

Original Article**Functional Outcome Assessment of The Knee Joint After Anterior Cruciate Ligament Reconstruction**SK Roy¹, S Debnath², DP Mahara³, RR Kairy⁴**Abstract:**

Anterior Cruciate Ligament injury is a common problem, frequently requires reconstruction especially for the young and active patient. Post operative assessment is mandatory for the demanding patients. There are different types of rehabilitation protocol including timing, range of motion, muscles strength, stability, proprioception, agility test (functional test) and scoring system. Here we used Lysholm and Gillquest knee score. In our study we include only 10 patients because we got total documentations for those patients only; we got normal function (95-100) in one case, near normal (84-94) in 9 cases and none of those fall in abnormal (< 84) category. We conclude that scoring assessment well correlates with the functional outcome.

Introduction:

Anterior cruciate ligament (ACL) injury is a common knee injury in young and sportsperson. Arthroscopy assisted ACL reconstruction with various grafts is the most popular knee surgery and also technically demanding. Following surgical anterior cruciate ligament reconstruction, deficits of proprioception and strength have been widely reported.¹⁻⁶ The major goals of ACL surgery and rehabilitation are to restore normal joint anatomy, to provide static and dynamic knee stability and return to the pre-injury level of activity (young sportsmen) as soon as possible. It is very important that the patient should involve actively in the rehabilitation, both before and after the operation.

ACL surgery and rehabilitation have undergone dramatic changes over the past decade due to extensive clinical experience, improved surgical techniques and better understanding of rehabilitation.

Post operative rehabilitation unlike in other procedures is very exhausting for six months to one year with need of patient compliance. Post operative (6 months to 1 year

later) assessment is mandatory to declare when return to demanding functional activities or a sport is safe or not.

Many Rehabilitation protocols are followed, among them few are as follows:⁷

- * Campbell Clinic Protocol
- * Shelbourne & Nitz Protocol (Accelerated)
- * Kerlan-Jobe Clinic Protocol
- * Paulos and Stern Protocol
- * Others

Protocol after ACL Reconstruction:⁷

Traditional Restrictive (graft protection) Protocol (6M-12M)

Accelerated Rehabilitation Protocol (6M-12M)

Goal:

1. Return to pre-injury level, which requires restoration of:
 - * Normal Range of motion
 - * Normal Muscle Strength
 - * Stable Knee
2. In Athletes: further requirements are:
 - * Agility
 - * Skill
 - * Speed

ACL reconstruction protocol has been changed significantly in the past from traditional or earlier restrictive (graft protective) protocol to recent more aggressive or accelerated protocol.

Traditional Restrictive (graft protection) Protocol:

Exercise protocols commonly combine uniplanar, non-weight bearing, open kinetic chain exercises and more functional, multiplanar, closed kinetic chain exercises.⁸⁻¹⁰

- * Knee splinting in slight flexion
- * Non weight bearing crutch walking (6 Months)
- * Delayed agility training (7 to 8 Months)

Poor result and non compliance:

- * Adhesions/ joint stiffness
- * Flexion contracture
- * PF pain/ Crepitus
- * Profound Quadriceps weakness and atrophy (about 40% atrophy)
- * Inability to return to pre-injury level even by 1 yr

Accelerated Rehabilitation Protocol:

This protocol provides better result.

- * Knee splinted in full extension
- * CPM & Weight bearing in day 1 (i.e. early ROM & WB)
- * Early CKC exercises (Mini squat/ cycling)& only selective OKC exercises (Isometric Quad Exercise /SLR Exercise)
- * Return to light sports activities by 2 months
- * Return to full sports activities by 4m - 6 month late

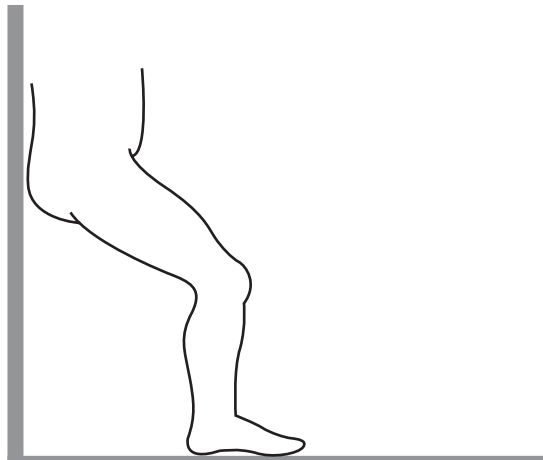
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1. Dr. Suman Kumar Roy, Orthopaedic Surgeon, Registrar, Apollo Hospitals, Dhaka.
 2. Dr. Shyamal Debnath Orthopaedics, National Institute of Traumatology & Orthopaedic Rehabilitation, Dhaka.
 3. Dr. DP Mahara, Orthopaedics, Tribhuban University Teaching Hospital, Kathmandu, Nepal.
 4. Dr. RR Kairy, Orthopaedics, National Institute of Traumatology & Orthopaedic Rehabilitation, Dhaka.

Corresponding Author:

Dr. Suman Kumar Roy, Orthopaedic Surgeon, Registrar, Apollo Hospitals Dhaka. E-mail: drssroy@gmail.com

CKC Exercise:

- * Motion at knee accompanied by motion at hip and ankle
- * Foot in contact with pedal, platform, or ground surface.
- * Involves simultaneous contraction and contraction (concentric and eccentric) of quadriceps and hamstrings
- * Increase joint compressive forces (physiological)
- * Decrease or no shearing forces or strain on ACL
- * Hence incorporated early in rehabilitation programme.



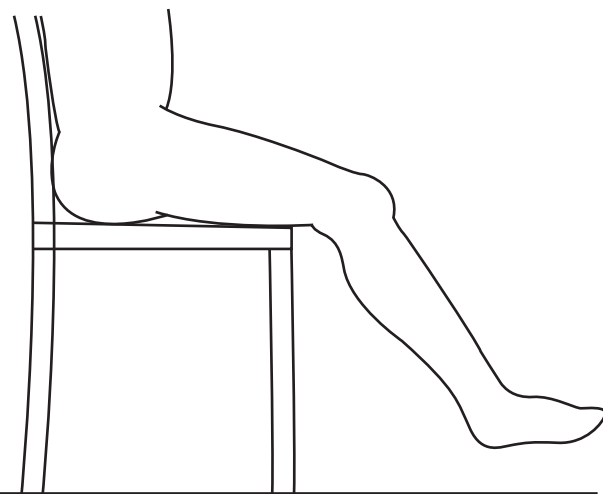
CKC Exercise

As for example:

- * Mini squat
- * Cycling
- * Leg press
- * Step up/ down

OKC Exercise

Motion at knee is independent of motion at hip and ankle
 Foot is free to move, e.g. Leg in extension, Leg curls
 Excessive strain on ACL graft & elongation.
 Hence, avoided during early rehabilitation
 It increase joint mobility
 Early reeducation of proprioceptive receptors
 Stimulates functional and sports related activities
 Increase muscle strength.



OKC Exercise

Other OKC: Isometric quadriceps Exercise, SLR exercise, hamstrings curls

Material and Methods:

This is a perspective study, includes those patient underwent ACL reconstruction in Different hospital of Dhaka and Kathmandu during the period of 2006 to 2009 and having full documentations.

Number of patient is ten; follow up period was 9 months to 16 months (Mean 11.7 months). Here we followed Lysholms score system also included functional hoop test (Agility test), ROM (Range of Motion) and JPS (Joint Position Sense) components.

Functional outcome assessments:¹¹

There are batteries of assessments to determine when an athlete after ACL reconstruction can safely return to functional activity or sports, which vary slightly according to different rehabilitation protocol, but in general they are:

- (1) Timing
- (2) Range of motion
- (3) Muscle strength (Dynamic Stability)
- (4) Stability (Static)
- (6) Proprioception
- (7) Agility test (Functional test)
- (8) Scoring system (Questionnaires)

The aforementioned tests are being performed for evaluation of function following ACL reconstruction.

Serial No.	Post op Time (in months)	Age Yrs	ROM In (M) degree	JPS Normal	JPS Operated	Lysholm score Scale (%)	Single Hop for distance (%)	Triple Hop (%)	Timed Hop for over test%	Cross over strength test%	Quadric strength	Hamstri ng
1	12	28	135	1	1.6	88	81	93.26	89.5	93.2	93.5	90.32
2	16	24	135	1	0.4	96	84.35	96.64	95.32	94.40	100	92
3	9	30	130	0.4	0.4	87	96	94.40	98.4	96.64	95.20	101.42
4	11	23	135	0.8	0.6	85	94	94.68	98.2	96.29	96.23	94.60
5	10	26	135	1	0.2	89	96	93.26	96.1	94.68	98.1	95.20
6	9	22	134	0.7	0.8	90	92	96.29	98.5	93.26	94.1	93.5
7	10	32	133	0.6	0.1	86	85	90.30	89.4	97.10	98.4	96.8
8	15	21	135	0.8	0.2	88	87	85.25	92.1	90.30	94.5	94.5
9	13	36	128	0.7	0.3	84	82	96.72	94.2	96.72	97.2	100
10	12	27	130	1	1.6	88	80	97.10	90.6	85.25	96.0	92.5
Average	11.7	26.9	133	0.8	0.62	88.1	87.73	93.3	94.2	93.2	96.32	95.08

Total No :10	Anterior Drawer Test	Lachman Test	Pivot shift test
Right :-6	Negative:- 3(stable)	Negative:- 2(stable)	Normal:- 3
Light :-4	+-: -5 Partially	+-: -6 partially	Glide :- 7
	++: -2 stable	++: -2 stable	Clunk :- Nil
	+++: - Nil	+++: - Nil	

(1) Timing:

- * Usually 6 month - 12 months(Surgeons preference)
- In our study average timing: 11.7 months

(2) Range of Motion (ROM):

- * Should be full (0 - 1300 to1400)
- Our result:1330

(3) Swelling (Joint effusion):

- * There should be no swelling or joint effusion when the athlete is ready to go back to sports

- * Persistent joint effusion produces significant Quad atrophy (neuromuscular inhibition)

- Isometric Quadriceps setting Ex, ankle pumps, limb elevation, compression bandage help to control or reduce the edema and joint effusion

(4) Muscle strength Tests (Dynamic stability):

* Any standard series measures the isokinetic strength of Quadriceps and hamstrings by the use of special device such as Cybex isokinetic dynamometer or Kim Con dynamometer.

* Most protocol recommend 80 - 90% isokinetic strength of these muscles as compared to uninvolved side as the prerequisite for safe return to sports

IN OUR SET-UP: We have measured the strength of Quadriceps and Hamstrings of both limbs with the use of simple STRAIN GAUGE weighing machine with the patient seated on chair at 90° knee flexion

- * Three readings of each muscle strength are taken
- * Average is calculated
- * Average muscle strength found of involved limb was
-Quadriceps ---96.32-% of normal side
-Hamstring ----95.08-% of normal side

(5) Stability Test (Static):

* Standard series measures the anterior stability of the involved knee joint accurately with a sophisticated device like KT-1000 Arthrometer and grade the laxity.

- * We totally rely on clinical tests alone, namely
- Anterior Drawer Test (ADT) at 90° flexion
- Lachman Test (LT) at 20-30° flexion
- Pivot Shift Test (Extension to flexion method)

LT

Normal (No instability) = 2
+ = 6
++ = 2
+++ = Nil

ADT

Normal (No instability) = 3
+ = 5
++ = 2
+++ = Nil

Pivot Shift Test:

Negative (Normal) = 3
Glide (nearly normal) = 7
Clunk (abnormal) = Nil

(6) Proprioception or Joint Position Sense (JPS):

- * Normal ACL is rich in mechanoreceptors for JPS
- * Disrupted ACL is devoid of these receptors impairing JPS
- * It is unclear : WHETHER RECONSTRUCTED ACL CAN RESTORE OR IMPROVE LOST PROPRIOCEPTION OR JPS
- * Ochi et al (1999) suggested " sensory innervations occurred in reconstructed ACL"
- * JPS improves at least 9 months or later after ACL reconstruction
- * Prolonged immobilization after ACL reconstruction
* Impair proprioceptive functions of other intact structures like capsules, ligaments, tendons, and muscles thereby increasing the chance of re-injury

Accelerated Rehabilitation :

- * Improves JPS by re-educating proprioceptive receptors
- * Early : by ROM, WB and CKC Ex
- * Later : by Agility training

General Recommendation:

Proprioception of Reconstructed knee should be almost normal for safe return to sports activities

In our study:

- No of patients: 10 (only documented cases are taken in study)
- Post op period: 9 -16months
- Functional Weight bearing (Flexion) Protocol at 0° to 30°
- Both reconstructed & normal knees compared
- Goniometer taped (fixed) on lateral aspect of the knee with the hinge at the level of lateral femoral epicondyle
- * Targeted angle(TA) between 0° - 30° flexion attained activity, held for about 5 seconds - knee straightened for about 7 seconds - instructed to reproduce the angle (RA)
- * Five repetitions done at different random angles(to avoid learning effect)
- * Difference in TA & RA is calculated, averaged, and compared with the normal knee

* Result: No loss of JPS of any patient as compared to the Normal

(7). Functional Hop Tests (AGILITY TESTS):

These tests provide quantitative functional status of the knee

Four most commonly used tests are:-

- * One- legged single Hop for distance
- * One- legged timed Hop
- * One- legged triple Hop for distance
- * One- legged cross- over Hop for distance

Methods and Calculation

Each test is performed three times for each extremity and then averaged.

(i) Single Hop.^{12, 13} Person stands on one limb, hops as far as possible, and lands on the same limb. The distance obtained for each extremity is measured and used for comparison.

In other words it is simply one hop for a maximum distance

$$\text{Limb symmetry} = \frac{\text{Involved}}{\text{Non-involved}} \times 100$$

Result: 87.73%

(ii) Timed Hop.^{11, 12} : Person stands on one limb and then hops a distance of six meter. The time is measured for each extremity and used to determine the symmetry index.

That is the time required to hop a distance of six meter

$$\text{Limb symmetry} = \frac{\text{Non-involved}}{\text{Involved}} \times 100$$

Result: 94.2%

(iii) Tripple Hop 13: Person stands on one limb and performs three consecutive hops, landing on the same foot. The distance is measured for each extremity and used to determine the symmetry index.

It is the three consecutive hops for a maximum distance on the same extremity

$$\text{Limb symmetry} = \frac{\text{Involved}}{\text{Non-involved}} \times 100$$

Result: 93.3%

(iv) Cross-over Hop 13: Person hops three times on one limb over a 15 cm wide center strip. The distance for each extremity is measured and used for comparison.

Is the three consecutive hops for a maximum distance but crossing the midline

$$\text{Limb symmetry} = \frac{\text{Involved}}{\text{Non-involved}} \times 100$$

Result: 93.2%

Interpretation:

Operated leg is compared with the non-operated leg and difference of 15% in each one is considered an abnormal result.

(8). Knee Scoring: (Subjective evaluation) :^{14, 15}

Draper and Ladd¹⁶ used the Lysholm and Gillquist Knee Score scale to assess knee function and activity levels of patients with ACL reconstructed knees.

It is a subjective scoring system evaluating

- Limp-----5
- Supports-----5
- Symptoms of locking-----15
- Instability-----25
- Pain-----25
- Swelling-----10
- Stair climbing-----10
- Squatting-----5

Lysholm and Gillquist Knee Scoring System:

Limp

- None 5
- Slight 3
- Severe/constant 0

Support

- None 5
- Stick/crutch 3
- Weight bearing impossible 0

Locking

- None 15
- Catching but no locking 10
- Occasional locking 6
- Frequent locking 2
- Locked on exam 0

Instability

- Never 25
- Rarely/severe exertion 20
- Frequent with athletics 15
- Occasionally with ADLs 10
- Often with ADLs 5
- Every step 0

Pain

- None 25
- Slight 20
- Marked with exertion 15
- Marked walking > 2 km 10
- Marked walking < 2 km 5
- Constant 0

Swelling

- None 10
- Severe exertion 6
- Ordinary exertion 2
- Constant 0

Stair Climbing

- No problems 10
- Slight impair 6
- One step at a time 2
- Impossible 0

Squatting

- No problem 5
- Slight impair 4
- Not beyond 900
- Impossible 0

Total Score-----

Score Evaluation Sysem :^{14, 15}

Evaluation Score = 0-100

95-100 = Normal function

84-94 = Symptoms only with vigorous activity, &

< 84 = Symptoms with activity of daily livings (ADLs)

Our results:

We used this system for its simplicity & easy interpretation

- Normal function (95-100) = 1
- Near normal (84-94) = 9
- Abnormal (< 84) = Nil

Conclusion:

Aggressive or Accelerated post operative rehabilitation protocol after ACL reconstruction with early involvement of passive mobilization, weight bearing, closed kinetic chain exercises with selected open kinetic chain exercises and later involvement of various agility and sports specific exercises have proved the test of time with the best functional outcome.

To declare the safety on return to sports/ functional activities, the functional outcome of the surgery needs to be assessed with battery of objective- subjective tools like ROM, Isokinetic muscle strength testing, stability testing, Proprioception, hopping for distance and scoring system in conjuncture to each other. No one test is complete in its own to be used alone for the same purpose.

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