Patient Information Sheet

MACI®

Matrix-Induced Autologous Chondrocyte Implantation

DAMAGE to the hyaline articular cartilage in the knee may lead to the accelerated onset of osteoarthritis. Lesions of the articular cartilage affect millions of people worldwide, but treatment is hampered by the fact that in adult life hyaline articular cartilage is limited in its ability to regenerate. This article briefly outlines the structure and function of hyaline articular cartilage, previous surgical treatment for articular cartilage defects and an innovative new treatment known as matrix-induced autologous chondrocyte implantation (MACI). As MACI is not appropriate for all candidates with cartilage damage, this information sheet also includes guidelines on patient selection and highlights the necessity for appropriate pre and post surgery rehabilitation.

What is Hyaline Articular Cartilage and what function does it serve?

Hyaline articular cartilage covers the ends of the bones in movable joints. Healthy hyaline articular cartilage has a pale and glistening appearance, and a firm and smooth texture. It serves as a load-bearing elastic material that is responsible for the frictionless movement of the surfaces of joints. It is capable of withstanding loads up to seven times the weight of the body.

What happens if the Hyaline Articular Cartilage layer is damaged?

Despite its durability, hyaline cartilage does not have a blood supply and consequently has a limited capacity for regeneration. Once damaged the human body forms fibrocartilage to take its place but this surrogate tissue is very soft and does not possess the appropriate structural properties needed to dissipate the forces stimulated by the body during day to day life. Patients with significant cartilage defects frequently have persistent joint pain, swelling, and "catching" in the knee. Full thickness cartilage defects will never heal of their own accord and ultimately lead to osteoarthritis.

How have cartilage defects been treated prior to the development of MACI?

Previously, a wide variety of surgical procedures such as knee debridement and abrasion arthroplasty, designed to promote fibrous repair of cartilage defects have been tried and found wanting. In young patients cartilage defects cannot be treated by joint replacement because of the risks of early loosening and premature wearing of the prosthesis.

What is MACI & how does it work?

MACI is an innovative new method of autologous chondrocyte implantation (ACI) for treating defects in the articular cartilage and for filling them with regenerative tissue. It offers an effective treatment by isolating and growing the patient's own cartilage building blocks, known as chondrocytes, and re-implanting these cells into the damaged area within the knee joint via surgery using a specialised collagen membrane.

Stage 1: Biopsy

What does MACI involve?

The procedure is performed in two stages. Firstly as a day patient, a sample of cartilage cells is removed arthroscopically from the non-weight bearing part of the knee. The chondrocyte cells are then isolated and grown in a special laboratory using highly developed tissue engineering procedures that take approximately four weeks. The second stage involves implanting the chondrocyte cells that have been seeded onto the collagen membrane into the defect in the knee via specialised knee surgery. A post-operative hospital stay of approximately 2 - 4 days will generally be required following surgery. After which the patient is discharged wearing a protective knee brace and using two crutches.

How can I best prepare for surgery and my postoperative recovery?

The rehabilitation process for MACI should begin prior to surgery, as patients need to be physically and mentally prepared for their operative procedure and the lengthy rehabilitation process. Patient education is essential, as the integrity of the chondrocyte repair must be protected.

What does recovery from MACI involve?

Following surgery it is necessary to undergo a rehabilitation program so as to stimulate the implanted chondrocytes to adapt to their natural function. Patients are required to protect the repair from weight bearing stresses and are restricted to toe-touch ambulation with two crutches for the first six postoperative weeks. Immediately after surgery the amount of knee bend (flexion) is restricted and a brace must be worn to ensure the protection of the cartilage repair. As a rough guide, patients should achieve between 60-90° knee flexion by three-weeks, 90-120° knee flexion by six weeks and have returned to a normal range (approx 130-160°) by 12 weeks post surgery. At the 12-week time-point compressive and decompressive forces, provided by full weight bearing, further stimulate the chondrocytes to synthesise the correct matrix molecules. However, return to work and sport and recreational activities should be carefully controlled and gradually progressed. Although the cartilage defect may well have been filled with hyaline-like cartilage within the first few months, it is not advisable to undertake stressful extension or weight bearing activities, such as squats or running before twelve months. Maturation and hardening of the new-formed cartilage will not be complete until 11-24 months have elapsed.

When was this technique developed and how successful has it been?

Autologous chondrocyte implantation (ACI), in combination with periosteal grafts, have been employed to treat cartilage defects since 1987 with successful results. Since then over five thousand people worldwide have been treated using this technique. The patented matrix-induced ACI technique (by

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Genzyme) is a modification of the periosteal ACI technique and addressed the problems of using a periosteum patch by replacing it with an inert porcine collagen membrane. The type I/III collagen employed is biocompatible and has been used in plastic surgery for many thousands of patients.

In this technique, the cells are actually seeded directly onto the collagen type I/III biomembrane to form a biocomposite. Cells adhering to the inert membrane are mechanically stable at the time of implantation so there is no longer the risk of leakage. The MACI technique is more convenient as the pre-cut patch is now glued in position with fibrin glue that only takes one minute to set, compared to the hour required to suture a patch of collagen or periosteum.

The MACI technique can also be performed via mini arthrotomy due to the fact that sutures are no longer needed. This has the added benefit of reducing soft tissue damage to the affected knee.

Is this treatment suitable for me?

The guidelines for selection of patients suitable for this procedure are as follows:

- Cause of defect – if this has been caused by trauma or osteochondritis dessicans the patient is suitable. If it is associated with rheumatoid or inflammatory arthritis, cartilage regeneration in this way is not suitable.
- The age limits are 15 to 55 years of age.
- If the knee is unstable or malaligned in any way then ACI is only indicated once the instability or malalignment has been addressed. However these problems may be addressed at the time of cartilage implantation.
- ACI should not be used in the presence of the following situations: obesity greater than one and a half times the ideal body weight for height, excessive bow leg or knock knee deformities.
- The patient must be able and willing to cooperate with a clearly defined and controlled rehabilitation program.

If I have severe osteoarthritis and have been scheduled for a knee replacement, is MACI suitable for me?

No. It is likely that if you scheduled for a knee replacement that the arthritis in your knee has gone too far to be addressed by cartilage implantation.

If this procedure is performed successfully, will it prevent knee replacement?

In all likelihood this procedure may reduce your chance of knee replacement but as this is a relatively new technique, we require more long-term information to answer this question.

Is this technique suitable for treating rheumatoid arthritis?

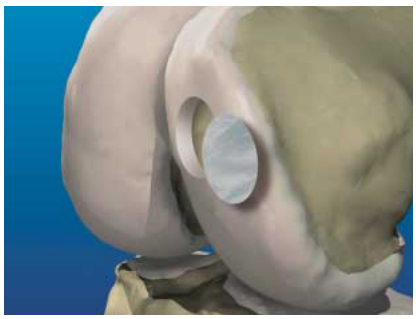
No. Progressive inflammatory or rheumatoid arthritis would simply continue to erode the area of enhanced repair.

Why isn't MACI recommended for people over the age of 55?

The chondrocyte cells of older patients do not grow as those from young patients. In addition the articular cartilage within the knees of patients over 55 years is usually too damaged for the procedure to be beneficial. However please consult your surgeon for definitive answer to this question.

Is this technique suitable to replace torn cartilage?

There are two types of cartilage in the knee, firstly the joint lining and secondly the menisci, which act as shock absorbers between the two joint surfaces. It is the joint lining that is suitable for ACI. The so called "torn cartilage" or meniscus is not suitable for this kind of technique although work is currently being conducted on transplant menisci and this technology may be available in years to come.



Stage 2: Implantation - membrane in position

Is MACI suitable to treat cartilage defects in other joints in the body?

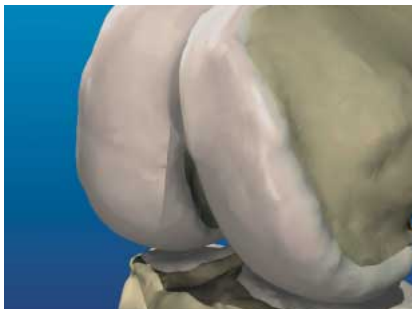
Whilst currently MACI is restricted to treatments of defects within the knee, ankle and shoulder joint, the use of MACI for local cartilage defects in other joints is currently under investigation.

When could I commence driving following MACI?

Approval needs to be obtained from the operating surgeon; however, it has been our experience that patients usually are given clearance to recommence driving approximately 4 to 6 weeks following implantation.

When could I return to work following MACI?

Upon clearance from the operating surgeon, but also depends on the demands of the job. For example, it has been our experience that patients can return to desk jobs after 3 weeks.



Stage 3: MACI - fully healed

What is the length of hospital stay following MACI?

This depends on whether there are any post surgery complications as well as the extent of the surgery, however, patients are usually eligible for discharge after 1 – 2 days.

What happens to the collagen membrane following MACI?

Research indicates that the type I/III collagen membrane used in the MACI procedure degrades over time. This process takes approximately 3 to 6 months to be complete.

When can I recommence high impact sport and recreational activities?

Approval needs to be obtained from the operating surgeon, however, it has been our experiences that return to heavy manual work, sport and recreational activities should be carefully controlled and gradually progressed. Although the cartilage defect may well have been filled with hyaline-like cartilage within the first few months, it is not advisable to undertake stressful extension or weight bearing activities, such as squats or running before 12 months post-surgery. Maturation and hardening of the new-formed cartilage will not be complete until this time.

For further information please consult with your treating physician who will advise you and provide further information regarding MACI.

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