

# Conservative management of ligamentous injuries of the knee

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## Introduction

The incidence of anterior cruciate ligament (ACL) injury in children older than 10 years of age is constantly increasing [1].

The management of an isolated ACL rupture in children must necessarily meet 3 objectives:

- The first is to restore the stability and proper function of the knee in order to lead a satisfactory life [2,3].
- The second is to reduce the risk of secondary meniscal and cartilaginous lesions in order to limit the risk of osteoarthritis [2].
- Finally, the risk of growth disorders must imperatively be limited [4,5,6].

Conservative treatment partially meets these objectives and is therefore an integral part of the available therapeutic arsenal.

Conservative treatment is actually an entirely separate entity that contains its own strict rules. Unfortunately, conservative management is frequently mistaken for lack of treatment.

Literature on this subject is relative sparse. In 2006, a literature review by Mahtadi et al. [4] found only seven studies on this subject, none of which were conducted on skeletally immature patients. As a result, the treatment plan suggested in this literature review remained vague and unclear. It was not before 2012 that Moksnes et al. [7] published their work on the principles of conservative treatment of ACL injuries in children.

## 1- Prerequisites: Recapitulation and definitions regarding rehabilitation

Conservative treatment requires strict cooperation between the patient, the physiotherapist, and the surgeon. It is therefore imperative that orthopedic surgeons be well versed in the concepts of rehabilitation medicine.

Muscle rehabilitation can be undergone in either an open or closed kinetic chain (OKC and CKC, respectively), and in either a dynamic (concentric or eccentric) or static (isometric) mode.

Dynamic exercises entail either a shortening or lengthening of the muscle fibers thereby provoking segmental movements of the limb: during concentric contraction, the muscle fibers shorten; during eccentric contraction, muscle fibers lengthen as the muscle is contracted thereby opposing the movement.

Static or isometric exercises entail muscle contractions against resistance without any effective muscular movement.

During OKC exercises of the lower limb, the foot is generally free and mobile compared to the knee. During CKC, the foot pushes against a support (e.g. the floor) and the knee is mobile compared to the foot.

Plyometrics are a group of bodybuilding exercises that focalize on striated skeletal muscle tonicity. They typically include certain activities such as sprinting, sudden changes in direction, and jumping as high as possible without momentum.

Isokinetic exercises, from the Greek iso- (ἴσος), signifying equal, and kinetic which relates to motion, are movements which may or may not be assisted by a machine that produce a constant speed.

## **2- Description of conservative treatment according to Moksnes et al. [7]**

Following an ACL rupture in children, the state of the meniscus will guide treatment.

When the ruptured ACL is associated with a meniscal tear that requires surgical management, or if the patient complains of significant instability of the knee, then operative treatment should be considered.

When there is no concomitant meniscal injury, then conservative treatment could be considered. In such patients, treatment algorithms generally recommend attempting conservative until maturity of the growth plate is achieved.

However, conservative treatment entails a certain number of conditions and requires strict cooperation between the patient, the physiotherapist, and the surgeon:

- Modification or restriction of certain physical activities and sports.
- A specific rehabilitation program.
- Custom-made articulated knee brace wear during physical exercise.
- Routine clinical follow-ups and MRIs. In our practice, an MRI is performed every six months along with a multidisciplinary follow-up with a sports physician and a pediatric orthopedic surgeon.

In patients who fail conservative treatment, surgical management should be considered [Fig.1]. Failed functional treatment is defined by the occurrence of a secondary meniscal lesion or the persistence of knee instability. In children, post-operative rehabilitation programs are generally less invasive than in adults and return to sports should be delayed, with recent trends moving towards even more prolonged restrictions of activity [8].

After initial urgent management with arthrocentesis, icing, and immobilization (in our experience with an adjustable articulated knee brace), the rehabilitation program takes place in 4 different phases and must be instated promptly. Each step of the program must be validated before proceeding to the next phase.

Consistent wear of the articulated knee brace is imperative during the entire duration of the rehabilitation program. There are no ideal knee braces and we recommend the use of knee braces with which the department is most accustomed.

### **Phase 1: Preparation and arthrocentesis (approximately six weeks)**

During the acute phase, the primary objectives are:

- Restoring active and passive knee extension (recurvatum and flexion > 120°) and resolving the intraarticular swelling.
- Reactivating the quadriceps and allowing for active locking of the knee
- Allowing for controlled double support with partial weight bearing.
- Obtaining symmetrical gait and sit-to-stand movement patterns.
- Painless participation in activities of daily living (especially going up and down the stairs).
- Initiating cardiovascular training.

*Means: Pool, Treadmill, BOSU Ball/Balance board, and Stairs.*

### **Phase 2: Muscle reinforcement and strengthening (6 to 12 weeks)**

During the 2<sup>nd</sup> phase, the primary objective is normalization of activities of daily living:

- Reinforcing the muscles of the lower limb surrounding the ruptured ACL (Triceps surae; Hamstrings; Quadriceps; Gluteus Medius and Maximus)
- Initiating open kinetic chain exercises from 90 to 45° only.
- Initiating single support proprioception training on stable surfaces.
- Highlighting the ligamentous and trunk compensation strategies during single support (unipedal squat under the supervision of the therapist) or double-leg jumps.
- Maintaining cardiovascular conditioning and optimizing core stability.

*Means: Cycling; Visual feedback; Lunges; Bipedal squats; Core strengthening; Targeted reinforcement*

After the completion of these two phases, objective isokinetic and laxity testing may be undertaken in order to assess muscle recuperation and knee stability. Nevertheless, these tests may be delayed until completion of phase three depending on the practices of the department.

### **Phase 3: preparation for running (12 weeks to 4 months)**

The primary goals during this phase include running without feeling of instability or intra-articular swelling, developing single leg hops with proper shock absorption, and avoidance of dynamic knee valgus.

This consists of:

- Controlled open kinetic chain exercises with full range of motion.
- Isolated eccentric exercises.
- Acquisition and optimization of unipedal squatting without utilizing ligamentous or trunk compensatory mechanisms.
- introduction to controlled plyometric exercises, starting with bipedal then unipedal stances.
- Optimization of unipedal proprioception on both stable and unstable surfaces.

*Means: Visual aids; Jumping; Unstable surfaces*

### **Phase 4: Isokinetic testing and return to running (4 to 5 months)**

- Optimization of muscle weakness through isokinetic testing.
- Optimization of proprioception.
- Introduction to controlled lateral hops
- Return to symmetric and economic running (joint stress)
- Quantification of applied forces for a gentle and progressive return to running

*Means: Functional exercises; Workout monitoring; Lateral hops*

### **Preparation for return to sports (5 to 6 months)**

- Multi-directional running with surprise changes in direction
- Functional exercises closely resembling (or simulating) the act of pivoting

*Means : Specific workouts closely resembling (or simulating) the patient's practiced sport*

### **Functional testing and return to workouts specific to patient's practiced sport (6 to 9 months)**

- Optimization of any lingering deficits as seen on functional tests
- Introduction to self-training at 6 months
- Increased workout load
- Introduction to group workouts at 7½ months

Regular MRI follow-ups should be ordered in order to identify any developing meniscal or osteochondral lesions. In fact, meniscal lesions on unstable knees are rarely symptomatic [9].

There is no consensus on the frequency of MRI follow-ups. We recommend the acquisition of an MRI every 6 months.

Failure of functional treatment is defined as the appearance of meniscal lesions or the persistence of knee instability. In case of failure, surgical treatment must be considered.

### **3- What can be expected from conservative treatment?**

The literature on this subject is relatively scarce. The first article published dates back to 1995 by Mizuta et al. [10] in which they argued against conservative treatment.

It was not before 2013 that Moksnes et al. [11] published their results of a series of isolated ACL ruptures treated by conservative treatment. This included a sample of 46 skeletally immature children aged 12 years and younger with isolated ACL ruptures diagnosed by MRI. These patients were followed-up for a minimum of 2 years after the initial incident. 78% of patients did not require surgical treatment; follow-up was carried out at regular intervals with clinical testing. However, 20% of these patients developed secondary meniscal lesions.

In 2018, after a symposium was held by the French Arthroscopy Society (SFA) in Marseille on the topic of ACL ruptures in children, Madelaine et al. [12] published the results of a multicentric study on the conservative treatment of ACL injuries in children. 53 patients were included with a median follow-up of 6.6 years. 21 patients were later operated, resulting in 37% therapeutic failure. Conservative treatment may also have consequences on the menisci, as 15% of patients presented a secondary meniscal lesion, with 1 patient requiring meniscectomy.

Risk factors for the failure of conservative treatment have been investigated with none being definitively identified. It would seem that instability in the first few months following the incident might be a predictor of therapeutic failure. Contrarily, patients who have yet to begin puberty (Tanner 1) seem to be protected. As a result, the onset of puberty seems to be a poor prognostic factor.

Conservative treatment is therefore a separate entity, with an increased risk of secondary cartilaginous and meniscal injury. It requires regular follow-ups in order to discontinue conservative treatment when the knee is considered to be in danger.

However, the risk of re-rupture after ACL reconstruction seems to be higher in children than in adults, and, according to the SFA symposium study in Marseille [13], ranges between 9% at two years and 22% at five years post-operatively. It should be noted that re-ruptures were more frequent with shorter tendon grafts.

## **Conclusion**

Conservative treatment and surgery are complementary modalities in the management of ACL ruptures in children.

Conservative treatment should not be considered for all patients and is rather reserved for isolated ACL lesions.

This type of management requires the patient's compliance and comprehension.

It would appear that younger patients have better expected outcomes. Management of a ruptured ACL in children is therefore neither "entirely surgical" nor is it "entirely conservative".

For the most part, conservative treatment meets the requirements for the treatment of ACL ruptures in children. If properly undertaken, it can restore the stability and function of the knee, with the running risk of secondary damage to the menisci and the articular cartilage. Nevertheless, one of the advantages of conservative treatment includes the lack of growth disturbances.

The ideal patient would be Tanner 1, without any meniscal tears, with no instability of the knee, and who is capable of adhering to the treatment protocol.