

ChondroCelect™ Rehabilitation Program

Rehabilitation differs depending on the type and site of the lesion and the patient personal profile. Grouping of the lesions and patient profiles is helpful to ensure good guidance in the rehabilitation. The surgeon assigns the patient to a group. For each group there's one guideline for the rehabilitation.

Group 1

Includes a patient with an isolated **femoral or tibia** chondral defect (max 1.5 cm diameter) without ligament failure or instability. The patient has normal alignment and an age < 50 years.

Group 2

Includes a patient with an isolated patellar or trochlear chondral defect without ligament failure or instability. Patient has normal alignment and an age < 50 years.

Group 3

Includes a person with **a combination of a patellar or trochlear and tibia or femoral implantation**. Patient with normal alignment and Age < 50 years.

Within each group following characteristics can differ.

- Larger defect diameter as stated in the group.
- Ligament reconstruction or reversible instability.
- bad alignment, with or without osteotomy
- age > 50 years
- repair on femur and tibia
- repair on trochlea and patella

Combinations of previous characteristics can slow down functional rehabilitation, especially during the integration and maturation phase. The patient should be well informed and motivated for participating regular or weekly an appropriate training program (see list of proper activities) because the maturation is progressive even after 1 year. Moreover, the patient needs daily routine in personal activities and exercises. The physiotherapist has to be available for consultation, guidance and advice. If functional goals are not reached within the set timetable, it is of great importance that the patient keeps in contact with the physiotherapist. This way individual adjustments can be made. The rehabilitation process should be tailored-made around the patient's functional status with constant respect for the general rules.

1. Postoperative rehabilitation guidelines - Group 1

Isolated repair on femurcondyl or tibiaplateau.

Goals for range of motion

| | |
|----------|---------------------------|
| Week 0-4 | 0° to 90° active flexion |
| Week 5 | 0° to 110° active flexion |
| Week 6-8 | 0° to 130° active flexion |
| Full ROM | progressively by 8 weeks |

Goals for weight bearing

| | |
|-----------|---|
| Week 0-2 | non-weight bearing |
| Week 3 | weight bear control 10 - 15kg for all activities |
| Weekly | increase 10kg every week. Still always use 2 crutches and progression normalization of gait |
| Week 6-10 | when the gait pattern is normal and swelling, pain and proprioception of the patient are optimal, gradually wean off crutches |
| Week 0-12 | an unloading brace is worn day and night. Afterwards weaning off gradually, starting at night |

Goals for strength and function

| | |
|-------------|--|
| Week 0-2 | isometrics in varied knee positions, pain free Use of myofeedback for muscle reeducation No open chain exercises with resistance below the knee |
| Week 2-6 | closed chain exercises, within weight bearing restrictions Weight shifting activities (isometric) Accent on proprioception and neuromotor control Aquatic therapy for improvement of general condition |
| Week 6-12 | bilateral closed chain exercises (concentric and eccentric), Stationary bike 1 hour every day Progression in proprioceptive exercises All within limits of weight bearing control |
| Month 3-6 | increase workload of the knee in functional activities Stepping within range of motion, Cycling with light resistance Short repetitions of bipodal landing on a sprung surface for example a mini trampoline. |
| Month 6-10 | gradually increase resistance, through increase of repetitions and a decrease of sets. Start with intense jogging = low average speed, high moving frequency over short distances, lots of sets |
| Month 10-24 | impact training, heavier weight training Sport-specific exercises and return to sports vary according to: Sport, the level of the patient and the medical guidelines High-level activities as football, basketball, can begin at 16 months or sooner if pain free and no swelling |

2. Postoperative rehabilitation guidelines - Group 2

Isolated repair on patella or trochlea femoris.

Goals for range of motion (3 times a day, brace loose for exercises)

| | Patellar repair | Throchlear repair |
|----------|---------------------------|---------------------------|
| Week 0-2 | 0° to 15° active flexion | 0° to 30° active flexion |
| Week 2-4 | 0° to 45° active flexion | 0° to 45° active flexion |
| Week 4-6 | 0° to 90° active flexion | 0° to 90° active flexion |
| Week 6-8 | 0° to 120° active flexion | 0° to 120° active flexion |
| Full ROM | progressively by 12 weeks | |

Goals for weight bearing

With brace fixed in full extension first 2 weeks

First 3 days plantar touch weight bearing
Day 3-week 2 to full weight bearing is advised

With brace loose, for range of motion exercises 3 times a day

Week 0-2 non-weight bearing
Week 3-4 weight bear control 10 - 15kg for all exercises
Weekly Increase 10kg every week. Still always use 2 crutches and
 Progression normalization of gait
Week 6-12 when the gait pattern is normal and swelling, pain and
 proprioception of the patient are optimal, gradually wean off
 crutches.
Week 0-4 a brace is worn day and night
Afterwards weaning off gradually, starting at night.

Goals for strength and function

Week 0-2 isometrics in varied knee positions, pain free
 Use of myofeedback for muscle reeducation
 No open chain exercises with resistance below the knee
Week 3-6 closed chain exercises, within weight bearing restrictions
 Weight shifting activities (isometric)
 Emphasis on proprioception and neuromotor control
 Aquatic therapy for improvement of general condition
Week 7-12 bilateral closed chain exercises (concentric-eccentric), Stationary
 cycling to 1 hour every day
 Progression in proprioceptive exercises
 All within limits of weight bearing control
Month 3-6 increase workload of the knee in functional activities
 Stepping within range of motion, Cycling with light resistance
 Short repetitions of bipodal to unipodal landing on a sprung
 surface for example a mini trampoline
Month 6 -10 gradually increase resistance, through increase of repetitions and
 a decrease of sets
 Start with intense jogging = low average speed, high moving
 frequency over short distances, lots of sets
Month 10-24 impact training, heavier weight training
 Sport-specific exercises and return to sports vary according to:
 Sport, the level of the patient and the medical guidelines
 High-level activities as football, basketball, can begin at 16
 months or sooner if pain free and no swelling

3. Postoperative rehabilitation guidelines - Group 3

Combination of repair on femur/ tibia and patella/ trochlea femoralis.

Goals for range of motion (3 times a day, brace loose for exercises)

| | Patellar repair, | throchlear repair |
|----------|----------------------------|---------------------------|
| Week 0-2 | 0° to 15° active flexion, | 0° to 30° active flexion |
| Week 3-4 | 0° to 45° active flexion, | 0° to 45° active flexion |
| Week 5-6 | 0° to 90° active flexion, | 0° to 90° active flexion |
| Week 7-8 | 0° to 120° active flexion, | 0° to 120° active flexion |
| Full ROM | progressively by 12 weeks. | |

Goals for weight bearing

| | |
|-----------|--|
| Week 0-2 | non-weight bearing, |
| Week 3 | weight bear control 10 - 15kg for all activities, |
| Weekly | Increase 10kg every week. Still always use 2 crutches and Progressive normalization of gait |
| Week 6-12 | when the gait pattern is normal and swelling, pain and proprioception of the patient are optimal, gradually wean off crutches. |
| Week 0-8 | an unloading brace is worn day and night, |
| Week 9-12 | weaning off brace gradually, starting at night |

Goals for strength and function

| | |
|-------------|---|
| Week 0-2 | isometrics in varied knee positions, pain free Use of myo-feedback for muscle reeducation |
| Week 3-6 | No open chain exercises with resistance below the knee closed chain exercises, within weight bear restrictions Weight shifting activities (isometric) Emphasis on proprioception and neuromotor control Aquatic therapy for improvement of general condition |
| Week 7-12 | bilateral closed chain exercises (concentric-eccentric), Stationary cycling to 1 hour every day Progression in proprioceptive exercises |
| Month 3-6 | All within limits of weight bearing control increase workload of the knee in functional activities Stepping within range of motion, Cycling with light resistance Short repetitions of bipodal to unipodal landing on a sprung surface for example a mini trampoline |
| Month 6 -10 | gradually increase resistance, through increase of repetitions and a decrease of sets. Start with intense jogging = low average speed, high moving frequency over short distances, lots of sets |
| Month 10-24 | impact training, heavier weight training Sport-specific exercises and return to sports vary according to: Sport, the level of the patient and the medical guidelines High-level activities as football, basketball, can begin at 16 months or sooner if pain free and no swelling |

4. General guidelines

Joint circulation exercises

- Are needed for nutrition and stimulation of the transplanted cells. If nutrition is provided daily, the cells can develop properly and integrate optimally. The exercises need to be
 - Repetitive, with a large ROM
 - performed daily and over an extensive time (i.e. 30 minutes a day)
 - easy to perform, safe and preferably active,
 - pain free
 - and last but not least without substantial loading

Joint circulation exercises are a necessity, in every stage of the rehabilitation, without nutrition no cell and tissue adaptations can be expected.



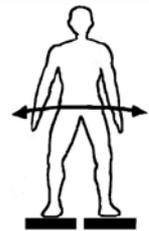
Progressive ROM increase

- the exact location of the implantation should always be obtained
- for an increase in range of motion (ROM) exercises are done
 - after an active circulation exercise,
 - with respect to glide-arthrokinematics of the joint
 - Long, static and with minimal stress.
 - no adverse muscle tension is allowed,
 - only local pain during stretch in region is normal
- to keep the ROM, implement full range circulation exercise
- stationary cycle can start if active 100° flexion has been obtained



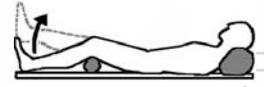
Weight bearing progression

- to start progression in weight bearing use
 - short loading times in functional weight bearing positions
 - perform lots of short sets to aim for lots of repetitions in total,
 - objective feedback of the weight balance control in different exercises
- Loading in slow movements can induce shear stress with a plastic deformation of the repaired surface. and thus damage the graft site. Therefore avoid slow, static loading movements
 - in extension zone, if tibia/femur graft site is more anterior,
 - In $> 45^\circ$ of flexion, if tibia/femur graft site is more posterior.
 - within $0^\circ - 40^\circ$ range, if graft site is patellar inferior
 - within $0^\circ - 40^\circ$ range, if graft site is thochlear superior,
 - in $> 45^\circ$ of flexion, if graft site is patellar middle or superior
 - in $> 45^\circ$ of flexion, if graft site is thochlear inferior
- If repair-site is small, progression in weight bear control can be more easily increased, with respect to the joint circulation exercises and the use of 2 crutches.
- It's normal to experience local swelling and pain in the month following the operation. Pain and swelling may not occur in connection, during and after the exercises!

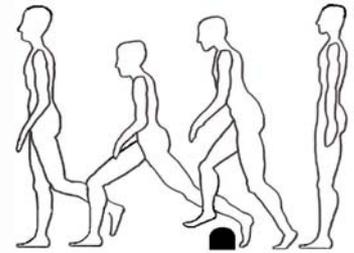


Strength and function

- Every new exercise is a **proprioception** exercise.
 - position sense (reference to contact surface or body part) and
 - Movement sense (direction, speed and force) should be addressed.
 - isolated muscle control (isometric, concentric, eccentric) is needed for the development and automatization of a correct coordination.
- **Postural balance** is optimized in a safe loading or weight bearing position . Following adaptations can be made for the progression using:
 - An exercise surface that is stable, to less stable ground (within patients limits)
 - eyes open to eyes closed condition,
 - equal bipodal balance to partial or shifted bipodal balance and
 - Bipodal to unipodal balance.



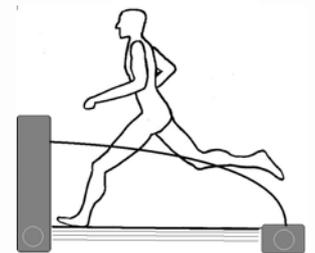
- **Strength training is functional training**, as much as possible. Isolated muscle training specific for strength is no primary goal. Normalization of open kinetic chain functions is needed, without the use of external force. External force might induce shear stress over the repaired site causing subsequent damage.



- **Closed kinetic chain exercises are preferable** to train stability in functional weight bearing positions.
- To gain specific **maximal power output** an example is added: With 1RM = one repetition maximum, ' = minute, " = second, set = exercises repeated without stopping)
 - Starting at endurance > 25 RM, rest 3' in between sets, 5 sets
 - To low-intensity > 20 RM, rest 2', 3 sets
 - High intense: 10 to 15 RM, rest 1', 2 sets
 - Strength/ maximal power: 3 to 8 RM, rest 30", 1 to 2 sets



- The **number of sessions** a week depends on the patient's recuperation time and the performed exercises. This is individually different, nevertheless 3 sessions a week is often possible and recommended.
- **Movement speed** during exercises should be functional speed. Learning a movement is more easy and safe at low speed. To prevent shear stress on the repaired site, weight bearing adaptation is necessary.



Proper recreational sport activities

Sports that are characterised by repetition of movement cycles, with low joint impact forces are preferable. In the rehabilitation they are placed under joint circulation exercises. Safety precautions are always a must.

Cycling. Getting on and off the bicycle should be exercised once with the physiotherapist to ensure a good control of the stability.

Cycling with a 'recumbent' bicycle (an inclined seating position) is possible as soon as emergency stop can be performed safely. Using any bike (mountain or race) it is recommended to reduce peak force. This can be achieved by performing: lots of moving cycles per minute, using clip-in paddles, stay in the saddle and choose a good easy road.



Aquatic sports. Safety precautions for getting in and out of the pool are recommended. Aqua therapy, such as aqua jogging is recommended as soon as movement cycle can be performed and the wound has healed.

Breaststroke will place the knee joint under stress and lots of flexibility is required. It is allowed to start at 4 months after the operation when it is pain free.

Crawl is allowed as soon as the movement cycle can be performed safely (starting after 6 weeks). Caution must be taken for the turns. Often peak force is generated. Turns are taken with uninvolved leg for landing and push-off.

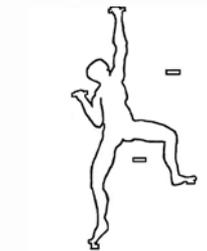


Inline skating or ice-skating Is allowed after 4 months. Previous experience and competence is required. Motor control for an emergency stop should be exercised on safety mat before starting.

Artistic, or acrobatic movements are best avoided.



Cross-country skiing. Is allowed after 4 months on a flat circuit. Previous experience and competence is required. Motor control for an emergency stop should be exercised on a safety mat before starting.



Sports like Diving, Golf, Indoor Climbing, Kayak, Taichi ... do not specific enhance joint circulation, although they are advisable. The variation in motor control and the joint protection can be relative easily managed within these sports.

Sports characterised by movement reaction time, high-velocity , high-impact during landing or push-off are not advisable. For example football, basketball, volleyball, tennis, paragliding, track and field, surfing, skiing, snowboarding... are all not advisable. The resulting force impact can damage the repaired site. This can occur initially without any symptoms. Therefore Sport-specific exercises and return to sports vary according to the specific Sport, the level of the patient and the medical guidelines.

High-level activities can begin at 16 months or sooner if the patient's knee is symptom free.

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