BIOTECH PROMED

Manual for Physiotherapists

Rehabilitation guidelines

following Hyalofast® implantation for the treatment of knee cartilage defects

FH-Prof. Barbara Wondrasch, PhD

Hyalofast®

Hyalofast is a biodegradable hyaluronan based (HYAFF®) scaffold for one-step surgical treatment of chondral and osteochondral defects.

It acts as a support for mesenchymal stem cells (MSC) from bone marrow aspirate or as a chondroprotective coverage which favours in situ residence of MSCs after their mobilization due to micro fracture or perforation procedures.

Hyalofast guides tissue remodelling and promotes the healing of cartilage tissue through the action of the MSCs which have populated the scaffold.

Hyalofast is applied in the cartilage defect via arthroscopy, or mini-arthrotomy.
Proper rehabilitation is of the utmost importance to the success of the treatment. Care should be aimed at protecting the joint surface while the cartilage heals and it should be customised in terms of intensity and difficulty, according to individual clinical conditions.

For more information visit:
hyalofast.anikatherapeutics.com

Rehabilitation Protocol following Hyalofast surgery

The rehabilitation protocol after cartilage repair with Hyalofast is designed to:

Protect the cartilage repairing tissue

Induce functional repair of the tissue

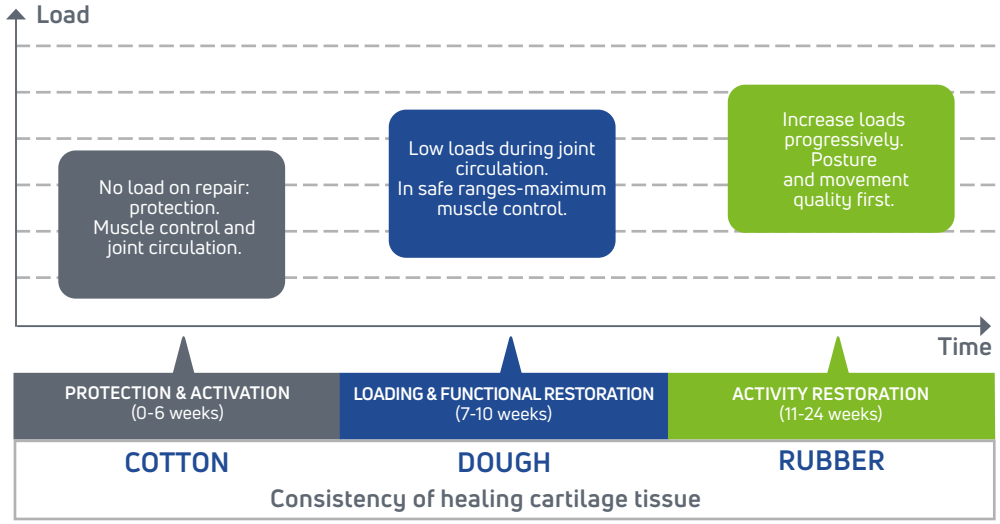
Allow optimal return to function

This rehabilitation program was designed using the knowledge of basic science, anatomy, and the biomechanics of articular cartilage, as well as the natural course of healing following surgery. Rehabilitation has to be seen as a process including active and passive modalities based on tissue healing and biomechanical aspects and, very importantly, patient education. Patient education is an integral component in therapeutic and management strategies to support and facilitate self-management, adherence and long-term outcomes. It should provide information about the issues of cartilage lesions, the surgical procedure and the content and timeline of the rehabilitation process. Furthermore, rehabilitation should be goal-based according to the SMART principle (Specific, Measurable, Applicable, Realistic, Time-Bound) and should follow patients` expectations. Therefore, this program is not intended as a substitute for individual clinical judgment, an individual assessment addressing structural and functional deficits is mandatory and a patient-specific rehabilitation program should be implemented.

Tissue healing and consequences for rehabilitation

The process of rehabilitation after cartilage repair is guided by three different biological healing phases, independent from the specific cartilage repair procedure used: 1) Protection and activation phase 2) Loading and functional restoration phase 3) Activity restoration phase

Phases of rehabilitation and biological healing phases

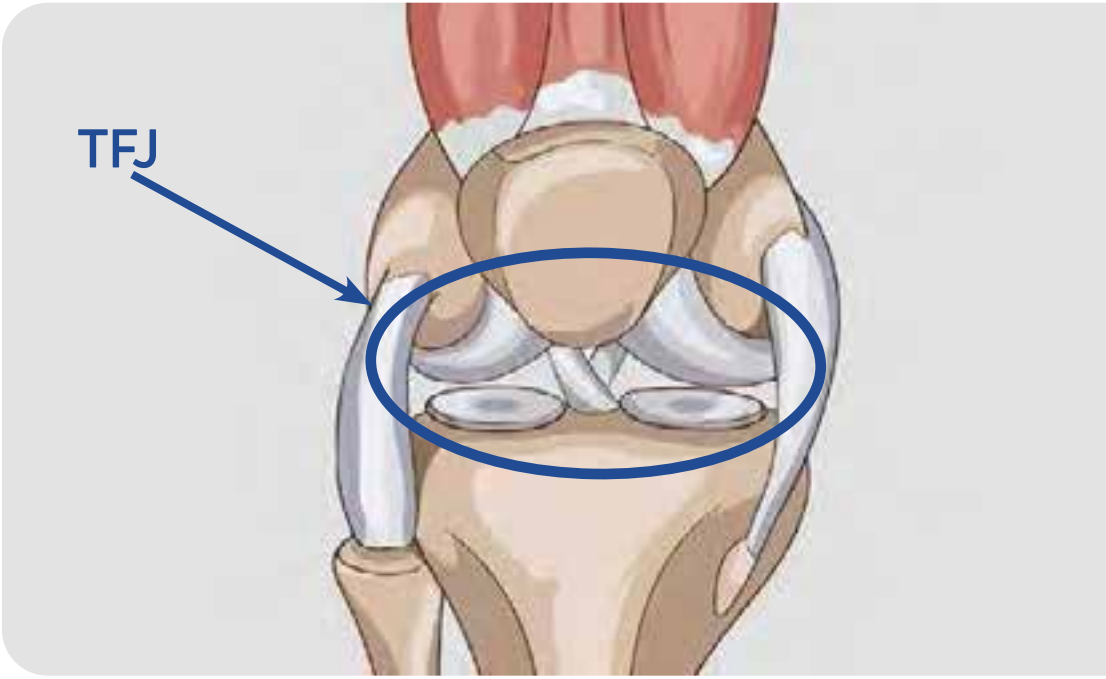


The first phase, **protection** and **activation**, is characterized by the formation of a blood clot and dense fibrin network which becomes organized into a primitive glue. During the second phase, **loading** and **functional restoration**, matrix production is at its peak of organisation of the collagen fibers. The focus of the third phase, **activity restoration**, is maturation and adaptation of the healing regenerated tissue. The progression through the rehabilitation program and rehabilitation modalities must be designed respecting the physiological development of the regenerating tissue. Progression through the rehabilitation phases should be based on specific criteria rather than to fixed timelines. Pain and effusion are the best indicators for overloading of the joint and the healing tissue, thus can be used as guide through the rehabilitation process progression.

Biomechanics of the knee and rehabilitation program design

An understanding of applied clinical biomechanics and an appreciation of the forces that will be exerted on the healing tissue are essential in the design of rehabilitation programs after cartilage repair. The contact area (distribution and magnitude), contact load and contact pressure during rehabilitation should be considered to minimise the danger of damaging the healing tissue, and to support the healing process by stimulating the tissue physiologically in safe positions. Therefore, information from the surgeon on the nature of the defect (size and location) is crucial. Relative to this information rehabilitation modalities and exercises can be designed in safe ranges, avoiding exercises which might be detrimental to the healing tissue.

The flexion and extension movement within the **tibiofemoral joint (TFJ)** is a combination of rolling and gliding of the surface of the femur and the tibia, linked up with a spin movement at the end of flexion and extension. To ensure a physiologic flexion and extension movement with a physiologic load distribution on the cartilage surfaces, restriction of these rolling and gliding movements, as well as the spin movement should be avoided. During this extension and flexion only parts of the tibia and femur are articulating so the load distribution in the tibiofemoral joint should be considered in the choice, and the progression of exercises. The TFJ is exposed to high mechanical load during vertical weight bearing (WB) activities (for example during walking, standing and stair climbing), which should therefore be avoided in the early protection phase.

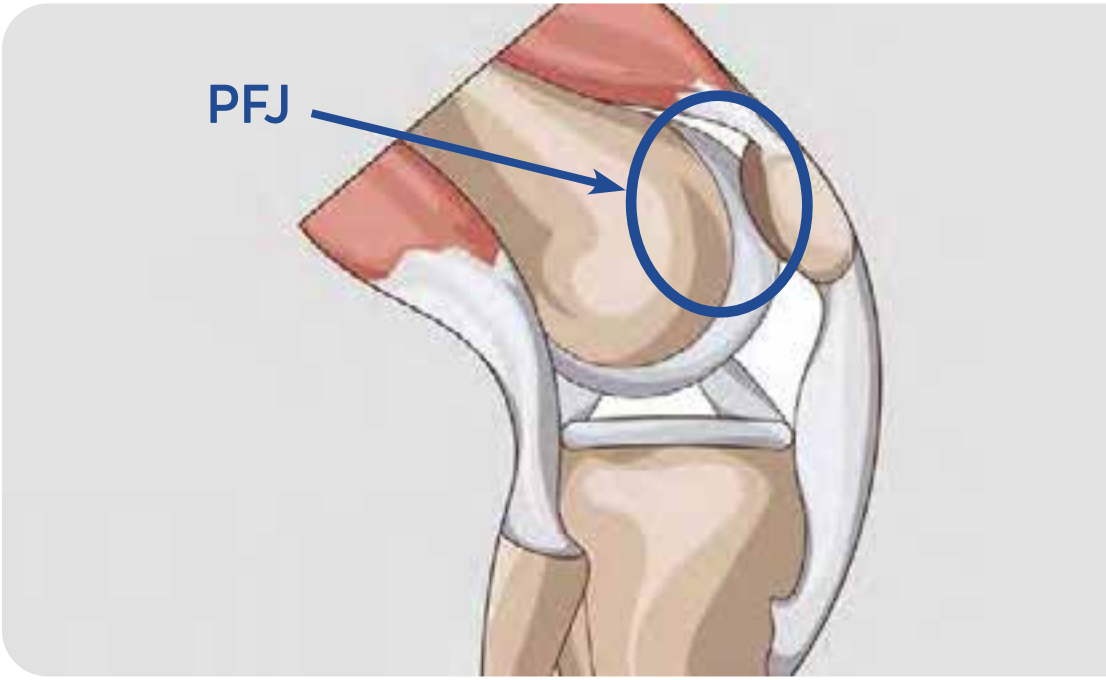


Biomechanics of the knee and rehabilitation program design

The **patellofemoral joint (PFJ)** is a sellar joint composed of the patella and the underlying femoral trochlea. This joint is stabilised by active and passive stabilisers.

The major active stabiliser is the quadriceps muscle, whereas passive stabilisation is provided by the femoral condyle, the peripatellar retinaculum and the medial and lateral patellofemoral ligaments. In higher knee flexion angles, particularly in WB positions, the load within the PFJ increases, implying increased loading of the healing cartilage tissue. However, near to extension the load within the PFJ is low.

Hence, WB activities with the knee in an extended position (a brace can be used to lock the knee in an extended position) are possible without harming the repair tissue.



PHASE 1 (WEEK 0-6)
Protection and activation phase

The first phase should focus on providing **joint homeostasis** by reducing effusion and pain, supporting nutrition of cartilage and joint, **restoration of ROM** (range of movement), **regaining neuromuscular control** and monitoring **WB restrictions.**

Joint homeostasis

MODALITIES*

- Cryotherapy
- Elevation (Fig. 1)
- Kinesio Taping
- Lymphatic drainage
- Manual therapy
  - Compression techniques to stimulate the chondrocytes
  - Low dosage
- Continuous passive motion (CPM)
- Active ROM exercises in closed-kinetic-chain (CKC) systems
  - Pain free, mid-range, every day, without resistance
  - Minimize shear stress
  - Provide intermittent pressure
  - Give sufficient rest periods

AIMS

1. Reduction of pain and swelling
2. Stimulation of cartilage and joint nutrition

Elevation with passive short arc movements

** The modalities are just suggestions and can vary or can be adapted to each patient demands. It is important that the key principles are followed.*

Restoration of ROM

MODALITIES

- Manual therapy: tibiofemoral and patellofemoral joint (Fig. 3)
- Soft tissue treatment of periarticular structures
- Active movement unloaded (non WB) and partial loaded in CKC systems (Fig. 2) without generating pain and effusion

AIMS

1. Preservation and restoration of flexion and extension
2. Normalisation of joint arthrokinematics
3. Avoidance of capsular adhesions

Flexion and Extension with a ball in supine position (unloaded position)

Manual therapy in the tibiofemoral joint

Neuromuscular control

MODALITIES

- Isometric exercises of Quadriceps and Hamstrings in varying knee angles (including neuromuscular electrical stimulation – NMES)
- Concentric in partial WB positions, small ROM
- Mini squats
  - Reduce shear forces over the repair site
  - Provide compression forces over the repair site
- Straight leg raises (knee in full and active extension) whilst lying on the side, in supine and in prone positions
- Bridging (Fig. 4)
- Clams

AIMS

1. Restoration of muscular joint control
2. Recruitment of Quadriceps and Hamstrings
3. Activation of the hip muscles

Bridging with arms elevated and using an resistance band

Weight bearing

MODALITIES

- Instruction on the use of crutches
- Assessment of the given amount of weight using standard bathroom scales (Fig. 5)
- Practicing the loading response phase during walking
  - Respect pain and effusion in WB positions
  - Adapt practice position to the allowed amount of WB (Fig 6)

AIMS

1. Protection of the repair site
2. Achievement of physiological gait pattern with crutches

Loading response with the given amount of load

Exercises with the given amount of load

Progression of weight bearing in Phase 1

The table below presents the progression of weight bearing and relies on the biology of the healing tissue. However, the following criteria should be used as a decision-making aid:

- Full active extension in the initial contact phase and mid stance
- Full active and passive knee extension
- No pain and effusion after long periods of walking (> 20 minutes)
- Instability
- No limping mechanism

Timing	Tibiofemoral joint	Patellofemoral joint
Week 0-2	Toe-touch WB 20% BW	Toe-touch WB 20% -30% BW with a brace locked in extension
Week 2-4	Partial WB 50% BW	Increase to full WB with a brace locked in extension
Week 4-6	Increase to full WB ⚠ Pain and effusion	

BW: body weight; WB: weight bearing

PHASE 2 (WEEK 7-10)
Loading & functional restoration

The focus of the second phase is a controlled, but progressive increase of WB activities. This can be achieved by **increasing joint ROM, improving neuromuscular control and low impact during ADLs and functional activity.** Pain and effusion should be the guide through this phase and are indicators for overloading. All modalities from phase 1 to reduce pain and effusion can be applied in this phase as needed.

Weight bearing

MODALITIES

- Gait retraining and strengthening of the "gait-specific" muscles (Fig. 7)
- Practicing the different walking phases

Walking phase "loading response" whilst lying on the side. Activation of the gait phase specific muscle with reduced load within the TFJ.

AIMS

1. **Achievement of physiological gait pattern without crutches**
2. **Movement without ambulatory devices**

Restoration of ROM

MODALITIES

- Manual therapy: tibiofemoral and patellofemoral joint
- Soft tissue treatment of periarticular structures
- Active movement unloaded (non-WB) and partial loaded in CKC systems without generating pain and effusion (Fig. 8 and Fig. 9)

AIMS

1. Free ROM
2. Preservation and optimisation of joint arthrokinematics

Active movement partial loaded in CKC systems

ROM exercises under load

Neuromuscular control

MODALITIES

- Concentrics in partial WB positions over the full ROM (Fig. 10)
- Concentrics in WB positions with short arc movements out of the defect zone
  - No pain and effusion during and after the exercises
  - Functional joint alignment (FJA) – (Fig. 11, 12, 13)
- Functional joint alignment
  - Pelvic angle
  - Femoral internal rotation
  - Foot pronation

AIMS

1. Control of movements
2. Absorption of forces acting on the knee
3. Static and dynamic stabilisation

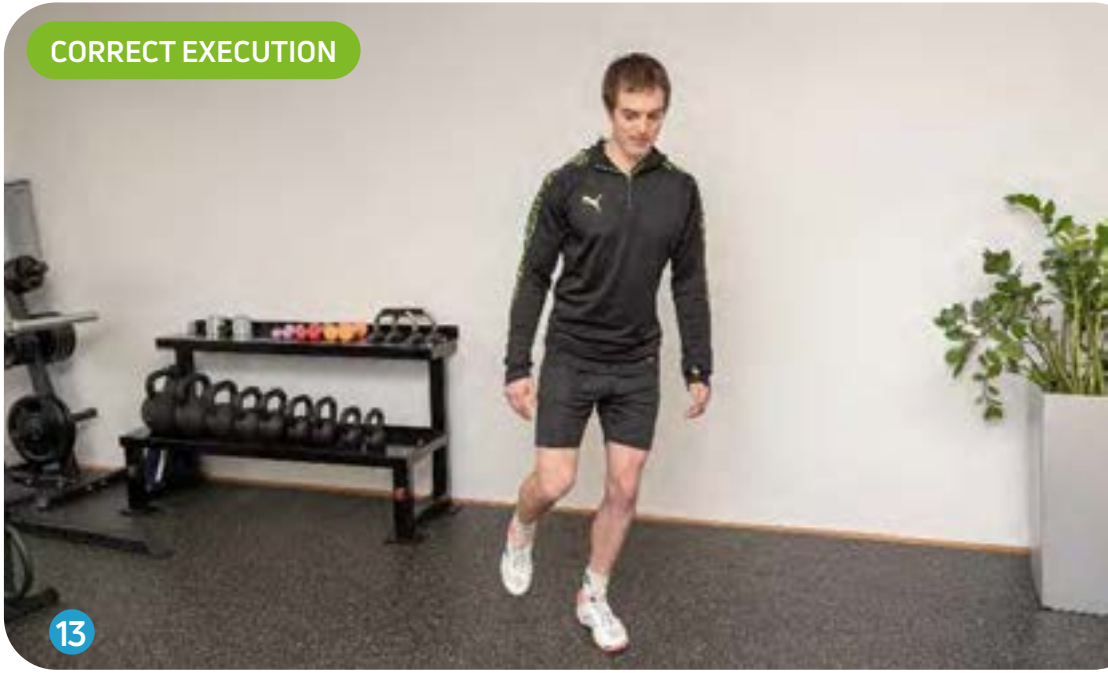
- Core stability
- Functional activation of the hip abductors and hip external rotators
- Static one-legged exercises
- ADL´s

Strengthening of the quadriceps in a partial weight bearing position over the full range of motion

Strengthening of the quadriceps in a full weight bearing position in a restricted ROM (70°-90 °) to spare the defect area

Neuromuscular control

Unphysiological joint alignment: foot pronation, external rotation of the tibia, internal rotation of the femur, hip flexion and poor core stability. This results in high joint loads within the knee.



Functional joint alignment

PHASE 3 (WEEK 11-24)
Activity restoration

This phase aims to prepare the patient to return to higher mechanical stress associated with work specific tasks and sports activity. A program should be developed that allows a continued recovery and meets the biomechanical and physiological demands of the respective work specific tasks and sport activities. Furthermore, any **remaining muscle strength deficits and additional impairments related to metabolic capacity, sport-specific movement patterns and symptoms should be addressed** to provide a safe return to sport. Modalities to control pain and effusion and to preserve ROM should be continued to provide joint homeostasis and nutrition of the repair tissue

Neuromuscular control

MODALITIES

- Concentrics in WB positions over full ROM
- Concentrics in WB positions with additional weight/resistance
- Eccentrics in non WB and WB positions
- Patients´demands
- No pain and effusion during and after exercising
- Before increasing load and implementing more complex movement patterns: MOVEMENT QUALITY FIRST
- Correct any movement dysfunctions
- Change to complex movement pattern
- Use of external feedback and instructions to enhance motor learning (Fig. 14)
- Plyometric training and jumping exercises
- ADL´s

AIMS

1. Dynamic stabilisation
2. Increase of loads during demanding activities
3. Development of feed forward and feedback mechanism

Instruction with external focus

RETURN TO SPORTS

Both time and functional criteria should be considered when planning the timepoint of returning to sports.

The following criteria are recommended:

- Nature of the lesion
- Surgery – concomitant procedures
- Clinical assessment
  - no pain
  - no effusion
  - no catching
  - no locking
  - no instability

- Radiologic assessment
  - MRI - MOCART Score
- Physical assessment
  - Full ROM
  - Muscle strength
    - to initiate dynamic movements
    - to attenuate ground reaction forces
    - to achieve high levels of performance during dynamic tasks
    - to function as a shock-absorber to dissipate peak forces

- Functional testing
  - single hop test (Fig. 13)
  - crossover hop
  - triple hop test
  - 6-meter timed hop test

- Subjective outcome scores
  - KOOS
  - IKDC 2000
  - Tegner activity scale

One leg hop

REFERENCE

1. Brittberg MI, A.; Madry, H.; Mandelbaum, B., editor. Cartilage repair - Current Concepts: DJO Publications; 2012.
2. Ebert JR, Edwards PK. The evolution of progressive postoperative weight bearing after autologous chondrocyte implantation in the tibiofemoral joint. Journal of sport rehabilitation. 2014;23(3):192-202. doi: 10.1123/JSR.2013-0041. PubMed PMID: 25115155.
3. Edwards PK, Ackland T, Ebert JR. Clinical Rehabilitation Guidelines for Matrix-induced Autologous Chondrocyte Implantation (MACI) on the Tibiofemoral Joint. The Journal of orthopaedic and sports physical therapy. 2013. Epub 2013/11/02. doi: 10.2519/jospt.2014.5055. PubMed PMID: 24175609.
4. Hambly K, Bobic V, Wondrasch B, Van Assche D, Marlovits S. Autologous chondrocyte implantation postoperative care and rehabilitation: science and practice. The American journal of sports medicine. 2006;34(6):1020-38. Epub 2006/01/27. doi: 0363546505281918 [pii] 10.1177/0363546505281918. PubMed PMID: 16436540.
5. Van Assche D, Staes F, Van Caspel D, Vanlauwe J, Bellemans J, Saris DB, et al. Autologous chondrocyte implantation versus microfracture for knee cartilage injury: a prospective randomized trial, with 2-year follow-up. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 2010;18(4):486-95. Epub 2009/10/13. doi: 10.1007/s00167-009-0955-1. PubMed PMID: 19820916.
6. Wondrasch B, Årøen A, Røtterud JH, Høysveen T, Bølstad K, Risberg MA. The Feasibility of a 3-Month Active Rehabilitation Program for Patients With Knee Full-Thickness Articular Cartilage Lesions: The Oslo Cartilage Active Rehabilitation and Education Study. Journal of Orthopaedic & Sports Physical Therapy. 2013;43:310-24. doi: 10.2519/jospt.2013.4354.
7. Wondrasch B, Risberg MA, Zak L, Marlovits S, Aldrian S. Effect of accelerated weightbearing after matrix-associated autologous chondrocyte implantation on the femoral condyle: a prospective, randomized controlled study presenting MRI-based and clinical outcomes after 5 years. The American journal of sports medicine. 2015;43(1):146-53. doi: 10.1177/0363546514554910. PubMed PMID: 25378208.

FH-Prof. Barbara Wondrasch, PhD

Barbara Wondrasch has been a physiotherapist since 1996 and sports physiotherapist since 1999. The focus of her clinical practice is within the field of traumatology, orthopedics and sports medicine. In 2001 she started her research activities in the "Center for Joints and Cartilage" of the Medical University of Vienna. The aim of this center was to develop evidence-based surgical and non-surgical treatment options for patients with focal cartilage lesions in the lower extremity. After getting her master´s degree in "Evidence-based Physiotherapy" (MSc) at the University of Applied Sciences in Vienna, she started her PhD-studies at the Norwegian School of Sports Sciences in Oslo (Supervisor: Prof. May Arna Risberg). She finished the studies in 2015 and the title of her dissertation was "Rehabilitation for patients with focal articular cartilage lesions in the knee".

Currently Barbara Wondrasch is working as a researcher and lecturer at the Department for Health Sciences at the St.Poelten University for Applied Sciences in Austria. She has several publications in peer-reviewed international journals and gives regular presentations and lectures at national and international conferences. The main topics of her scientific work are prehabilitation and rehabilitation for patients with osteoarthritis and cartilage injuries, outcomes of rehabilitation and prevention of musculoskeletal disorders.

For more information visit:
www.biotechpromed.com

BIOTECH PROMED

C/ Repartidor, 38, baixos 1º B, 08022, BARCELONA

www.biotechpromed.com

HYALOFAST®

CREDITS HEALTH MAR.KETING GMP-Artwork-0694