

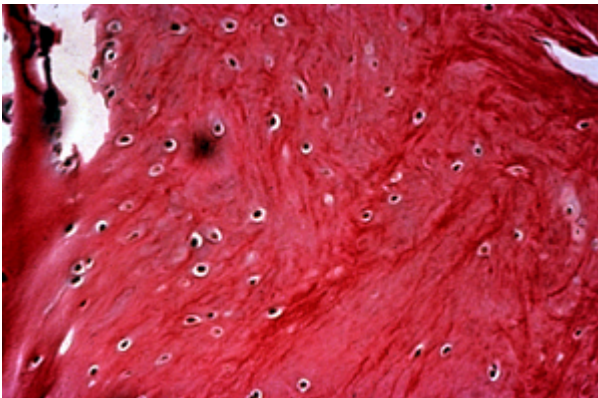
# Knee Cartilage Implantation

Carticel™ ...

Autologous Cultured  
Chondrocyte Implantation

**OAP** is one of the few centers in the country performing this procedure on an *outpatient* basis!

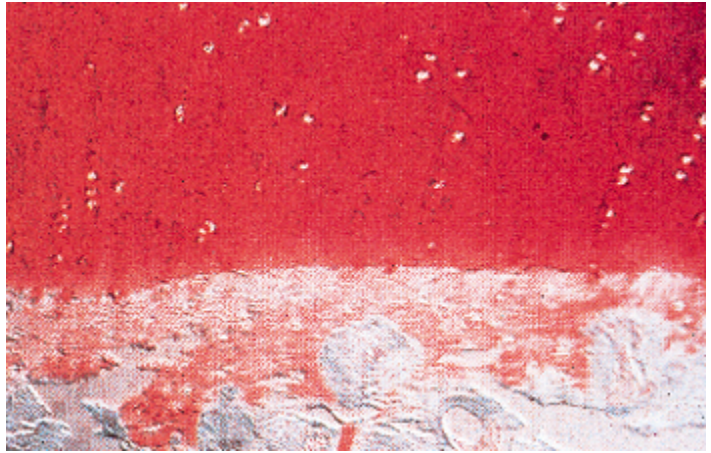
One of the most difficult surgical challenges facing orthopaedists has been trying to treat patients who have lost portions of the normal joint surface cartilage in their knees but are too young or too active for a total knee replacement. These localized damaged areas often act as sandpaper and go on to degrade and destroy the healthy adjacent joint articular cartilage. Treatment regimes in the past have focused on attempting to get a healing patch of fibrocartilage to "fill in" the defect, either by drilling the underlying bone with a series of honeycomb-like holes, abrading the bone with a burr, or microfracturing the crater with a special pick. Each of these treatments would cause a bleeding and subsequent healing response that would sometimes fill in the defect with a rubbery, firm coating somewhat like the original articular cartilage in appearance. Unfortunately this fibrocartilage has none of the biochemical or mechanical qualities of normal hyaline joint cartilage because it consists of primarily Type I collagen and typically will breakdown over time. It also doesn't have the wear, lubricating, or impact resistance capabilities of normal hyaline cartilage, which consists of Type II collagen.



*Histological specimen of fibrocartilage. There is a fibrous appearance of the disorganized collagen fibers which consist of mostly Type I collagen.*

*Courtesy of Genzyme Corp.*

*A specimen of normal articular cartilage. Note the organized columnar arrangement of the cartilage cells (chondrocytes) and the consistent red staining with Safranin-O stain. Hyaline cartilage consists of mostly Type II collagen.*



Fortunately an exciting new surgical technique has recently been developed which has shown promising results in the battle against articular cartilage defects. In September, 1997, the Food and Drug Administration approved the procedure for autologous chondrocyte implantation as marketed by Genzyme Tissue Repair (Cambridge, MA). The Carticel™ technique, based on the work of Swedish physician Dr. Lars Pederson, provides a safe commercial means of culturing and multiplying the patient's own articular cartilage cells in a slurry solution that is then reimplanted in the joint cartilage defect. What makes this procedure different from all the healing fibrocartilage techniques is that the live implanted cartilage cells produce a surrounding hyaline matrix which is biochemically similar to normal articular cartilage. This can provide relief of the pain, a return to active function, and presumably a lasting biologic repair.

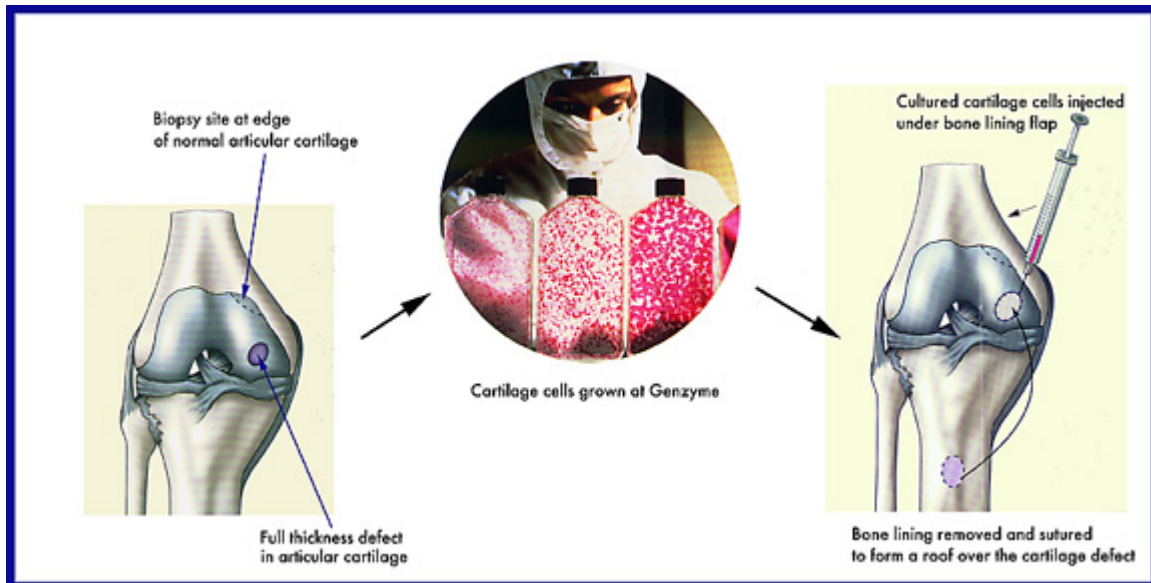
*Specimen of chondrocyte implantation technique (rabbit) showing hyaline appearing cartilage and successful Type II collagen production.*



*Courtesy of the University of Sahlgrenska*

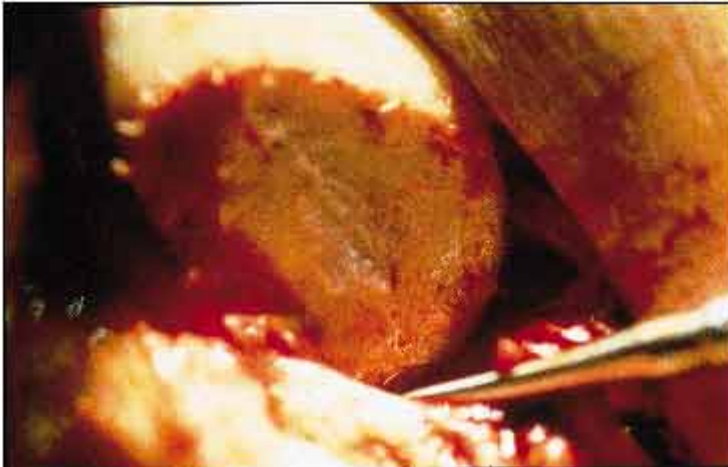
The Carticel™ procedure currently involves two surgeries. The first is an arthroscopic outpatient procedure to remove a small portion of normal joint surface from the edge of the non-weightbearing portion of the knee (often the biopsy is taken during the same

arthroscopic procedure that was being done to evaluate the defect in the first place, thereby avoiding the need for a separate procedure). This biopsy is then sent to Genzyme Tissue Repair where over a 4 week period it is cultured out and grown into a solution of the patient's own cartilage cells.



Once the cells are ready, the patient returns to surgery for cartilage implantation. After making an incision in the knee and cleaning any remaining damaged cartilage in the lesion back to a normal border, the surgeon removes a piece of lining (periosteum) from the adjacent upper tibia bone and sews this over the defect. This forms a water-tight membrane roof over the crater to contain the cultured cartilage cells. The cells are then injected into the defect.

Postoperatively the patient remains on crutches non-weightbearing for usually about 8 weeks, followed by another 4-6 weeks using a cane. Various techniques including formal physical therapy in addition to a constant passive motion (CPM) machine are used to begin motion of the joint as soon as possible since this helps the new cells to mature correctly. Although pain relief is typically noted by 4-6 months, aggressive impact sports are prohibited for at least 12-18 months after the surgery, depending on the size and location of the original lesion.



*Final appearance of the periosteum sutured over femoral condyle defect. The cartilage cells have been injected under the flap and the final suture placed to close the "cover" and provide a water-tight seal.*

*All photos courtesy of Dr. Lars Peterson unless otherwise specified.*

*Arthroscopic appearance of the same area 12 months after Carticel™ implantation. The defect is no longer visible and there is now hyaline cartilage (biopsy proven) filling the original defect site.*



Results of the Carticel™ procedure have been encouraging although it is not always successful. An analysis was done of the U.S. and Swedish registry of 153 consecutive patients undergoing this procedure with follow-up from 1 week to 94 months. The following results were obtained:

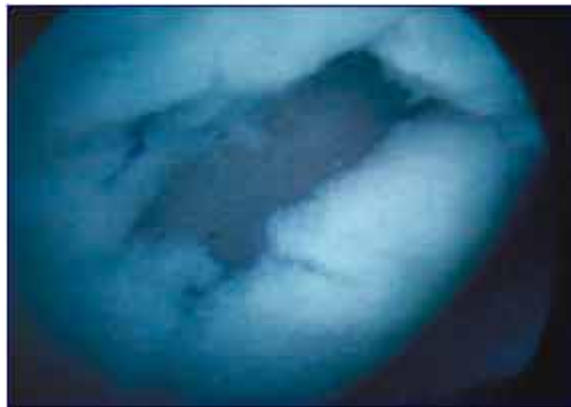
Patients with clinical improvement	Good or Excellent results	Good or Excellent results at 2 years persisting at 5 years post-op
85%	42%	97%

Thus, a total of 85% of patients showed some or complete improvement with the implantation technique. The Carticel procedure demonstrated good durability at 5-10 years out.

## Indications

The Carticel™ procedure is not a cure-all for knee arthritis. It has been shown to be effective only for localized defects although they can be fairly large (6-10 cm<sup>2</sup>). Successful results require that the confining borders of the lesion be normal articular cartilage, so this is not a technique available for older patients with wide spread arthritic change or systemic arthritis diseases such as rheumatoid or psoriatic arthritis. Age itself not a true factor, however, as the Carticel™ procedure has been performed successfully in patients ranging from 9 to over 55 years old. Essentially, knee cartilage implantation works best for:

- Localized, full-thickness lesions of articular cartilage confined to the femur caused by acute or repetitive trauma.
- Lesions of the femur in ACL deficient knees.
- Osteochondritis dessicans lesions.
- Implantation is currently not approved by the FDA for defects of all joints although early clinical studies are showing some promising results in the ankle, hip and shoulder.



- The Carticel™ procedure is currently only approved for use on the femur (including femoral trochlea) and the patella.