

# ACL REHABILITATION PROTOCOL

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## STRUCTURED APPROACH & GUIDED EXERCISES



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# 1- Introduction

**Anterior Cruciate Ligament (ACL)** injuries are among the most common and functionally disabling lesions in sports traumatology. While surgical reconstruction is often necessary, the long-term success of treatment depends just as much on the quality of the rehabilitation process.

In this context, **Prof. Etienne Cavaignac and the SPS Therapy team** propose a **structured and progressive ACL rehabilitation protocol**, grounded in clear clinical criteria. This step-by-step plan adapts to all levels of physical activity and is proposed to safely guide patients through five recovery phases, from surgery to return to sport.

This proposal is based on the extensive clinical experience of this team, which has performed over 3,000 ACL reconstructions. It is particularly useful for patients who do not have easy or regular access to a physiotherapist. **However, it is not intended to replace personalised care and must not substitute the guidance of a trained rehabilitation professional.**

Why such structure? Because in ACL rehab, improvisation leads to complications: swelling, joint stiffness, loss of extension, or failed return to sport. This protocol is proposed to reduce those risks by offering a reliable, standardised pathway supported by scientific evidence and clinical experience.

All the exercises described in this protocol are demonstrated in **video format, [available here](#) on Professor Cavaignac's official YouTube channel**. These videos are organised by rehabilitation phase and offer a practical, high-quality complement to this written guide. Each exercise is also directly linked to its video tutorial, ensuring accessible and safe guidance at every step of your recovery.



## 2- The multidisciplinary team behind the protocol

This protocol is the result of collaborative work between orthopaedic surgeons from **CHU Toulouse** and physiotherapists from the **SPS Therapy** team.

### Contributors:

- Prof. Etienne Cavaignac (Orthopaedic surgeon, knee specialist)
- Maxime Testory (Orthopedic Surgeon & Traumatologist)
- Benoît Hennart (Physiotherapist)
- Maxime Ourliac (Physiotherapist)
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### 3- General principles of ACL Post-Operative Rehabilitation

Rehabilitation after **ACL surgery** must meet several key goals:

- Restore full extension early on
- Avoid joint swelling and haemarthrosis
- Reactivate the quadriceps and regain walking control
- Prepare the patient progressively for a return to sport

A defining feature of this protocol is that **progression is based on criteria, not time alone**. The patient only moves to the next phase when the objectives of the current one are fully met.

This method minimises complications and personalises recovery – whether the patient is a high-level athlete or a non-sporting individual.

### 4- The 5 phases of rehabilitation

Each phase is structured with:

- Therapeutic goals
- Key exercises (video-supported)
- Recommended equipment
- Clinical criteria to progress

The following sections present the original rehabilitation protocol proposed by **Pr. Etienne Cavaignac and the SPS team**, reproduced in its structured format as used in clinical practice.



## 5. Rehabilitation Phase 1

### **“Pain control, mobility, and neuromuscular reactivation”**

Day 0-10 post-ACL surgery

#### **Goals of Phase 1 :**

Phase 1 begins immediately after ACL reconstruction and covers the first 10 days post-surgery. Its main objective is to initiate recovery **without compromising the surgical repair**, through careful management of pain, swelling, and inflammation.

The challenge is not to progress quickly, but to avoid early complications such as effusion, joint stiffness, or quadriceps inhibition (AMI).

Rehabilitation at this stage is based on **low-load, high-control movements**, emphasizing **knee extension, patellar mobility**, and **neuromuscular stimulation of the vastus medialis**. Exercises must be **pain-free and well tolerated**, with a focus on restoring full active knee extension and eliminating AMI as early as possible.



## Key interventions and patient education :

- **Objectives:**

The main goals of this phase are the **management of edema and inflammatory reactions**, a strong emphasis on **knee extension work** (which is fundamental at this stage), the **elimination of arthrogenic muscle inhibition (AMI)** through vastus medialis stimulation and knee locking exercises, and the **maintenance of patellar mobility**.

- **Patient education:**

- Knee locking 10 min, three times a day
- Raise the foot of the bed by 15 cm -> facilitate knee drainage
- Practice self-massage
- Apply ice therapy three times a day for 20 minutes
- Strengthen the hip muscles in abduction, adduction, flexion, and extension
- Stairs: lead with the non-operated leg when going up, and with the operated leg when going down

- **Weightbearing:**

No splint is used during this period. Patients must always use two crutches when relearning how to fully extend the knee during gait retraining.

- **Interventions (EDEMA management):**

Use of **Game Ready®**, **drainage massage**, **self-massage**, and **pressotherapy** is recommended to control swelling. Clinicians should remain vigilant for **any signs of complications**, such as changes in general health or the presence of fever.



Each exercise listed in the table is linked to its corresponding demonstration video. The complete playlist of Phase 1 exercises is available [here](#).

## Rehabilitation Table - Phase 1

### RANGE OF MOTION :

| EXERCISE                             | OBJECTIVE                            | INSTRUCTIONS                                                                                                                                                                                                                                                                                    | PROGRESSION |
|--------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <u>Passive patellar mobilization</u> |                                      |                                                                                                                                                                                                                                                                                                 |             |
| <u>Seated heel slide</u>             | Maintain joint ROM                   | Priority is to simulate knee extension with a slider under the foot while staying BELOW YOUR PAIN THRESHOLD (be careful not to over-stretch your hamstring), keep knee flexion BELOW YOUR PAIN THRESHOLD (do not work excessively in flexion during first 10 days due to risk of hemarthrosis). |             |
| <u>Supine heel slide</u>             | Maintain joint ROM                   | As above but while lying on your back.                                                                                                                                                                                                                                                          |             |
| <u>Stability ball slide</u>          | Maintain joint ROM                   | As above but while seated on a stability ball.                                                                                                                                                                                                                                                  |             |
| <u>Stability ball marching</u>       | Objective : loading & proprioception | Instruction: sit on a stability ball, transfer your weight from one leg to the other, like if you were walking; keep your trunk upright.                                                                                                                                                        |             |



## STRENGTHENING :

| EXERCISE                                       | OBJECTIVE                                                                                                                                | INSTRUCTIONS                                                                                                                                                                       | PROGRESSION                         |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| <u>Supine TKEFeedback with/without bolster</u> | Eliminate AMI<br><br>(Winner of the 2024 VJSM Video Technique Award - <a href="#">More info here</a> )                                   | Ask the patient to focus on lifting the heel off the table while keeping the thigh in firm contact with the wedge.                                                                 | Locking without wedge               |
| <u>Supine TKEFeedback with/without bolster</u> | Eliminate AMI - Progression of TKE with bolster<br><br>(Winner of the 2024 VJSM Video Technique Award - <a href="#">More info here</a> ) | Lift the heel off the table without lifting the leg. "Press the knee into the table."<br>Success: Observe the quality of the contraction, recruit the end range of knee extension. | Feedback in leg extension (Phase 2) |
| <u>Hip strengthening protocol</u>              |                                                                                                                                          |                                                                                                                                                                                    |                                     |

## Key milestones before moving to Phase 2 :

To progress safely to Phase 2, the following clinical criteria must be met:

- Extension at 0
- AMI grade 0 or 1A
- Stroke Test 0 or 1
- No hematoma



## 6. Rehabilitation Phase 2

### "Targeting quadriceps reactivation and restoring control"

Day 10-30 post-ACL surgery

#### Goals of Phase 2 :

Once pain and swelling are under control and passive motion is regained, rehabilitation enters Phase 2. This stage is focused on **overcoming arthrogenic muscle inhibition (AMI)** and **restoring active control** of the knee.

The cornerstone of Phase 2 is regaining efficient and voluntary quadriceps activation, especially terminal knee extension. This is achieved through targeted neuromuscular work and isolated strengthening drills under control, progressively preparing the patient for weight-bearing functional patterns. Gait normalization and proprioceptive activation also begin during this phase.



## Key interventions and patient education :

- **Objectives:**

The main goals of this phase are to **maintain full knee extension**, **progressively improve knee flexion**, and **work on restoring a normal gait pattern**.

- **Weightbearing:**

The patient should now be able to walk without crutches, as gait retraining progresses.

- **Interventions:**

Continue the interventions initiated in Phase 1, maintaining the same protocols and therapeutic principles.



Each exercise listed in the table is linked to its corresponding demonstration video. The complete playlist of Phase 2 exercises is available [here](#).

## Rehabilitation Table – Phase 2

### RANGE OF MOTION :

| EXERCISE                    | OBJECTIVE                         | INSTRUCTIONS                                                                              | PROGRESSION                                                                                         |
|-----------------------------|-----------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| <u>Cycling</u>              | Improve ROM in flexion            | 10 to 15 minutes to start session; lower seat (or bring closer) as knee ROM improves.     |                                                                                                     |
| <u>Single Leg press 6/6</u> | Improve ROM / Activate quadriceps | Use 50% of bodyweight; 6 seconds concentric, 6 seconds eccentric; 3 to 5 sets of 10 reps. | Increase resistance at each session if there is no pain or swelling in the knee (stroke test, heat) |
| <u>Hurdle step-overs</u>    | Improve ROM / motor control       | Step over hurdles while focusing on heel-to-toe landing.                                  | Adjust hurdle height to patient's ability                                                           |



## STRENGTHENING :

| EXERCISE                                  | OBJECTIVE                                 | INSTRUCTIONS                                                                                               | PROGRESSION                                                             |
|-------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| <u>Terminal knee extension - Feedback</u> | Eliminate AMI                             | Sitting at the edge of a table, work and maintain terminal knee extension.                                 | If the contraction is good, go to the final TKE progression -> standing |
| <u>Standing Banded TKE</u>                | Work on TKE when standing on a single leg | Place a band above the popliteal fossa. Lock the knee and lift the opposite leg while pretending to march. |                                                                         |
| <u>Prone TKE</u>                          |                                           |                                                                                                            |                                                                         |
| <u>Basic Squat</u>                        |                                           |                                                                                                            |                                                                         |
| <u>Walking backwards on treadmill</u>     | Work on dynamic TKE                       | On a treadmill, walk backwards slowly while focusing on good TKE.                                          |                                                                         |



## **Key milestones before moving to Phase 3 :**

To progress safely to Phase 3, the patient must meet all of the following:

- Full Extension
- AMI grade 0
- Stroke Test 0
- Flexion +120°
- Positive Quadriceps Lag test

## 7. Rehabilitation Phase 3

### **"Progressive loading, proprioception, and strength control"**

Day 10-30 post-ACL surgery

#### **Goals of Phase 3 :**

Phase 3 marks a critical transition toward functional rehabilitation. The focus is now on **building strength, refining motor patterns, and restoring neuromuscular control**, particularly during **single-leg work and dynamic stability tasks**.

This phase represents the critical transition from isolated movements to integrated functional patterns – particularly in single-leg stance and dynamic stability.

While pivoting is still prohibited, controlled strengthening, lateral control, and motor pattern refinement become essential. Clinical vigilance on swelling and pain response remains important to modulate the workload and avoid relapse.



Each exercise listed in the table is linked to its corresponding demonstration video. The complete playlist of Phase 3 exercises is available [here](#).

## Rehabilitation Table – Phase 3

### RANGE OF MOTION :

| EXERCISE                        | OBJECTIVE                                             | INSTRUCTIONS                                                                                                                   | PROGRESSION |
|---------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------|
| <u>Tibial internal rotation</u> | Improve ROM in internal rotation, especially at tibia | Sit with your forefoot on a slider and hold a soft ball between your knees, rotate your foot inwards without moving your knee. |             |



## STRENGTHENING :

| EXERCISE                      | OBJECTIVE                                           | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                          | PROGRESSION                                                                                                                        |
|-------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <u>Split squat with stick</u> | Leg strengthening,<br>good quality motor<br>control | With a stick along<br>your back (3 contact<br>points: occiput,<br>thorax, coccyx), take a<br>big step forward into<br>a lunge position. In<br>this position, go<br>straight up and down<br>while keeping the 3<br>contact points with<br>the stick (vertical<br>torso). Check the<br>alignment of your<br>foot, knee and hip in<br>the front leg. The<br>toes must point<br>straight ahead, not<br>outwards.<br><b>Control of dynamic<br/>valgus.</b> | Once you can do this<br>movement properly<br>and without pain for<br>10 reps, switch to the<br>Goblet version                      |
| <u>Goblet split squat</u>     | Progression of split<br>squat with stick            | Like the initial version<br>but hold a kettlebell<br>in the goblet position<br>(hold handle on top<br>with both hands and<br>against sternum). Use<br>10% of your<br>bodyweight and<br>increase 10% each<br>week.<br><b>Control of dynamic<br/>valgus.</b>                                                                                                                                                                                            | When the weight is<br>so high that you can't<br>keep it against your<br>sternum, switch to<br>the DB version of the<br>split squat |



| EXERCISE                          | OBJECTIVE                                                        | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                                                                                                     | PROGRESSION                                                      |
|-----------------------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <u>Split squat with DB</u>        | Progression of Goblet split squat                                | Like the previous version but instead, hold a dumbbell in each hand. Make sure you keep doing the movement correctly<br>Control of dynamic valgus.                                                                                                                                                                                                                                                               |                                                                  |
| <u>Glute bridge (double leg).</u> | Strengthen glutes, hamstrings and core;<br>Work on motor control | Lie on your back with your knees bent, feet flat on the ground. Your feet should be hip width. Lift up your toes so that only your heels are on the ground. Your arms will be on the ground, palms up. Lift your butt until there is a straight line between your knees and shoulders. Contract your glutes and abdominals. Keep your foot / knee / hip aligned. Lower your butt to the floor slowly and repeat. | Once you have mastered this movement, try the single-leg version |
| <u>Glute bridge (single leg).</u> | Progression from double-leg glute bridge Single-leg work         | Bring your non-working leg as close as possible to your torso (low-back protection). Same sequence as previous exercise, but on a single leg                                                                                                                                                                                                                                                                     | Progression: Feet-Elevated Glute Bridge                          |



| EXERCISE                                     | OBJECTIVE                                                                                               | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                              | PROGRESSION                     |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <u>Feet-Elevated Glute Bridge</u>            | Progression from double-leg glute bridge Single-leg work                                                | Same as for double-leg glute bridge. Put heels on a chair, bench or plyometric box.                                                                                                                                                                                                                                                       | Go to single-leg version        |
| <u>Feet-Elevated Single-leg glute bridge</u> | Progression of feet-elevated double-leg bridge. Works glutes more Increases working ROM Single-leg work | Same as for single-leg glute bridge. Put one heel on a chair, bench or plyometric box                                                                                                                                                                                                                                                     | Hip thrust                      |
| <u>Double-leg hip thrust</u>                 | Progression from Feet-Elevated Glute Bridge. Can add load                                               | Place your shoulder blades on a bench. Your knees should have a 90° angle and your butt will be near the floor. Feet pointing straight ahead; feet / knee / hip aligned Lift up your pelvis until it is horizontal. Contract your glutes. Keep looking at your pubic bone the whole time. Lower your butt to the floor slowly and repeat. | Progression: Single-leg version |



| EXERCISE                     | OBJECTIVE                                                            | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROGRESSION                                                                                                                                                |
|------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Single-leg hip thrust</u> | Progression from Double-leg hip thrust. Can add load Single-leg work | Same as double-leg version. Bring your non-working leg as close as possible to your torso.                                                                                                                                                                                                                                                                                                                                                                                                      | Add weight                                                                                                                                                 |
| <u>Single-leg Press</u>      | Strengthen quadriceps and glutes                                     | Set of 10 reps. Increase weight so that you are at failure on 10th rep.                                                                                                                                                                                                                                                                                                                                                                                                                         | Increase resistance at each session if there is no pain or swelling in the knee (stroke test, pain)                                                        |
| <u>Single-leg squat</u>      | Strengthen quadriceps and glutes. Work on unilateral motor control   | Stand with a dumbbell in each hand (these are solely for balance). Squat down on 1 leg until your thigh is parallel to the ground while keeping your back straight; lift your arms and dumbbells forward. Have a bench or chair behind you as a reference for the depth of your squat. Stand up by focusing on contracting your quadriceps and glutes. Extend your other leg in front of you with the heel grazing the floor. Focus on doing the movement correctly. Control of dynamic valgus. | Regression: if you have pain during this exercise, it is too complex or your range of motion is not sufficient, do the "Assisted Single-leg Squat" instead |



| EXERCISE                         | OBJECTIVE                                                        | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                   | PROGRESSION                                                               |
|----------------------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <u>Assisted Single-leg Squat</u> | Regression from Single-leg squat                                 | Sit on a plyometric box facing a pulley tower with the non-working leg extended in front of you. Do a single-leg squat by using the pulley to help you stabilize on the descent. The pulley helps you manage the depth of your squat and master the movement<br>Control of dynamic valgus.                                                                                                                                                     |                                                                           |
| <u>Single-leg RDL with stick</u> | Strengthen hamstrings and glutes. Single-leg work. Motor control | Stand with your knees slightly flexed, feet together and arms alongside your body. Your back should be straight, shoulders pulled back & down, chest up. Place a stick along your back with the same 3 contact points. Bend forward on 1 leg while keeping your back straight and stretching your other leg behind you until your torso is parallel to the ground. Your chest and back leg must stay aligned from head to heel (flexed ankle). | Once you have mastered this movement, go to the Single-leg RDL KB version |



| EXERCISE                                               | OBJECTIVE                                                        | INSTRUCTIONS                                                                                                                                                                                                                                          | PROGRESSION                                                          |
|--------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| <u>Single-leg RDL with KB</u>                          | Strengthen hamstrings and glutes. Single-leg work. Motor control | Like the previous exercise but Hold a kettlebell in the hand that is on the same side as your “flying” leg. Focus on doing the movement correctly.                                                                                                    | When the weight gets too heavy, go to the Single-leg RDL 2KB version |
| <u>Single-leg RDL with 2KB</u>                         | Strengthen hamstrings and glutes. Single-leg work. Motor control | As above. Hold a kettlebell in each hand. Focus on doing the movement correctly.                                                                                                                                                                      |                                                                      |
| <u>Stability ball leg curls (double-leg)</u>           | Strengthen hamstrings. Improve stability                         | Lie on your back with your feet on the ball. Lift up your hips and hold them as high as possible during the entire movement. Flex your knees to pull the ball towards you, and then extend them. Repeat.                                              | Stability ball leg curls (double to single leg)                      |
| <u>Stability ball leg curls (double to single leg)</u> | Strengthen hamstrings. Improve stability                         | Lie on your back with your feet on the ball. Lift up your hips and hold them as high as possible during the entire movement. Flex your knee to pull the ball towards you, and then extend it. Repeat. Then extend only one leg to push the ball away. | Progression: stability ball leg curls (single leg)                   |



| EXERCISE                                                  | OBJECTIVE                                       | INSTRUCTIONS                                                                                                                                                                                                                         | PROGRESSION                                                 |
|-----------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <u>Stability ball leg curls</u><br>( <u>single leg</u> ). | Strengthen hamstrings. Improve stability        | Lie on your back with only 1 foot on the ball. Lift up your hips and hold them as high as possible during the entire movement. Flex your knees to pull the ball towards you, and then extend them. Repeat.                           |                                                             |
| <u>Seated leg curls</u><br>( <u>eccentric</u> ).          | Strengthen hamstrings<br>(especially eccentric) | On a leg curl machine, flex both your knees and then return the weight slowly using 1 leg over 3 seconds. Select a weight that's heavy enough so the 10th rep will be near failure.                                                  |                                                             |
| <u>Clamshell</u>                                          | Activation of glutes                            | Lay on your side on the ground, with both legs flexed at 90° (feet aligned with chest): Keeping your feet together, slowly lift the top knee as high as possible without moving any other part of your body (no low back movement!). | Once you have mastered this movement, add a resistance band |



| EXERCISE                    | OBJECTIVE                        | INSTRUCTIONS                                                                                                                                                                                                                                                                                                                             | PROGRESSION                                            |
|-----------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| <u>Banded clamshell</u>     | Activation of glutes             | <p>Lay on your side, knees flexed and stacked (thighs aligned with chest and feet behind). Your weight will be on your elbow (under your shoulder) and knee. Lift your hips up while keeping your body aligned and hold this position during the exercise. Lift your top knee while keeping your feet together and your legs flexed.</p> | Once you have mastered this movement, add a side plank |
| <u>Side plank clamshell</u> | Activation of glutes + core work | <p>Lay on your side, knees flexed and stacked (thighs aligned with chest and feet behind). Your weight will be on your elbow (under your shoulder) and knee. Lift your hips up while keeping your body aligned and hold this position during the exercise. Lift your top knee while keeping your feet together and your legs flexed.</p> |                                                        |



| EXERCISE                          | OBJECTIVE                                                         | INSTRUCTIONS                                                                                                                                                                                                                                | PROGRESSION                                           |
|-----------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| <u>4-way hip</u>                  | Strengthen muscles around the hip. Motor control. Single-leg work | Stand facing a cable machine. Do 10 hip extensions, then 10 hip adductions, 10 hip flexions and 10 hip abductions. Adjust the weight so that you have proper form for all the reps.                                                         |                                                       |
| <u>Front plank</u>                | Core training                                                     | Hold for 30 seconds. Monitor your position, glute activation and transverse abdominis work.                                                                                                                                                 | Lift your hand or foot. Could add a single-arm row... |
| <u>Side plank</u>                 | Core training                                                     | Hold for 30 seconds. Monitor your position, glute activation and transverse abdominis work.                                                                                                                                                 | Lift your hand or foot. Could add a single-arm row... |
| <u>Pallof Press (double-leg).</u> | Anti-rotation core exercise                                       | Stand parallel to a cable machine, with the knees slightly flexed. Activate your transverse abdominis. Press the cable or band away from your chest then bring it back to the starting position. Keep your torso stable to resist rotation. | Do this exercise on 1 leg                             |



| EXERCISE                         | OBJECTIVE                   | INSTRUCTIONS                                                                               | PROGRESSION                                |
|----------------------------------|-----------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------|
| <u>Pallof Press (single-leg)</u> | Anti-rotation core exercise | As above. Stand on 1 leg, with the free leg flexed at 90°. Work on each leg and each side. |                                            |
| <u>Copenhagen Plank on knees</u> | Strengthen adductors        | With the tibia resting on a bench, get into a plank position. Hold for 20 to 30 seconds.   | Go from an isometric to a dynamic movement |
| <u>Copenhagen plank on feet</u>  | Strengthen adductors        | Like the previous exercise but place only one foot on the bench.                           | Go from an isometric to a dynamic movement |

## PLYOMETRICS :

| EXERCISE                               | OBJECTIVE                                                | INSTRUCTIONS                                                                                                                                           | PROGRESSION |
|----------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <u>Tall to Short</u>                   | Low-intensity plyometrics Landing phase                  | Stand with your arms above your head. Rise on your toes, then drop down and land in a half-squat.                                                      |             |
| <u>Tall to Short (single-leg)</u>      | Low-intensity plyometrics Landing phase Single-leg work  | Like the previous exercise but on 1 leg.                                                                                                               |             |
| <u>Pogo</u>                            | Low-intensity plyometrics                                | Hop with your feet together. Alter the height as your rehabilitation progresses.                                                                       |             |
| <u>Drop tall to short (double-leg)</u> | Low-intensity plyometrics. Landing phase                 | Stand on a step and drop down while landing on both legs in a half-squat. Start with a 15 cm height and work up to 30 cm<br>Control of dynamic valgus. |             |
| <u>Drop tall to short (single-leg)</u> | Low-intensity plyometrics. Landing phase Single-leg work | Same instructions as previous exercise, but land on 1 leg<br>Control of dynamic valgus.                                                                |             |



## **Key milestones before moving to Phase 4 :**

- Good quality single-leg squat
- Single-leg Bridge 85% of contralateral
- Single-leg Calf raise 85% of contralateral
- Single-leg Raise 85% of contralateral
- Side Bridge Endurance 85% of contralateral
- Leg Press 1.5x Bodyweight
- Quadriceps Dynamometer (1.45 N/kg)



## 8. Rehabilitation Phase 4

### **"Refining knee control and preparing for return-to-activity"**

Month 3 - 5 post-ACL surgery

#### **Goals of Phase 4 :**

By Phase 4, the patient should demonstrate strong neuromuscular control, movement symmetry, and the ability to manage moderate to high functional loads. This stage is not yet focused on returning to full sport, but on acquiring the physical qualities required for it – particularly under fatigue and with full motor control.

In this phase, patients **resume running** through a structured interval program (e.g. from La Clinique du Coureur) while **reinforcing motor control** and maintaining previous gains.

Exercises are increasingly demanding and often involve **closed kinetic chain work**, **postural control**, and **dynamic limb precision**. **Low-level plyometrics** and **advanced unilateral drills** are introduced progressively, under close supervision.



## Rehabilitation Table - Phase 4

### RUNING :

Follow the program from "The Running Clinic" to restart running.

## Health through running



### Interval training program - I

| WEEK 1                                                                                             | DATE | WEEK 5                                                                                  | DATE |
|----------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------|------|
| 5x M + 3x (1'C / 1'M) + 5M<br>4x (1'C / 1'M)<br>5x (1'C / 1'M)<br>6x (1'C / 1'M)<br>7x (1'C / 1'M) |      | 10x (2'C / 1'M)<br>3x (3'C / 1'M)<br>4x (3'C / 1'M)<br>5x (3'C / 1'M)<br>6x (3'C / 1'M) |      |
| WEEK 2                                                                                             | DATE | WEEK 6                                                                                  | DATE |
| 8x (1'C / 1'M)<br>9x (1'C / 1'M)<br>10x (1'C / 1'M)<br>11x (1'C / 1'M)<br>12x (1'C / 1'M)          |      | 7x (3'C / 1'M)<br>8x (3'C / 1'M)<br>2x (4'C / 1'M)<br>3x (4'C / 1'M)<br>4x (4'C / 1'M)  |      |
| WEEK 3                                                                                             | DATE | WEEK 7                                                                                  | DATE |
| 13x (1'C / 1'M)<br>14x (1'C / 1'M)<br>15x (1'C / 1'M)<br>3x (2'C / 1'M)<br>4x (2'C / 1'M)          |      | 5x (4'C / 1'M)<br>6x (4'C / 1'M)<br>1x (9'C / 1'M)<br>2x (9'C / 1'M)<br>3x (9'C / 1'M)  |      |
| WEEK 4                                                                                             | DATE | WEEK 8                                                                                  | DATE |
| 5x (2'C / 1'M)<br>6x (2'C / 1'M)<br>7x (2'C / 1'M)<br>8x (1'C / 1'M)<br>9x (1'C / 1'M)             |      | 1x (14'C / 1'M)<br>2x (14'C / 1'M)<br>1x 20'C<br>1x 25'C<br>1x 30'C                     |      |



1. Start and finish the session with 5 minutes of walking (optional).
2. Depending on symptoms and comfort:
  - Resume the previous training session
  - Repeat the same training session
  - Skip 1 or 2 sessions
3. Run at least 4 times per week and up to 6 times per week
4. Complement the training with a mechanically less stressful activity (cycling, aquajogging)

M : Marche régulière

C : Course, vitesse d'un jogging régulier



Each exercise listed in the table is linked to its corresponding demonstration video. The complete playlist of Phase 3 exercises is available [here](#).

## STRENGTHENING :

| EXERCISE                     | OBJECTIVE                                                     | INSTRUCTIONS                                                                                                                                                                                                                                                                                       | PROGRESSION          |
|------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <u>Lateral Band Walks</u>    | Strengthening of glutes. Motor control<br>Lateral movements   | Put one resistance band below your knees and a second band above your ankles. Start in a half-squat position, focusing on the alignment of your legs and trunk. Do 10-12 lateral shuffles in one direction, then in the other to return to where you started.<br><b>Control of dynamic valgus.</b> |                      |
| <u>Bulgarian split squat</u> | Strengthening of quadriceps. Motor control<br>Single-leg work | Start in a lunge position but with your rear foot elevated. Go up and down, flexing and extending your front knee while keeping your foot / knee / hip aligned (control of dynamic knee valgus).<br><b>Control of dynamic valgus.</b>                                                              | Option to add weight |



| EXERCISE                                          | OBJECTIVE                                                        | INSTRUCTIONS                                                                                                                                                                                                | PROGRESSION                                   |
|---------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <u>Walking Lunge</u>                              | Work on motor control                                            | Walk by doing lunge steps while being aware of your leg's alignment.<br>Control of dynamic valgus.                                                                                                          | Option to add weight                          |
| <u>Walking Lunge 2DB</u>                          | Work on motor control                                            | Like the previous exercise but Hold a dumbbell in each hand.<br>Control of dynamic valgus.                                                                                                                  | External disruption                           |
| <u>AQUA bag overhead walking lunge</u>            | Motor control.<br>External disruption                            | Same as walking lunge but hold an AQUA bag above your head with your arms extended.<br>Control of dynamic valgus.                                                                                           |                                               |
| <u>Nordic Hamstring Curls with Stability ball</u> | Learn how to do a Nordic hamstring curl<br>Strengthen hamstrings | Using a "Nordic Bench" and a stability ball, do a Nordic hamstring curl.<br>Focus specifically on your trunk alignment, activating your glutes and the transverse abdominis (reduction of lumbar lordosis). | Nordic Hamstring Curl using a resistance band |

| EXERCISE                                          | OBJECTIVE             | INSTRUCTIONS                                                                                                                | PROGRESSION                        |
|---------------------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b><u>Band-Assisted Nordic Hamstring Curl</u></b> | Strengthen hamstrings | Like the previous exercise but place a long resistance band around your torso to help you control the speed of the descent. | Nordic hamstring curl (unassisted) |
| <b><u>Nordic Hamstring Curl</u></b>               | Strengthen hamstrings | Like the previous exercise but without any assistance                                                                       |                                    |

## PLYOMETRICS :

| EXERCISE                                        | OBJECTIVE                                          | INSTRUCTIONS                                                                                                                                                                                                                                                            | PROGRESSION                     |
|-------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b><u>Non-Countermovement Vertical Jump</u></b> | Energy production and landing                      | Start in a squat position, then jump as high as possible and land softly in the "ready" position. Do not squat down further before you jump up (no energy transfer). Focus on the landing position (control of dynamic knee valgus). Control of dynamic valgus.         |                                 |
| <b><u>NCM Forward Jump</u></b>                  | Energy production and landing Forward displacement | Start in a squat position, then jump as high and as far as possible, landing softly in the "ready" position. Do not squat down further before you jump (no energy transfer). Focus on the landing position (control of dynamic knee valgus). Control of dynamic valgus. | Do the exercise on a single leg |



| EXERCISE                    | OBJECTIVE                                                  | INSTRUCTIONS                                                                                                                                                                                      | PROGRESSION                     |
|-----------------------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <u>Countermovement Jump</u> | Energy production, transfer and landing                    | Start in a standing position, then quickly dip down into a half-squat and try to jump as high as possible. Focus on the landing position. Control of dynamic valgus.                              |                                 |
| <u>Drop Jump</u>            | High-intensity plyometrics                                 | A drop jump is countermovement jump that starts on a 30 cm high step. The instructions are the same as above. Control of dynamic valgus.                                                          |                                 |
| <u>Single-Leg Jump</u>      | Energy production, transfer and landing<br>Single-leg work | Stand on 1 leg, then quickly dip down into a squat on that leg and try to jump as high as possible. Land on the same leg. Focus on the landing position. Control of dynamic valgus.               |                                 |
| <u>90° Jump Turns</u>       | Work on landing with rotation                              | Start in a standing position, then jump as high as possible and turn your body 90° towards the right or left. Land in a squat position. Focus on the landing position. Control of dynamic valgus. | Do the exercise on a single leg |



| EXERCISE                                                   | OBJECTIVE                 | INSTRUCTIONS                                                                                                                                                                         | PROGRESSION                                                     |
|------------------------------------------------------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| <u>Lateral Broad Jump</u><br>( <u>double-leg landing</u> ) | Work in the lateral plane | Start on a single leg and jump sideways (towards the inside) as far as possible, landing on both feet in a squat position. Focus on the landing position. Control of dynamic valgus. | Increase the distance and height of the jump. Link up the jumps |
| <u>Lateral Broad Jump</u><br>( <u>single-leg</u> )         | Work in the lateral plane | Stand on one leg, then jump sideways (towards the inside) as far as possible and land on the other leg. Focus on the landing position. Control of dynamic valgus.                    | Increase the distance and height of the jump. Link up the jumps |



## **Key milestones before moving to Phase 5 :**

- Completion of a structured running program
- Single-Leg Hop Test:  $\geq 90\%$  of contralateral limb
- Single-Leg Triple Hop Test:  $\geq 90\%$  of contralateral limb
- Single-Leg Crossover Hop Test:  $\geq 90\%$  of contralateral limb
- Side Hop Test:  $\geq 90\%$  of contralateral limb
- Leg Press:  $\geq 1.5 \times$  bodyweight
- Clearance from surgeon, physician, or rehabilitation specialist



## 9. Rehabilitation Phase 5

### **“Return to sport - high-demand functional rehabilitation”**

Month 5+ post-ACL surgery

Phase 5 marks the **final stage of the ACL rehabilitation protocol**. At this point, biological healing is complete, and the focus shifts to **functional readiness and return to sport**.

The primary objective is clear: **progressively resume and complete the return to sport**, with the support of structured, sport-specific training.

This phase is **individualised** according to the athlete's discipline, competitive level, and previous rehabilitation trajectory. Sport-specific drills are typically managed externally – by the club or personal trainer – and include progressive exposure to high-impact, high-speed movements.

The **training becomes fully tailored to real-world performance**, under the supervision of qualified sport professionals.



## 10. Conclusion

### **An evidence-informed, criteria-based framework for optimal ACL recovery.**

Rehabilitation after ACL reconstruction is never linear – it requires adaptation, monitoring, and a constant dialogue between the patient and the care team. Through this structured five-phase protocol, **Pr. Etienne Cavaignac and the SPS team** offer a practical and scientifically grounded pathway to reduce complication risks, restore joint function, and support a safe return to physical activity.

This protocol is not a set of rigid instructions – it is a decision-making guide proposed to be adapted to each patient's needs, objectives, and progression.

By integrating clinical expertise with functional benchmarks and patient-reported outcomes, the protocol ensures that each phase of recovery is justified, measurable, and tailored. The addition of video demonstrations and phase-by-phase validation criteria makes it a powerful tool for both **rehabilitation professionals and informed patients**.

We hope this document will serve as a **trusted reference** for those seeking high standards in post-ACL surgery care – and a reminder that true recovery is not just about healing, but about **rebuilding confidence, control, and resilience**.

 Access the full protocol online:  
[www.professeur-cavaignac.com](http://www.professeur-cavaignac.com)



This rehabilitation protocol reflects the clinical approach proposed and validated by Professor Etienne Cavaignac and the SPS team.

It was co-created through close interdisciplinary collaboration between surgeons and physiotherapists, combining surgical expertise, field-based rehabilitation experience, and scientific evidence.

We would like to sincerely thank and acknowledge the contributors to this work:

- Prof. Etienne Cavaignac - Orthopaedic Surgeon, Knee Specialist
- Dr. Maxime Testory - Orthopaedic Surgeon & Traumatologist
- Benoît Hennart - Physiotherapist
- Maxime Ourliac - Physiotherapist
- Kevin Lacaze - Physiotherapist

Their commitment to quality care, knowledge-sharing, and innovation made this protocol possible.

This document corresponds to the standard post-operative pathway described on Prof. Cavaignac's [official website](#), and is part of a broader effort to provide transparent, high-level rehabilitation resources to both patients and medical professionals.

All exercises listed in this guide are available in [video format](#) on Professor Cavaignac's official YouTube channel, organised by rehabilitation phase.

# ACL REHABILITATION PROTOCOL

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## STRUCTURED APPROACH & GUIDED EXERCISES

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