sessions in order to achieve adequate test-retest reliability. Positioning and stabilisation are also important to isolate the target muscle group. Other factors that may effect the reproducibility are range of motion, which has to be exactly the same in each test session and gravity correction, because additional force must be exerted to accelerate the limb against gravity and vice versa. This tends to reduce or increase the torque output recorded (2).

Adequate patient instruction and familiarisation, warm-up procedure, volume of commands, eye contact, the time of the day are also of importance. Exact planning and description of the chosen procedure is therefore extremely important when performing reproducibility studies and studies in general.

3.3 Warming up and stretching:

As with any activity, it is important with a good warming up prior to the testing/training. Do a warming up of big and relevant muscle-groups for approximately 10-15 minutes. Adequate activities are for example jogging, biking and rope skipping.
Afterwards, it is advisable that the patient performs some stretching of the muscles around the joint to be tested. In case of injuries, it is important that you always adapt the warming up to the level of the patient.

3.4 Familiarisation:

Let the patient "play" with the machine by first using sub maximal and then maximal force, at different speeds. Familiarisation may be time consuming, but is essential to obtain reliable and reproducible results. Generally, prior to actual testing, three sub maximal and three maximal repetitions have been found adequate for obtaining reliable measurements of isokinetic peak torque, work and power (2).

3.5 Indications and contra indications (12):

-Anterior knee pain
-Retro patellar chondro-pathy
-Chondromalacia patella
-Apexitis patella

Indications:	*Pain for 2-3 months in relation to load provocation with walking stairs, bicycling and long sitting *Post-operative status after retinaculum release
Contra Indications:	*Infections *Tumours *Inflammatory rheumatism *Serious cartilage defects degree 3 to 4 *Patello-femoral arthrosis *Implants (E.g. total/hemi knee)
Relative Contra Indications:	*R.A. *Osgood Schlatter *Problems of the epi-apophysis *Multiple operations *Fractures *Cyst-formation *Operation according to Hauser (=displacement tibial tuberosity)

-Menisci pathology

Indications:	*Post-operative arthroscopic part./total menisectomy after a relative short lasting period of meniscus problems.
Contra Indications:	*Infections *Tumours *Inflammatory rheumatism *Serious cartilage defects degree 3 to 4 *Implants *Meniscus suture *Meniscus fracture *Meniscus problems>6 months
Relative Contra Indications:	*Post-operative infections *Post-operative haematoma *Open technique part/total menisectomie

-Medial and lateral collateral ligament injuries

Indications:	Medial or lateral collateral ligament injury with instability.
Contra-Indications:	*Infections *Tumours *Inflammatory rheumatism *Implants *Stieda Pellegrini syndrome *Multi-directional instability *"Unhappy triads"
Relative Contra-Indications:	*Immobilisation>8 weeks *Avulsion fractures *Cut wounds *Epiphysiolysis *Myositis Ossificans

-Rupture Anterior/Posterior cruciate ligaments

Indications:	*Insufficient ACL/PCL problems shorter than 6 months *Post-operative arthroscopic ACL/PCL resection with eventual part. Menisectomy
Contra-Indications:	*Infections *Tumours *Inflammatory rheumatism *Implants *Double ligament injury/combination injuries *Avulsion ACL/PCL *Joint laxity
Relative Contra-Indications:	*ACL/PCL rupture in combination with anterior knee pain *Chronic instability longer than 6 months

-ACL/PCL plastic

Indications:	*ACL/PCL plastic by means of allo-autograft *Double ligament plastic (central plastic + de-rotation plastic)
Contra Indications:	*Infections *Tumours *Inflammatory rheumatism *Serious cartilage defects degree 4 *Implants
Relative Contra Indications:	*Meniscus suture *Bleeding *Post-operative infections *Post-operative thrombosis *ACL/PCL plastic Leeds-Kyo / Dacron *Extra-articular plastic *Primary reconstruction

3.5.1 Indications in general (2, 3, 7, 9, 11):

Isokinetic testing is employed to assist in the detection of strength and weaknesses in the musculature around a given joint. It is also used to establish baseline values to help in the assessment of the extent of an injury, and for the subsequent construction of a rehabilitation program.

- Post operative
  - ACL-injuries
  - PCL –injuries
  - Meniscus
  - Total-knee prosthesis
- Anterior knee pain
- Retro patellar chondro-pathy
- Chondromalacia patella
- Diffuse knee pain
- When other functional activities are too painful
- Muscle weakness/atrophy
- Co-ordination problems
- Instability

3.5.2 Contra-indications in general (2, 3, 7, 9, 11):

- Absolute:
  - Non united fractures to limb
  - Epilepsy
  - Cardiac insufficiency (unless monitored)
  - Severe peripheral vascular disease
  - Aneurysms
  - Anticoagulants
  - Recent (< 3 months prev) X-ray/chemo therapy
  - Long term steroid use (> 3 months)
  - Acute (< 7 days) muscle/ligament tear (>grade I)
  - Pregnancy
  - Any neurological condition (e.g. stroke, Parkinson's disease) unless closely monitored
  - Skin problems under load cell
  - Severe osteoporosis
  - Malignancy (in area to be tested)

- Relative:
  - Pain
  - Limited range of motion (severe)
  - Soft tissue healing
  - Bone healing
  - Effusions
  - Osteoporosis
  - Anaemia
  - Inflammation pathology, Rheumatoid Arthritis
  - Recent surgery (discretion must be used)

In addition, the literature mentions the following contraindications:

- Joint pain
- Algodystrophy.
- In an early post operative phase
- With undesired rubbing of the concerned structures (tendinitis, osgood schlatter etc.).
- With danger for high intra-articular pressures (irritated tissue).
- With inflammation of the movement system
- With stress
- With general contra indications regarding the cardio vascular system (instable angina pectoris, serious extravasation of blood, CVA instabilised).
- With general contra indications with regard to the skeletal system (serious osteoporosis, malign tumours in the direct surroundings)