TREATMENT OF CARTILAGE LESIONS

Angelo J. Colosimo, MD

-Head Orthopaedic Surgeon University of Cincinnati Athletics

-Director of Sports Medicine University of Cincinnati Medical Center

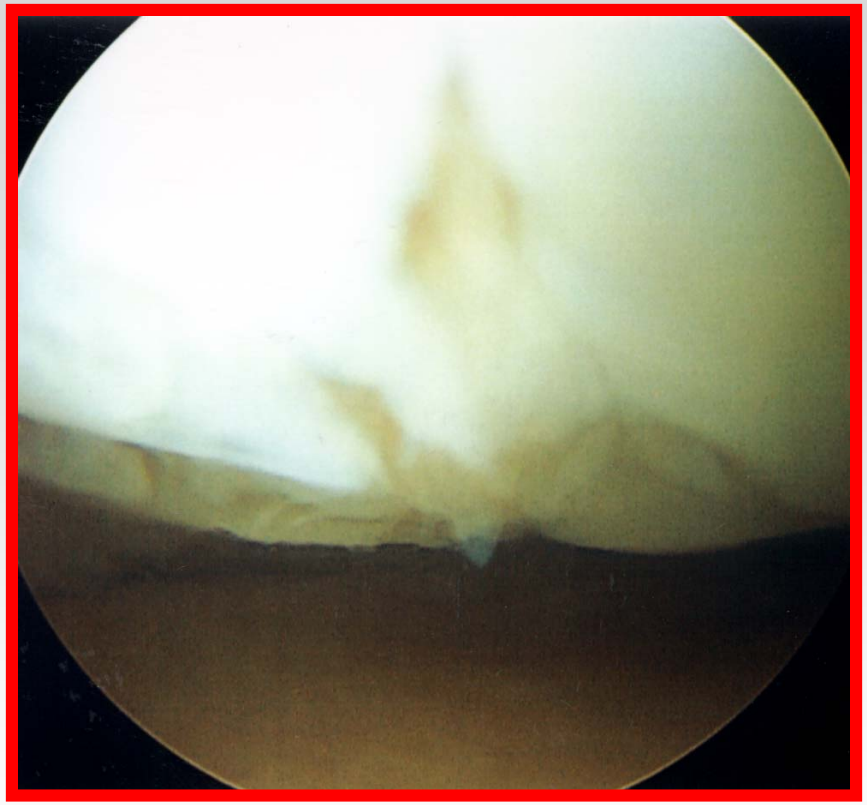
-Associate Professor of UC College of Medicine

-Medical Director Holmes Sports Medicine

INTRODUCTION

"Ulcerated cartilage is a troublesome thing, once it is destroyed it is not repaired"

Hunter, 1743

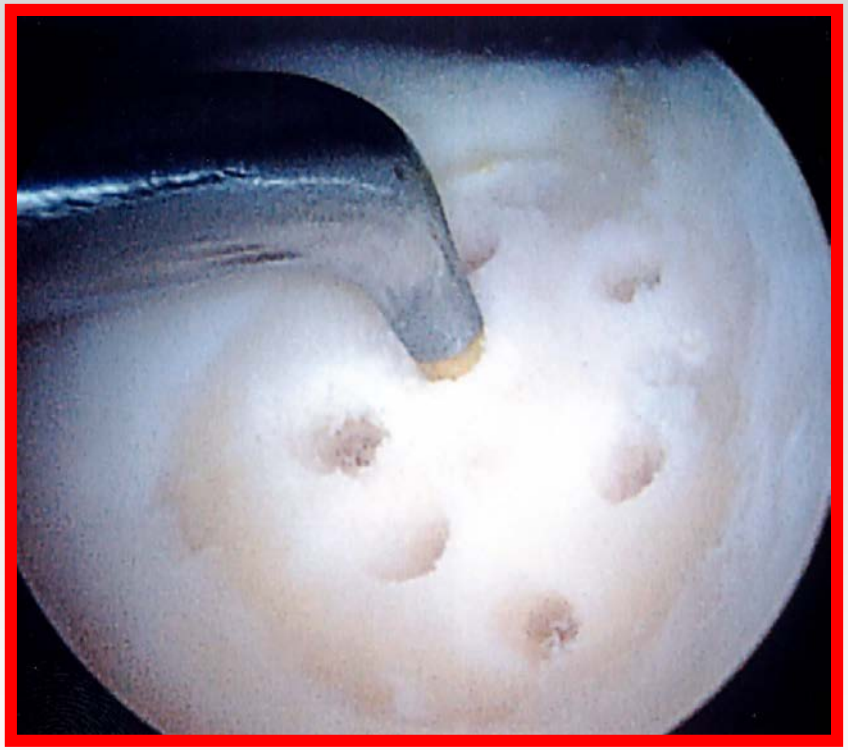


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INTRODUCTION

- Focal cartilage defects in the knee pose a difficult clinical challenge
- Repair, regeneration and transplantation
- Treatment remains an unsolved clinical and scientific problem



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INTRODUCTION

- The goal of articular cartilage repair is to:
  - Restore joint congruity
  - Provide full pain-free motion
  - Prevent further tissue deterioration
  - Stimulate healing

INTRODUCTION

- Despite numerous attempts at addressing the problem of chondral lesions, treatment options remain limited and the long-term outcomes uncertain.

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INTRODUCTION

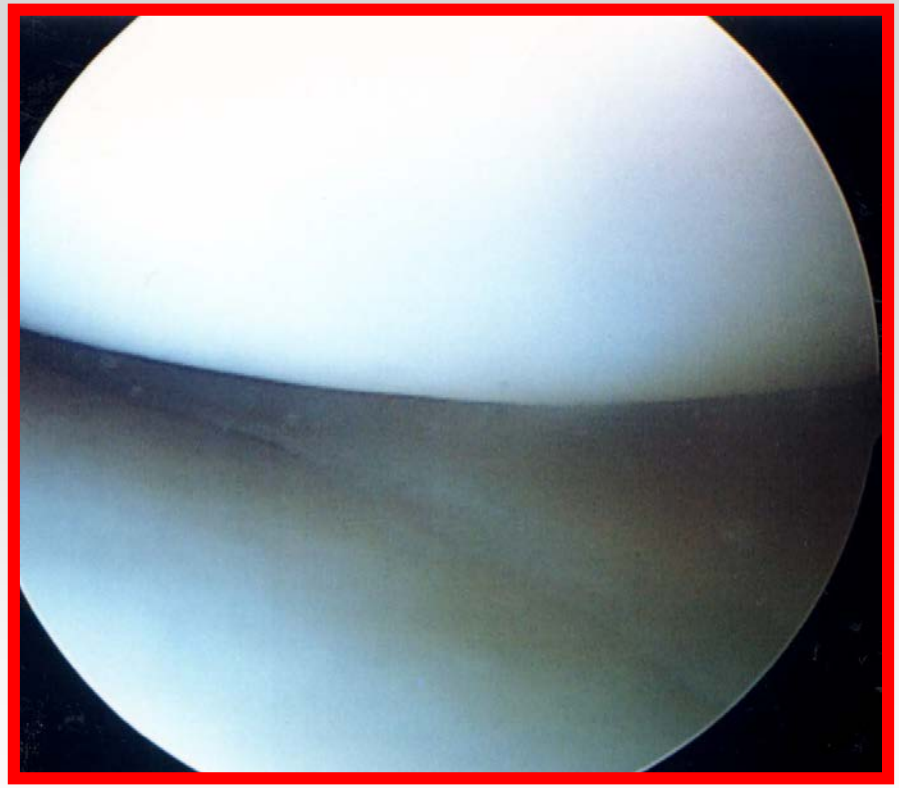
- Current treatment options provide, at best:
  - Temporary pain relief
  - Diminished clinical symptoms
  - Temporary functional improvement

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INTRODUCTION

- Articular cartilage functional properties:
  - Load bearing distribution
  - Reduces peak stresses on subchondral bone
  - Joint lubrication

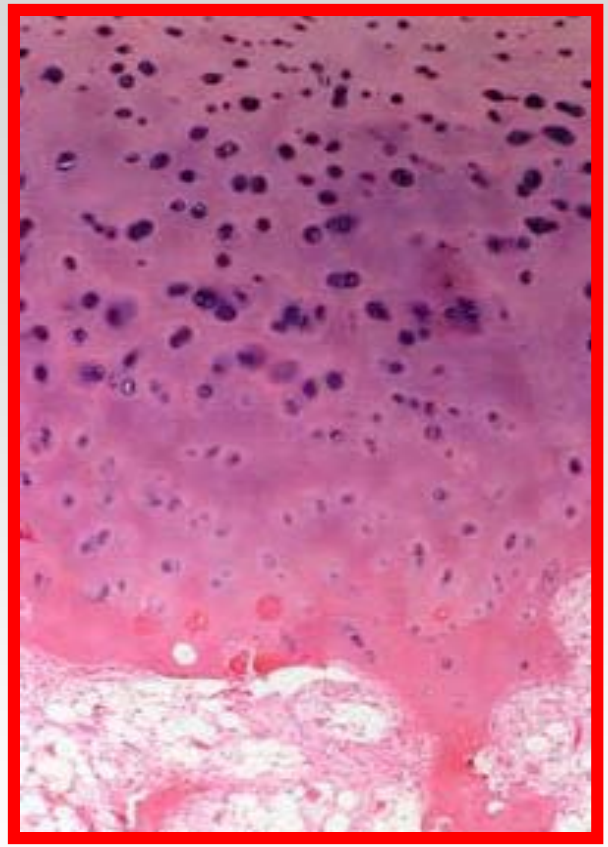


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

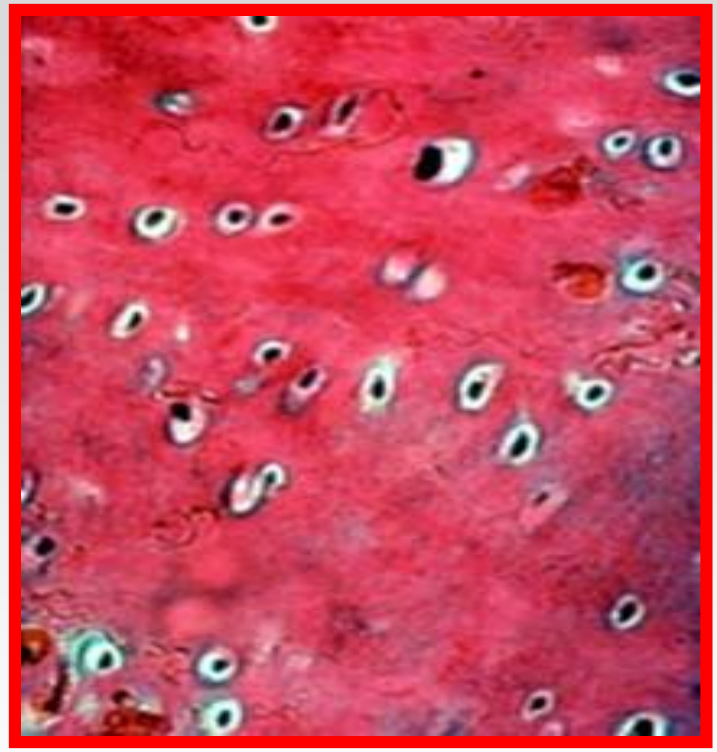
ARTICULAR CARTILAGE - COMPOSITION

- Hyaline Cartilage:
  - Resists ***compressive*** forces
  - The collagen structure gives the tissue its form, strength and durability
  - Type II Collagen
  - Primary function is load bearing
  - Withstands cyclic load and shearing forces
  - Articular cartilage is designed for long term performance



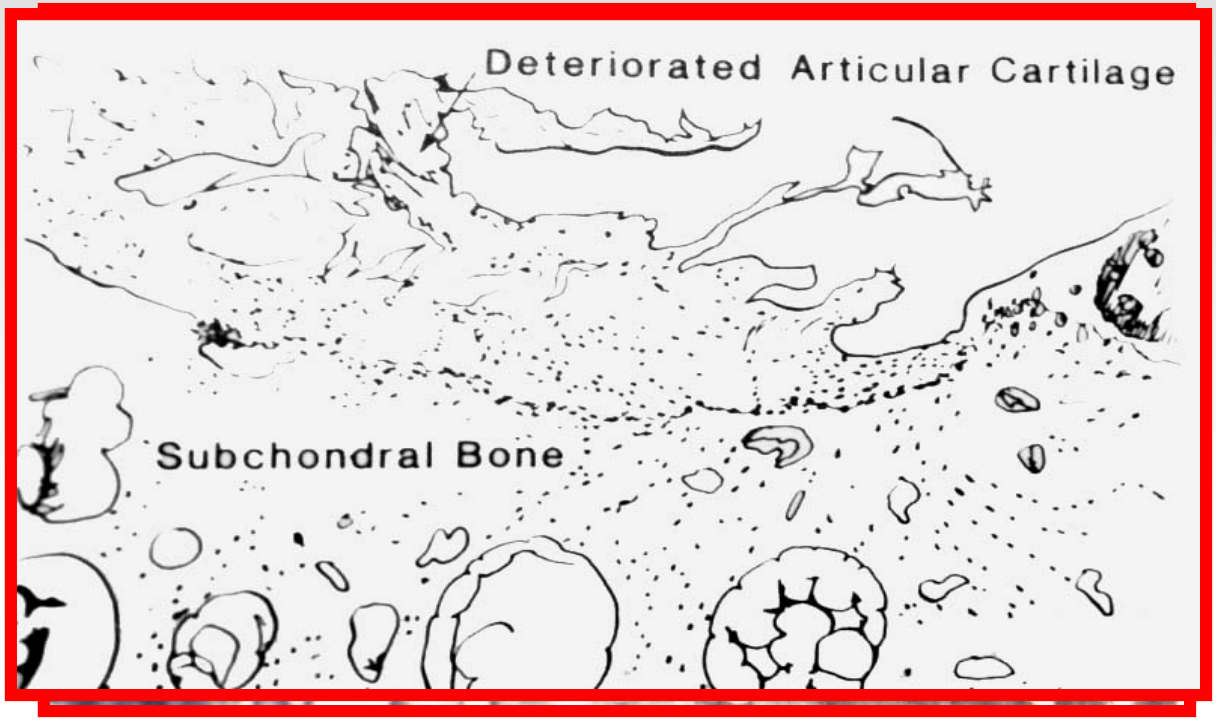
ARTICULAR CARTILAGE - COMPOSITION

- Fibrocartilage (repair cartilage):
  - Resists *tension* forces
  - Histological studies show unorganized cellular pattern
  - Not structured for efficient load bearing
  - Lower concentration of proteoglycans
  - Long-term performance is inferior to normal articular cartilage
  - No type II collagen



ARTICULAR CARTILAGE LESIONS

- Two Categories:
  - Partial thickness Defects
  - Full thickness Defects



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

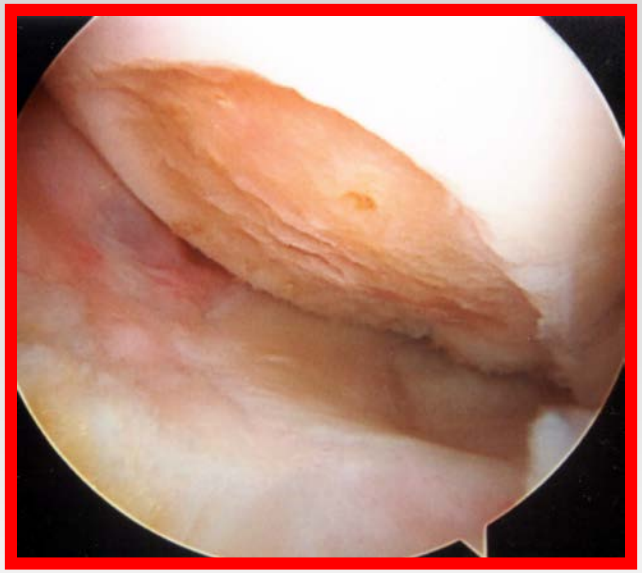
AVAILABLE SURGICAL OPTIONS

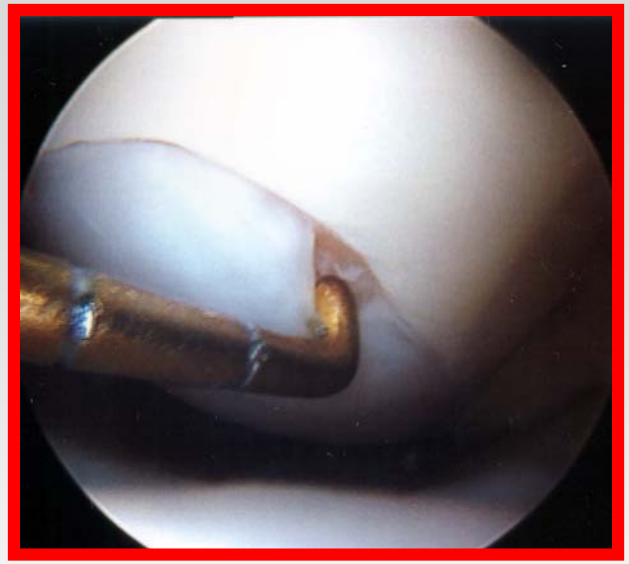
I. Debridement & Curettage
II. Drilling
III. Microfracture Technique
IV. Osteochondral Autograft Transplantation
V. Osteochondral Allograft Transplantation
VI. Autologous Chondrocyte Implantation
VII. Growth Factors
VIII. STEM cells

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

FULL-THICKNESS INJURY





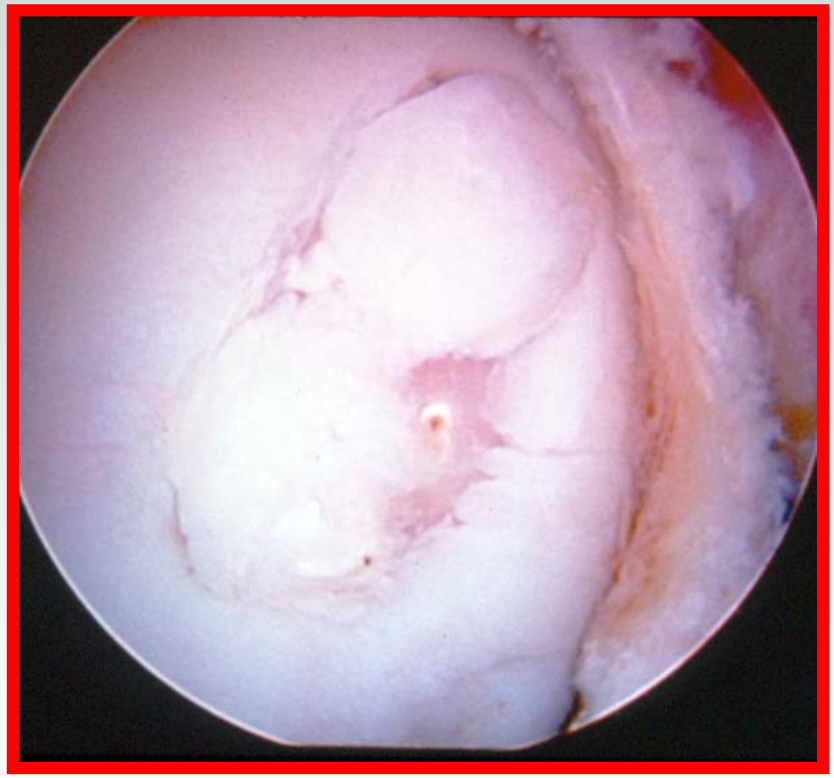
UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

AUTOLOGOUS OSTEOCHONDRAL TRANSPLANTATION *(MOSAICPLASTY)*

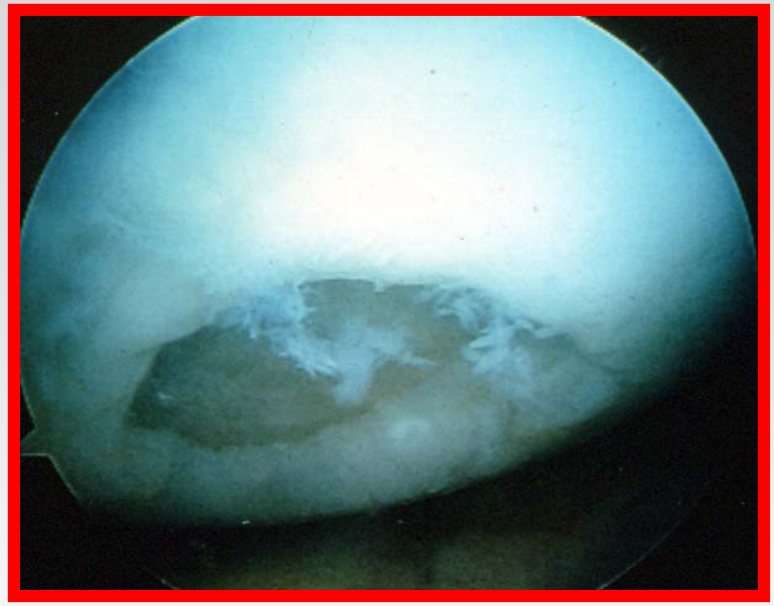
AUTOLOGOUS OSTEOCHONDRAL TRANSPLANTATION

- Mosaicplasty:
  - Osteochondral plugs transplanted from non-weight bearing articular cartilage to chondral defect in weight bearing area



OATS - MOSAICPLASTY

- The closer repair cartilage comes to restoring hyaline cartilage the more durable
- Limited surgical techniques
- Osteochondral autograft transplantation (OATS):
  - Restore height
  - Restore shape
  - Hyaline cartilage
  - Intact tidemark
  - Firm carrier – subchondral bone – nutrition
- OBI Plugs



OATS - MOSAICPLASTY

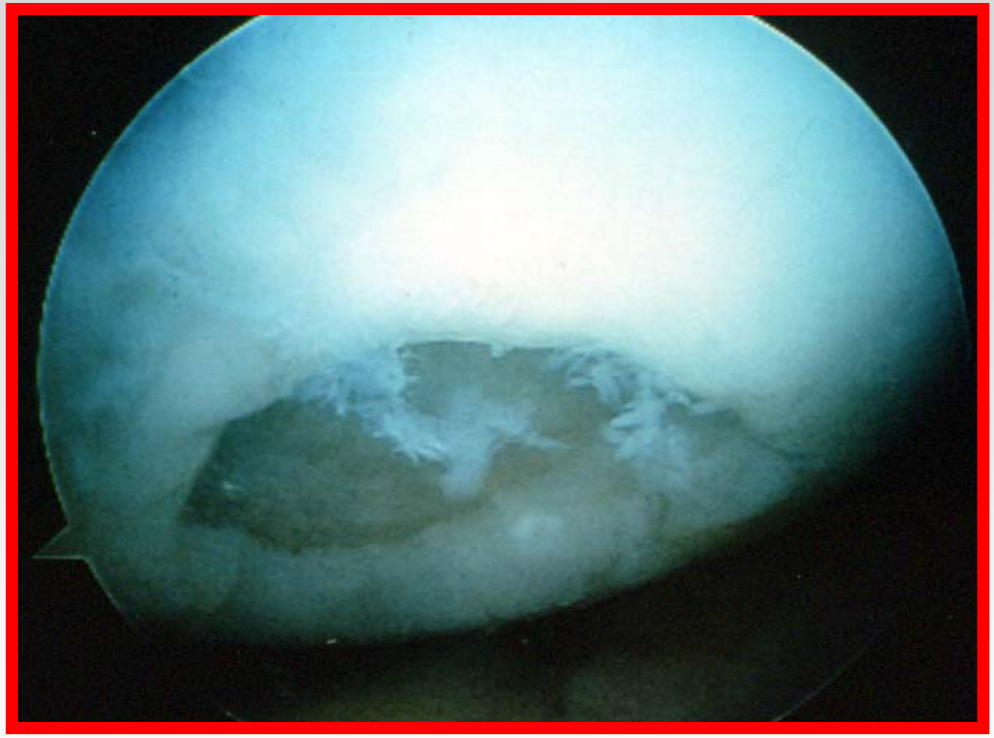
- No disease transmission
- Good chondrocyte survival
- Reliable bony union
- Limited donor size
- Graft size

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INDICATIONS FOR OATS

- Ideal Lesion:
  - Small (10-30mm)
  - Full thickness
  - Femoral condyle (medial or lateral)
  - Stable surrounding articular cartilage



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

INDICATIONS FOR OATS

- Why OATS???
  - Microfracture and abrasion easier
  - OATS:
    - Repair with autologous hyaline cartilage
    - Cell viability/survival
    - Restore height and shape of defect
    - Long term survival (tidemark)

30 months s/p OATS

INDICATIONS FOR OATS

- Contra-indications:
  - Deep, crater like defect
  - Loss of subchondral bone
  - Difficult to cover large defect
  - No appropriate harvest sites
  - Severe Malalignment

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OATS - SURGICAL TECHNIQUE

UCHealth
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OATS SURGICAL TECHNIQUE

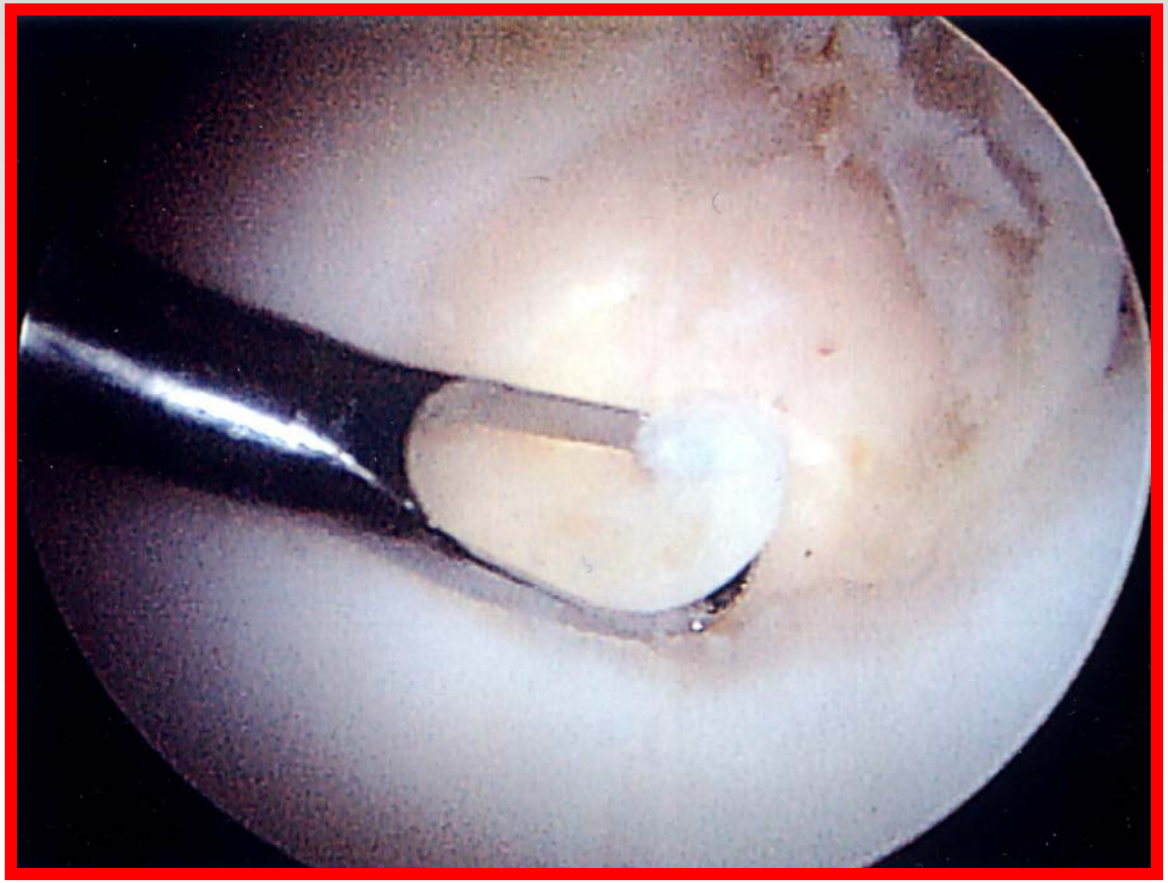
- Step 2: Chondral defect sizing

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OATS SURGICAL TECHNIQUE

- Step 3: Recipient defect preparation

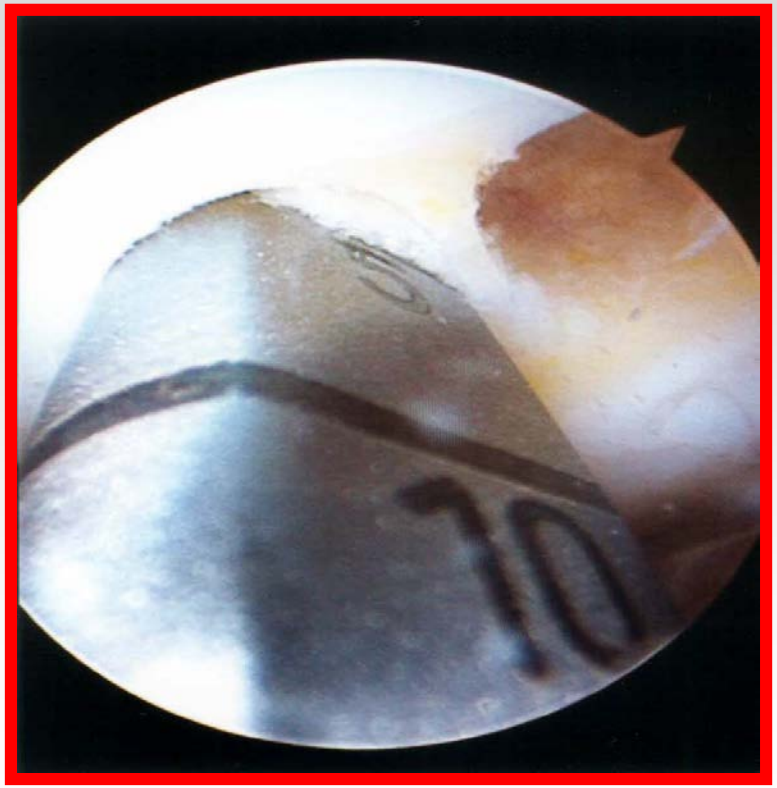


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OATS SURGICAL TECHNIQUE

- Step 3: Recipient Defect Preparation

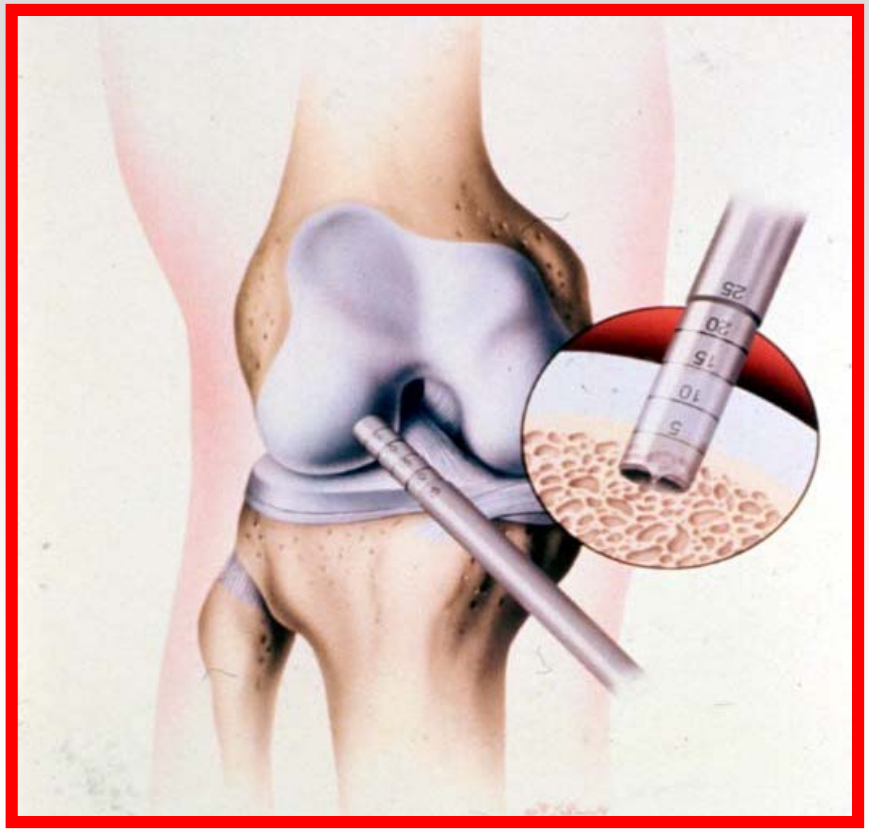


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

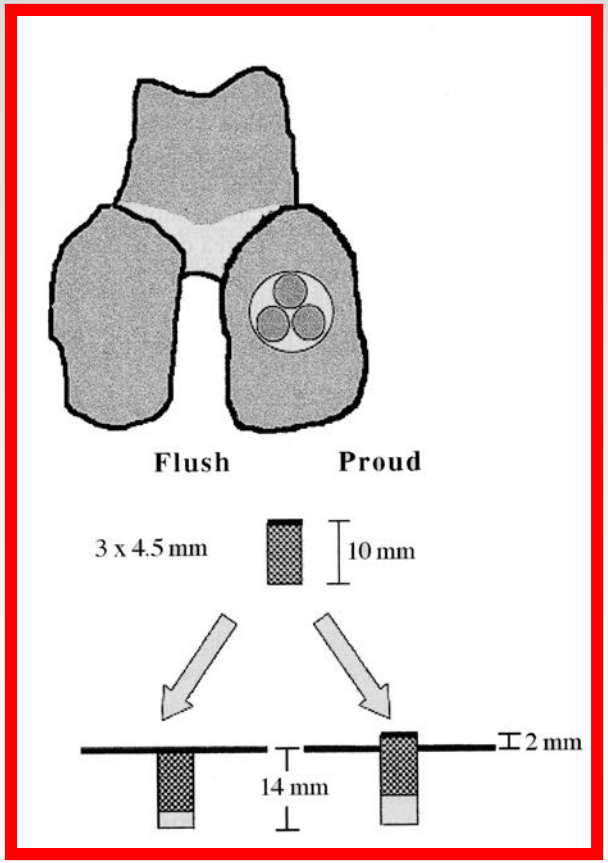
OATS SURGICAL TECHNIQUE

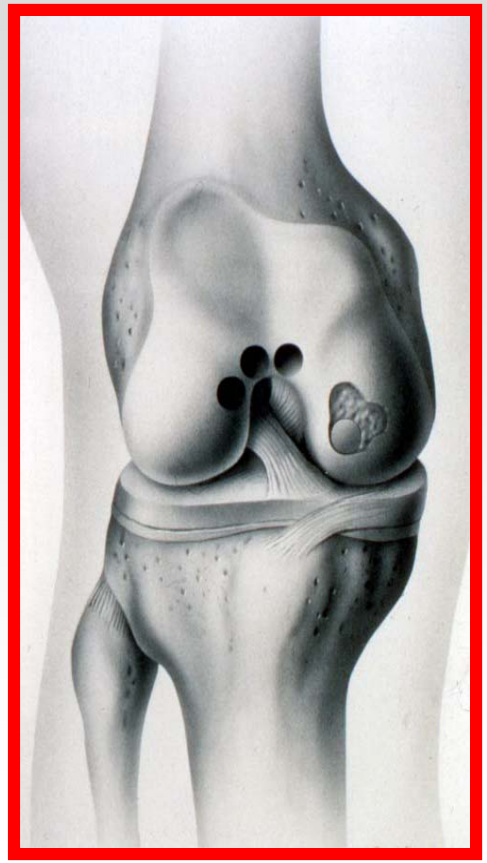
- Step 4: Determine depth of recipient defect



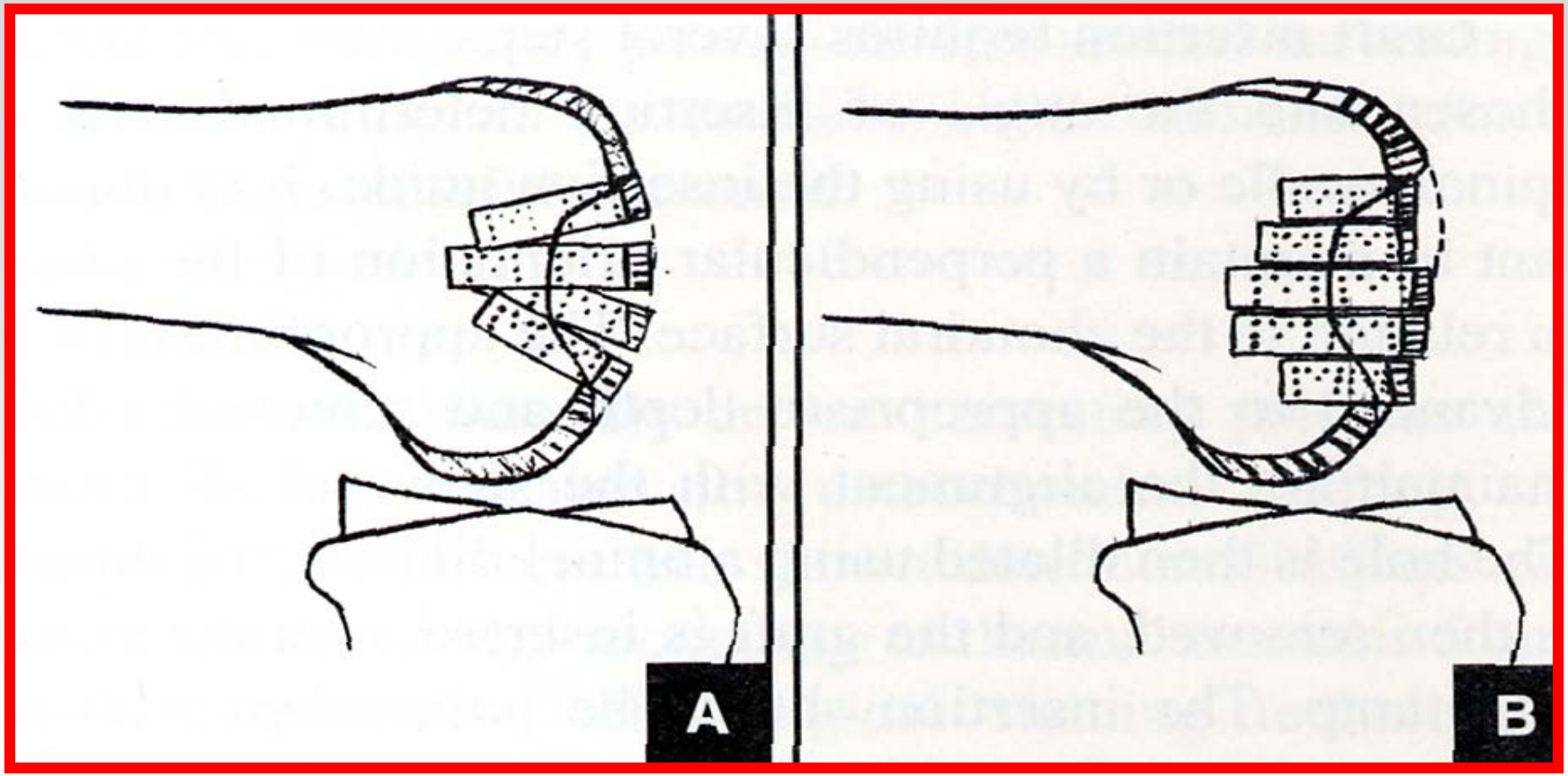
OATS SURGICAL TECHNIQUE

- Step 7: Final donor core seating





OATS – Plug placement



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OATS SURGICAL VIDEO

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

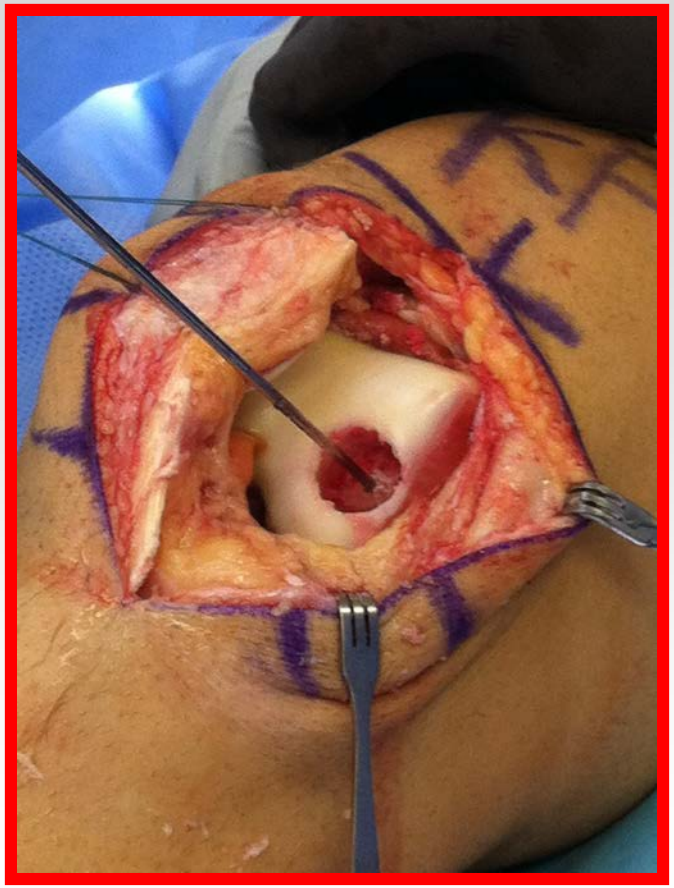
OATS SUMMARY

- Mosaicplasty appears to be a viable alternative for full-thickness cartilage defects
- Regeneration of hyaline or hyaline-like cartilage
- Longevity???

OSTEOCHONDRAL ALLOGRAFTS

INTRODUCTION

- First used in 1908 by Lexer
  - He reported a 50% success rate
- In the 1940s and 1950s they were thought to be a biologic alternative to the total joint replacement
- In the 1970s fresh osteochondral allografts were used for limb salvage after large tumor resections
- Today they are used more widely due to increased availability

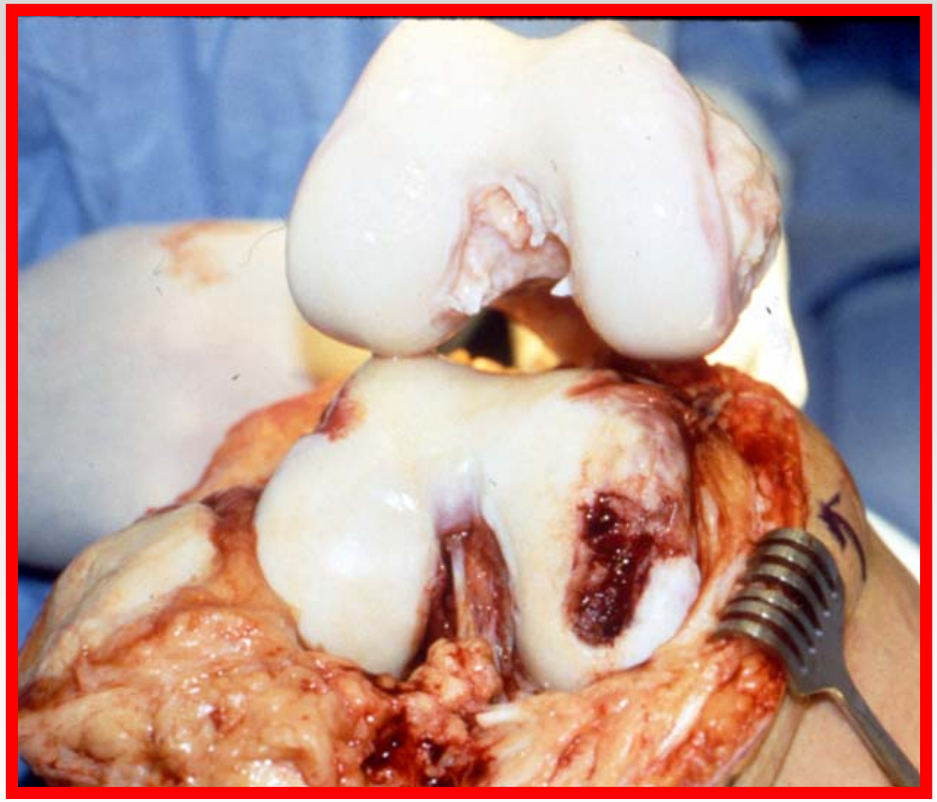


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Used for Large focal osteo-articular defects and bone loss
- Mature hyaline cartilage and bone
- Success = cell viability
- Fresh, Fresh frozen or cryopreserved

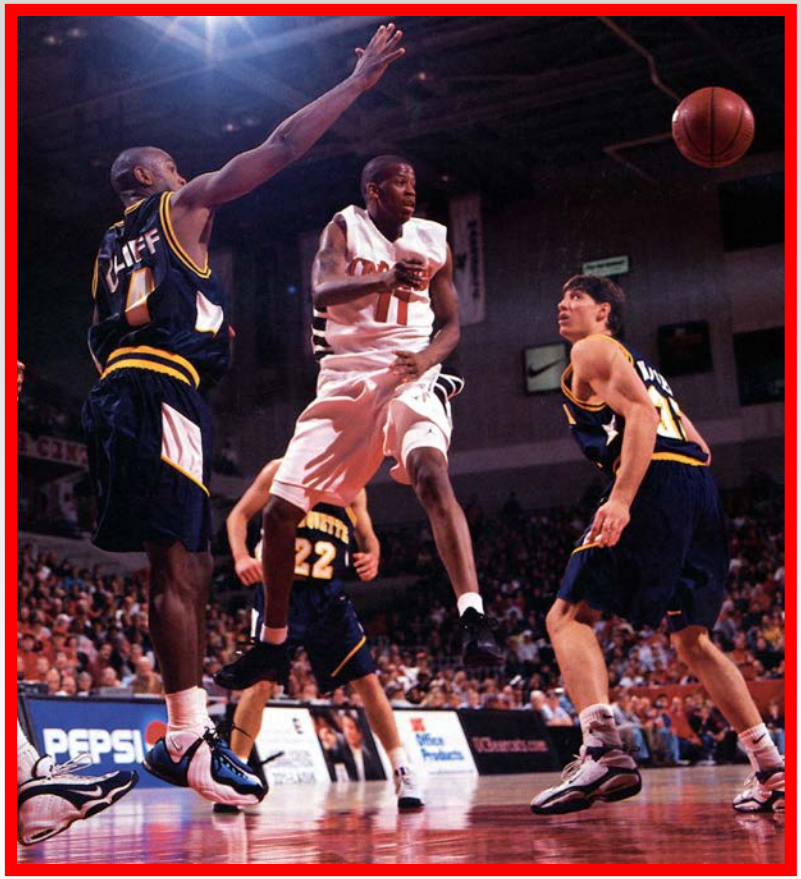


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Immunology:
  - Studied extensively
  - Intact hyaline cartilage
  - Immunologically privileged
  - No donor match

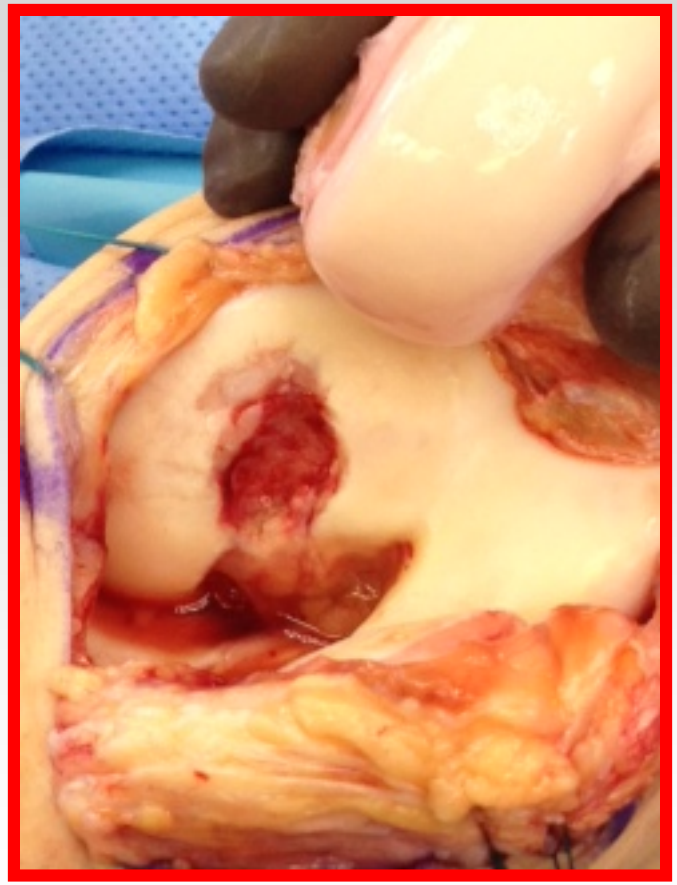


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Cell Viability
  - Fresh
    - Changing storage medium every 2-3 days increases viability
    - Viability decreases as days progress
      - Day 1- 100%
      - Day 15-29 – 80%,
      - Day 60- 50%
  - Fresh Frozen (10-15%)
  - Cryopreserved (35-40%)
    - Use of cryoprotective agents increases chondrocyte viability compared to fresh frozen grafts



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Incorporation
  - Allograft bone is replaced by Host bone in 2-3 years
  - Creeping substitution
  - Gross et al reported 85% success rate in 126 knees with fresh allografts

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Immunology
  - Chondrocytes are immuno-privelaged
  - Humoral antibodies cannot penetrate into the matrix
  - Rejection is insignificant
  - Tissue typing and immunosuppressants are unnecessary
  - Possibility of immune response to allograft cells and marrow

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Considerations:
  - Size of defect
  - Availability of size-matched quality donor
  - Extremity alignment
  - Monopolar vs bipolar defects
  - Ligamentous stability
  - Meniscal injury

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

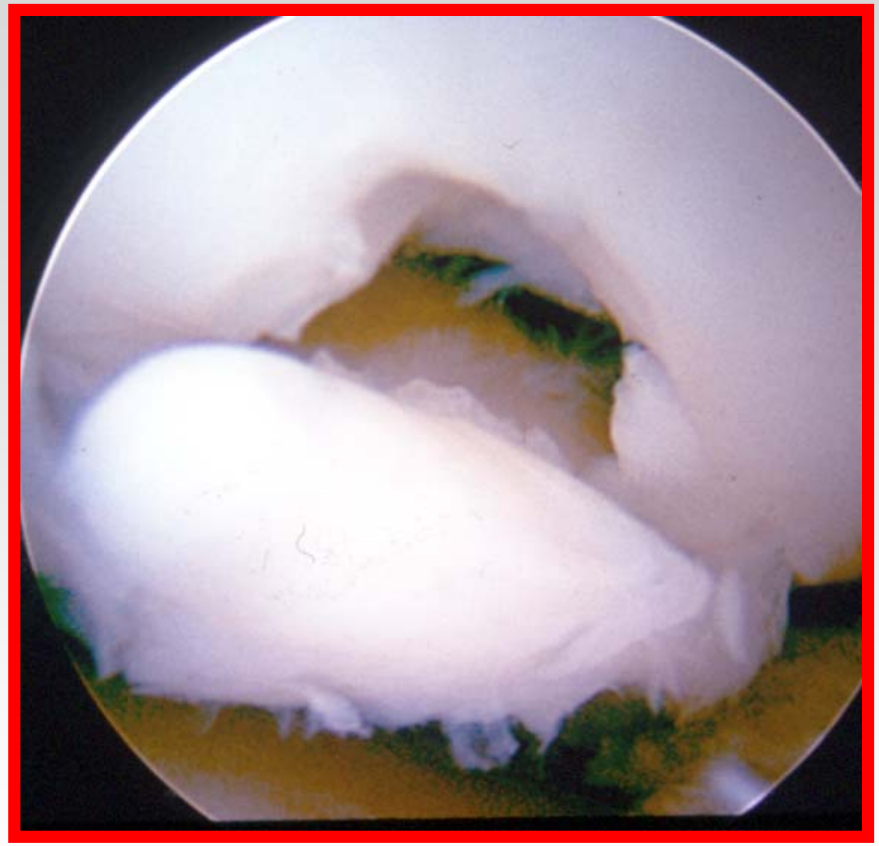
- Indications:
  - Large, deep, extensive osteochonrdal lesions
  - Bone loss
  - Skeletal maturity
  - No arthritic changes
  - <50 years old
  - Correctable alignment and ligamentous laxity

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Optimal Outcomes:
  - Single defect
  - >2cm
  - 1 compartment
  - No angular deformity



OSTEOCHONDRAL ALLOGRAFTS

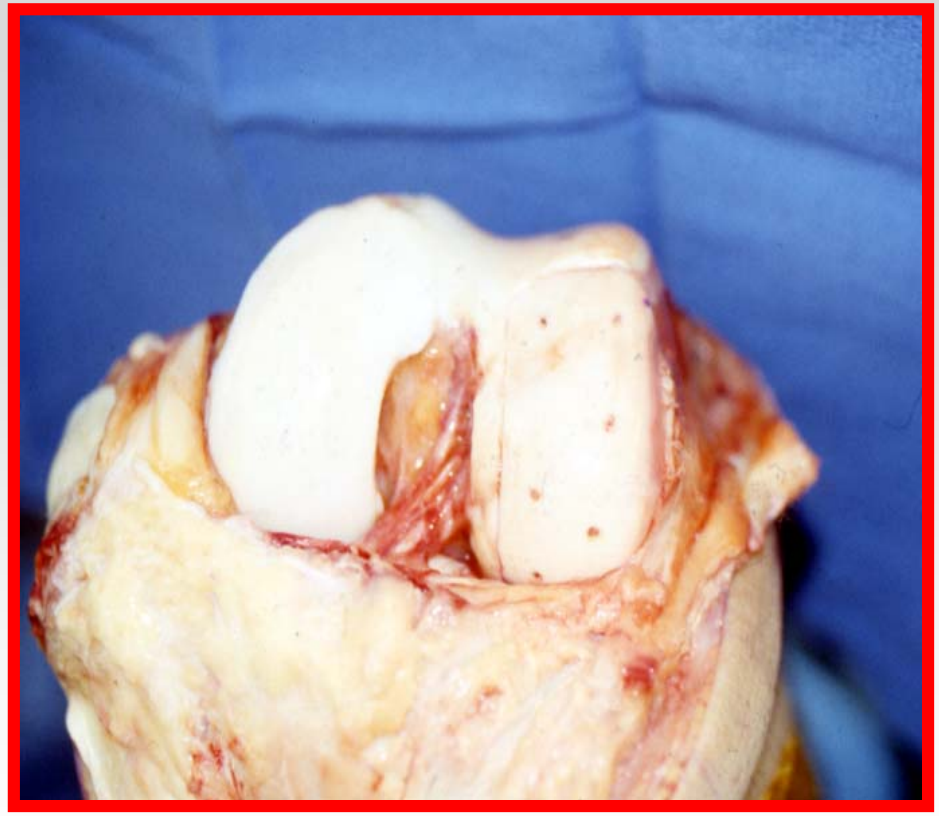
- Contraindications:
  - Inflammatory arthropathy
  - Uncorrected ligamentous instability
  - Uncorrected malalignment
  - Diffuse arthrosis
  - AVN

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

- Grafts work best in post-traumatic changes and osteochondritis dissecans
- Age and size match



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFTS

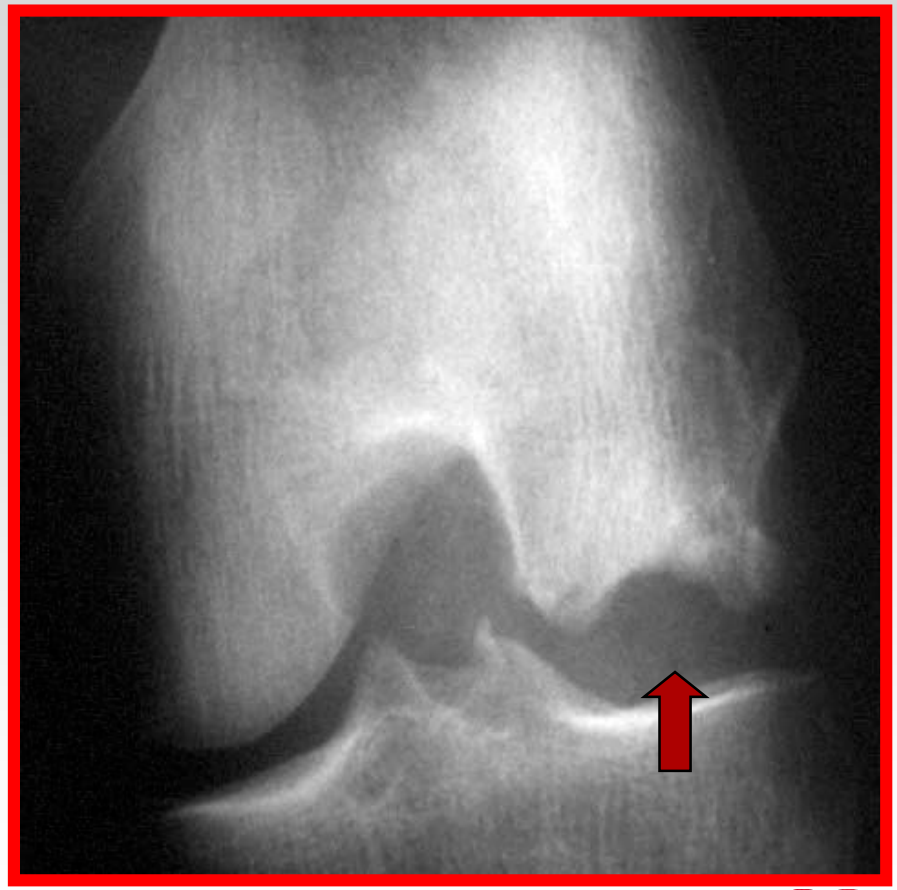
- Advantages:
  - Readily available
  - Lack of donor site morbidity

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

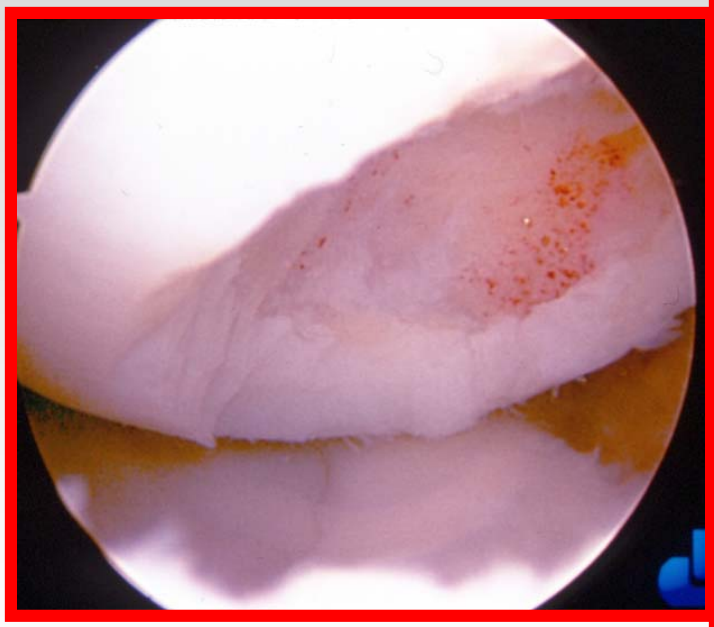
OSTEOCHONDRAL ALLOGRAFTS

- Disadvantages:
  - Disease transmission
  - Donor procurement expense
  - Chondrocyte survival
  - Open procedure



OSTEOCHONDRAL ALLOGRAFT KS CASE

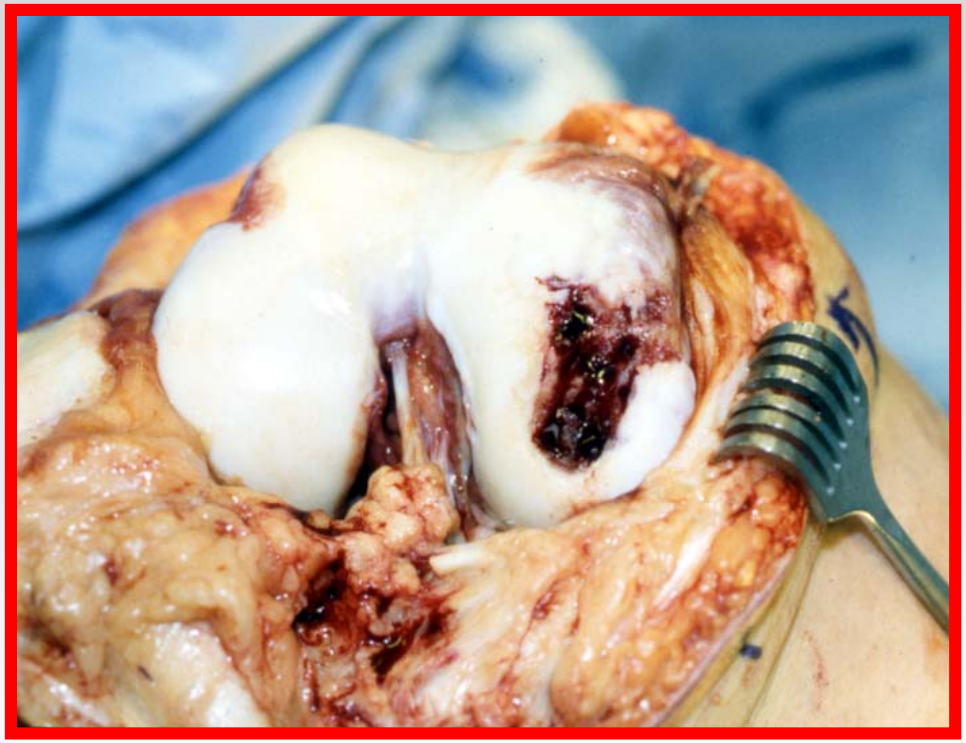
- Pre-operative findings

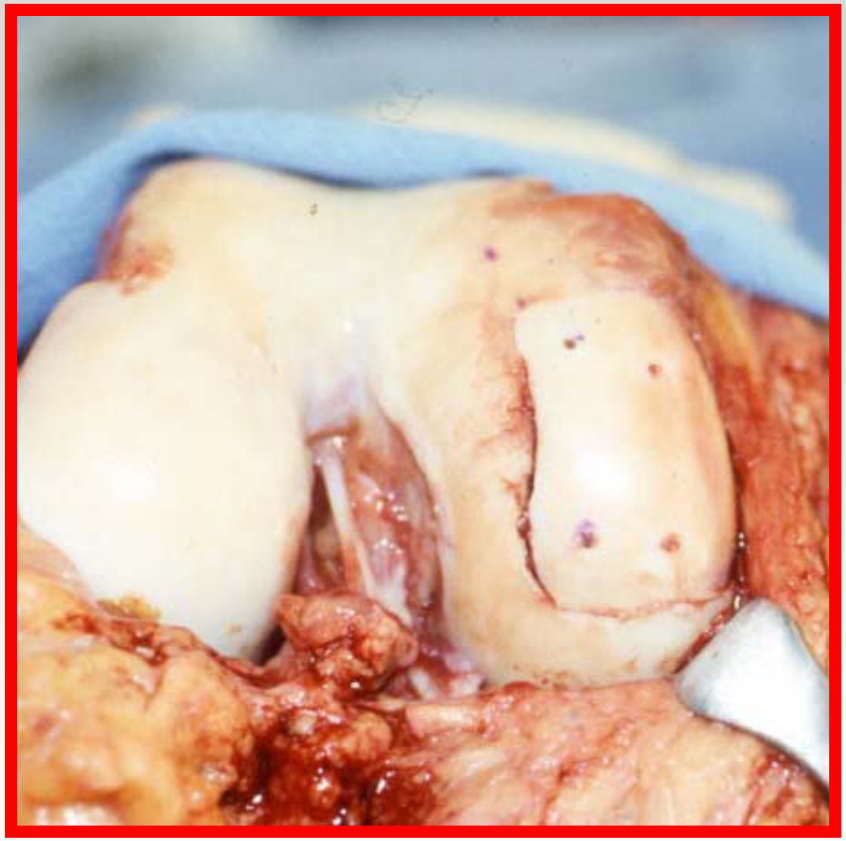


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFT KS CASE





UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFT KS CASE

- Follow-up at 6 weeks

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFT KS CASE

- Follow-up at 1 year

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

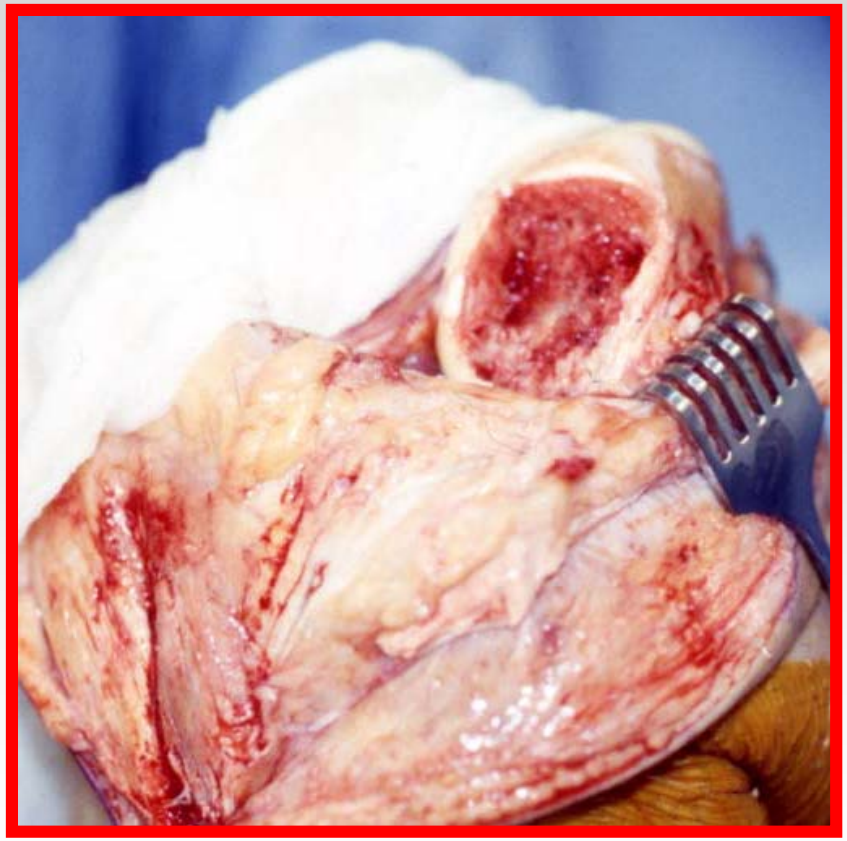
OSTEOCHONDRAL ALLOGRAFT MH CASE

- Pre-operative radiographs

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

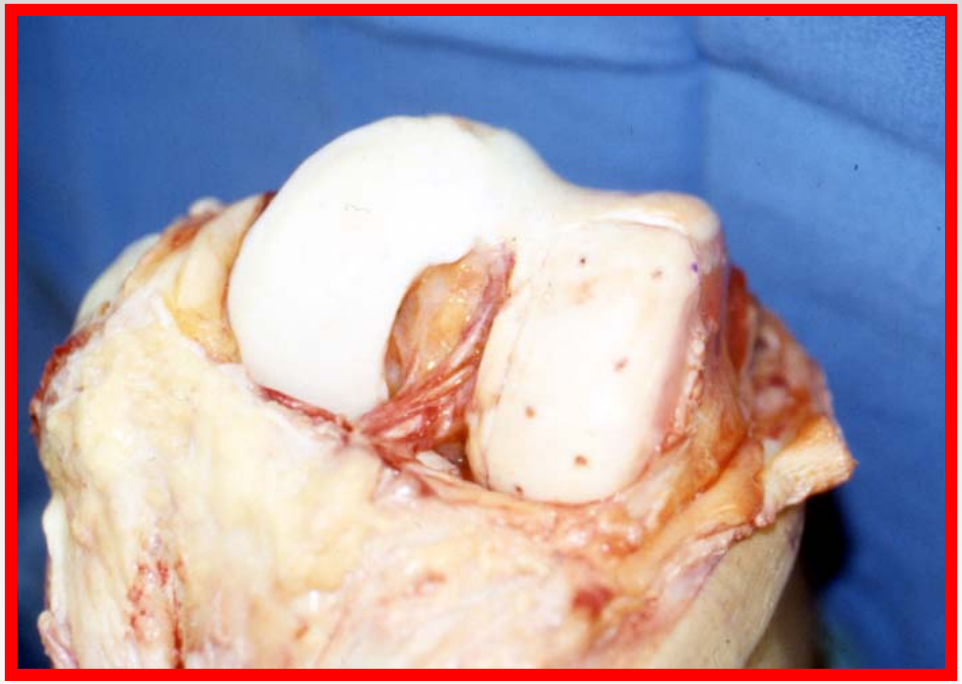
OSTEOCHONDRAL ALLOGRAFT MH CASE

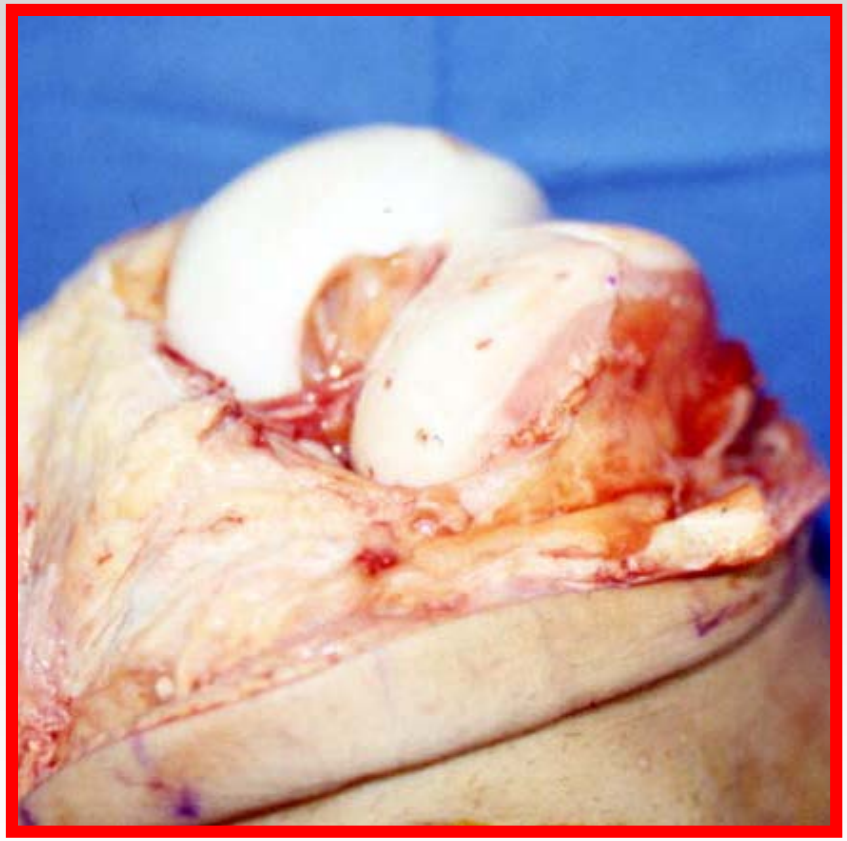


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

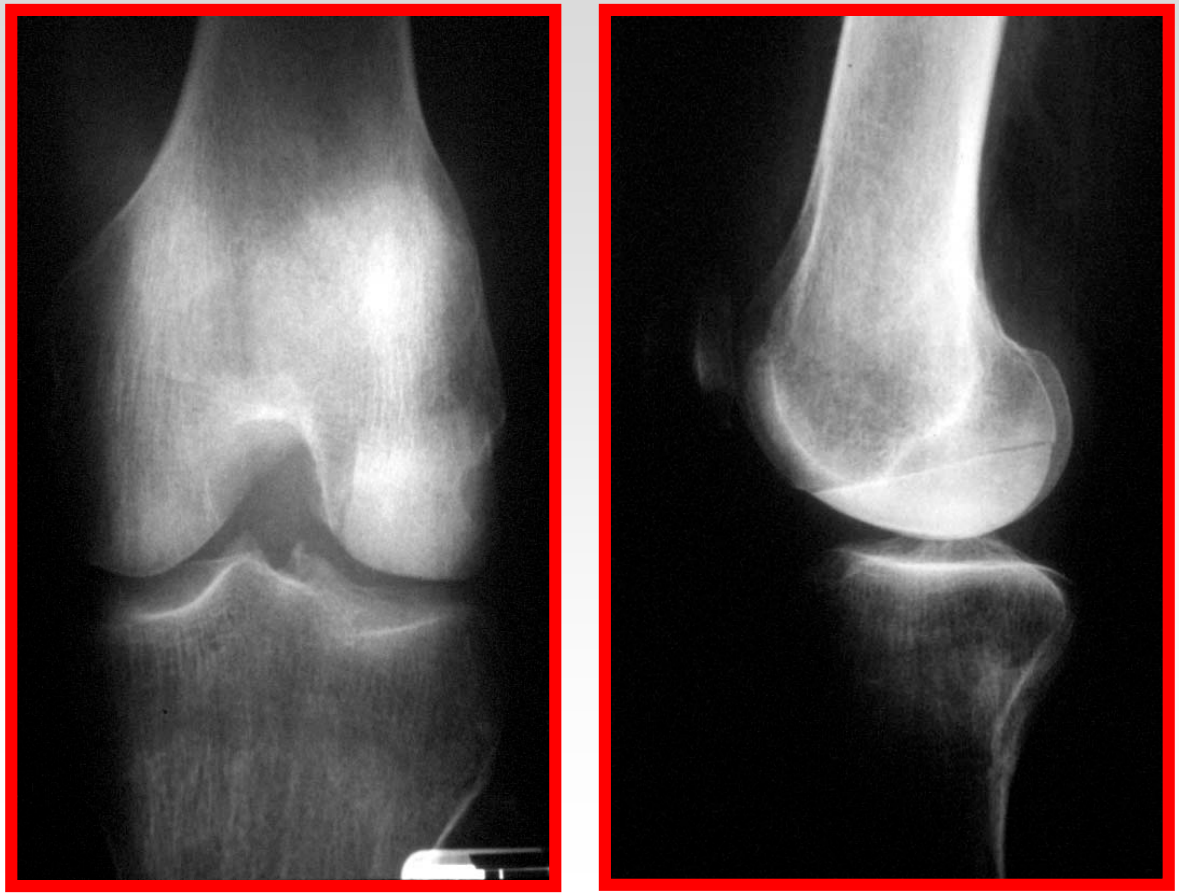
OSTEOCHONDRAL ALLOGRAFT MH CASE





OSTEOCHONDRAL ALLOGRAFT MH CASE

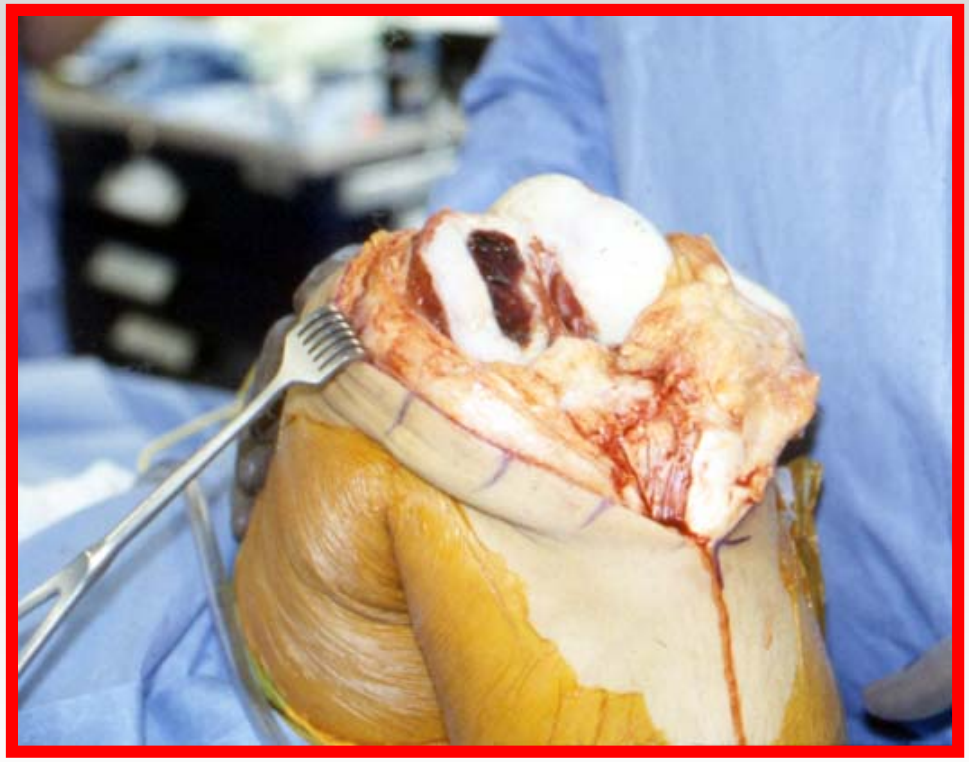
- Follow-up 1 year



UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

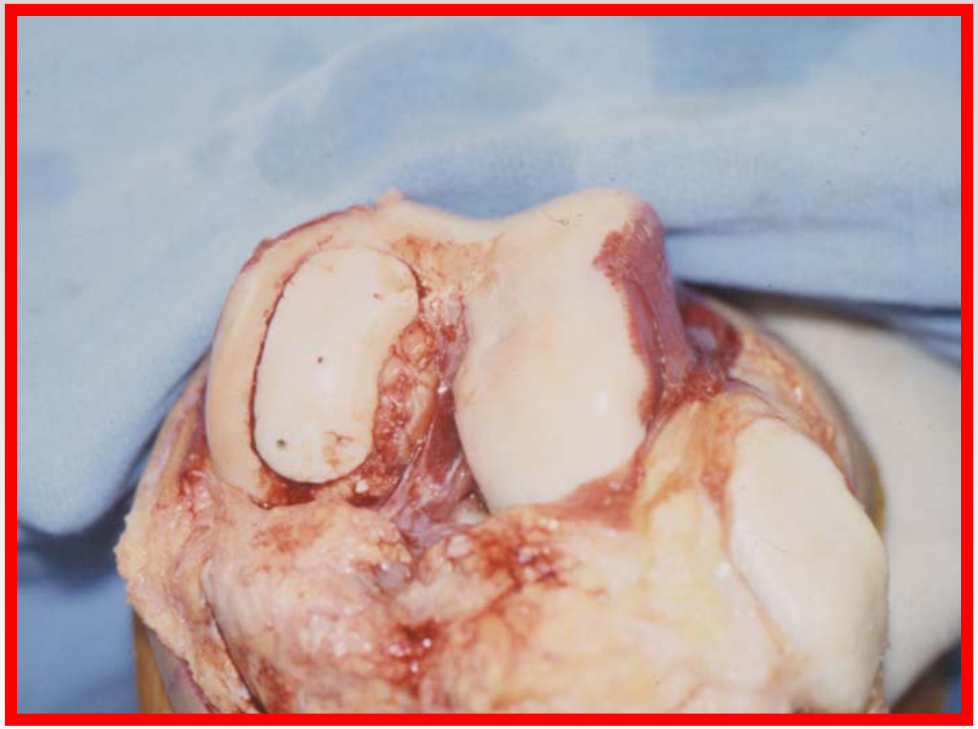
OSTEOCHONDRAL ALLOGRAFT NH CASE

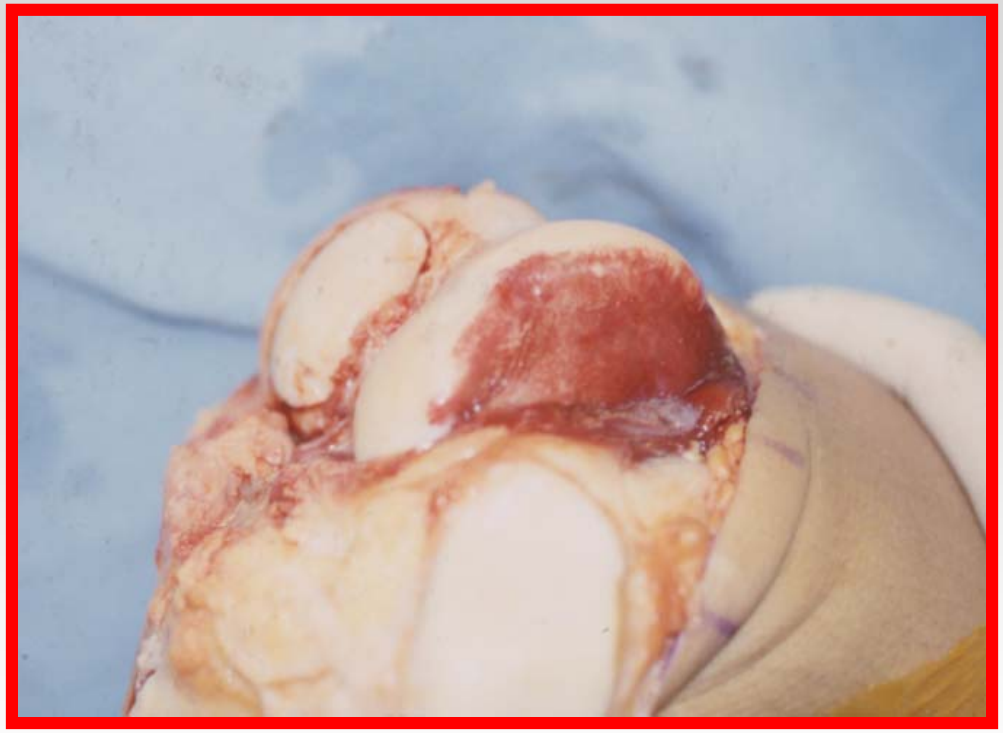


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFT NH CASE





UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

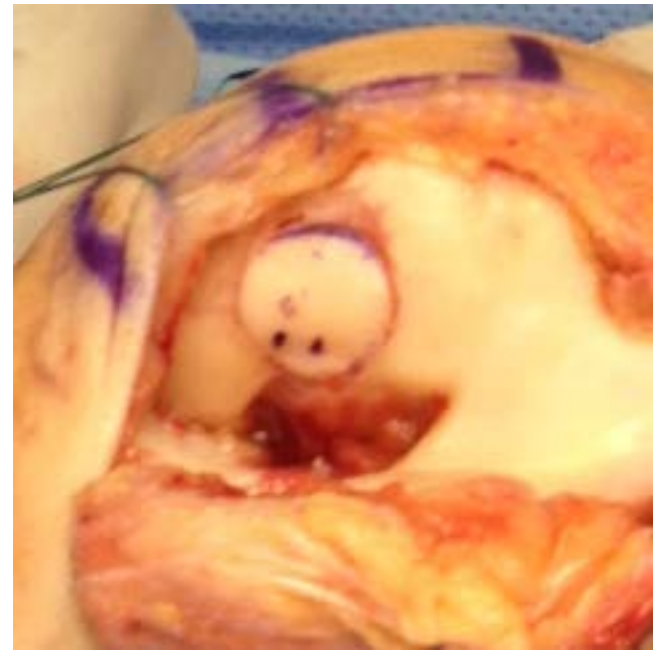
UNIVERSITY OF Cincinnati

OSTEOCHONDRAL ALLOGRAFT NH CASE

- Follow-up at 2 months post-operatively for an osteochondral allograft of the LFC

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

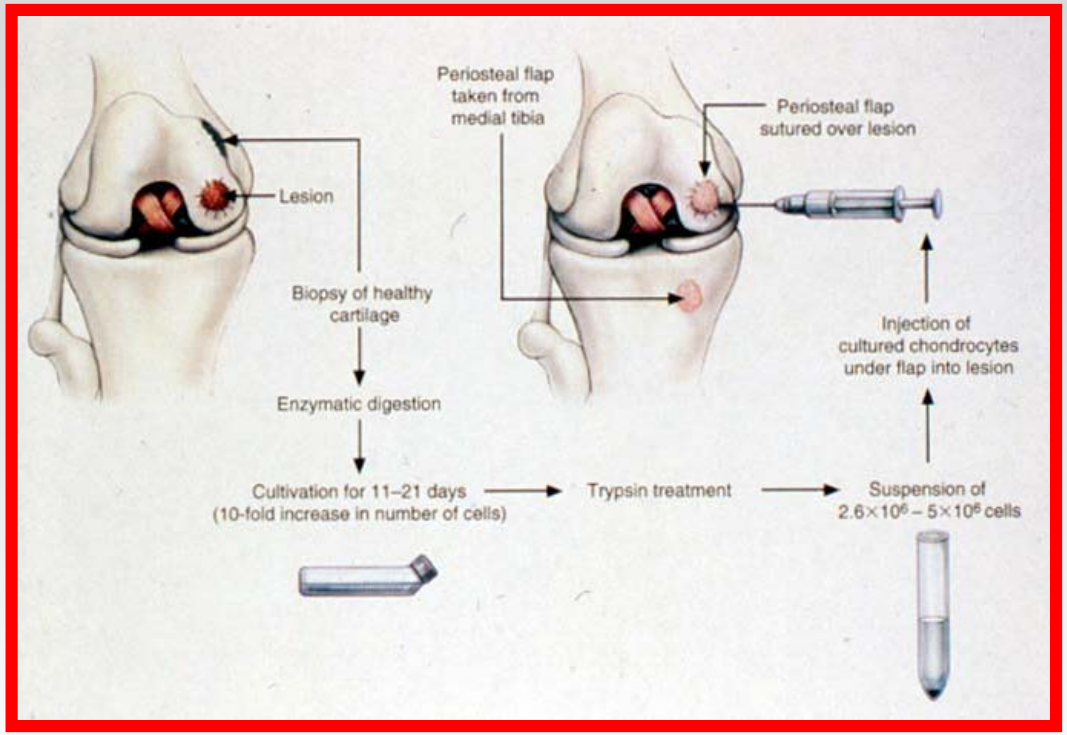


OSTEOCHONDRAL ALLOGRAFT KF CASE

AUTOLOGOUS CHONDROCYTE IMPLANTATION

AUTOLOGOUS CHONDROCYTE IMPLANTATION

- Introduced:
  - Sweden (1987)
  - US (1995)
- Two stage procedure
- Open procedure
- Laboratory dependant
- MACI Patch
  - FDA December 2016

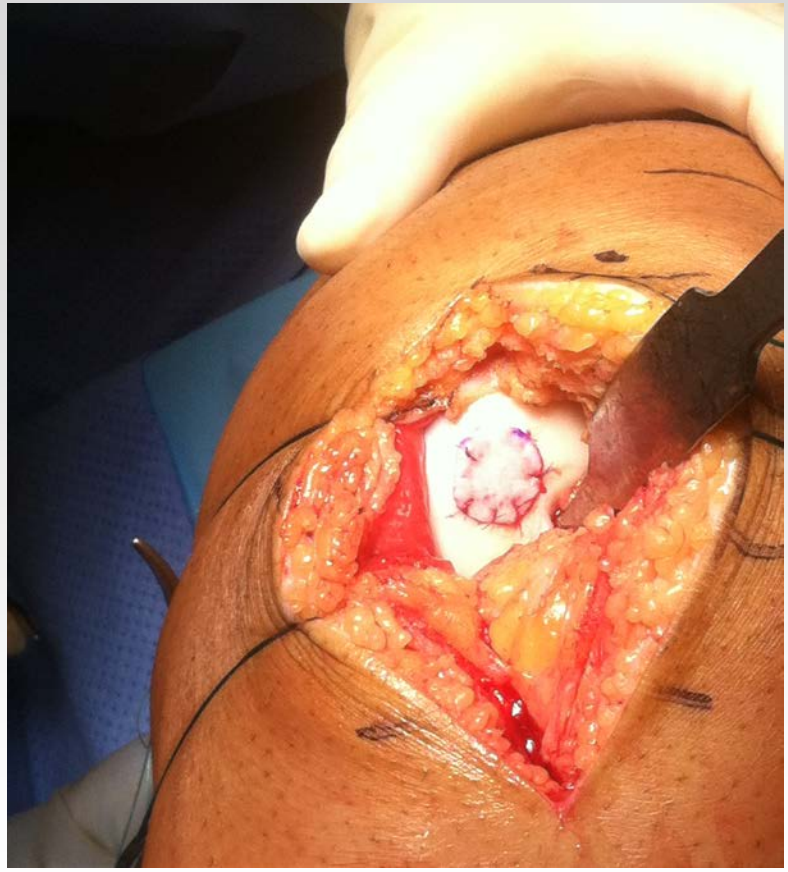


UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

AUTOLOGOUS CHONDROCYTE IMPLANTATION

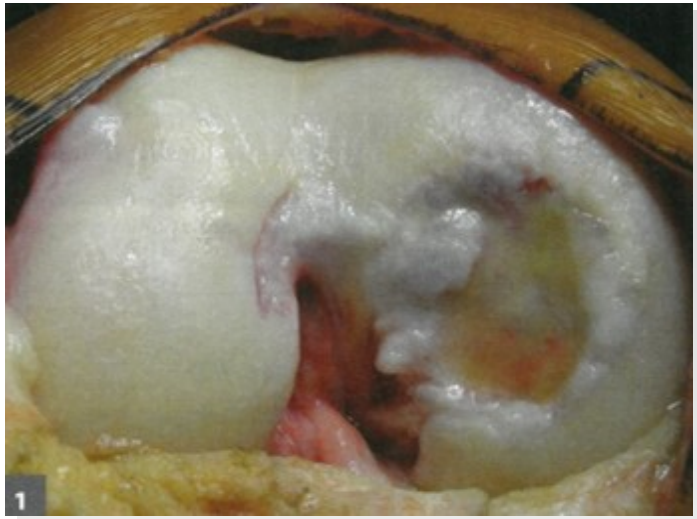
- Indications:
  - Lesions 1- 10 cm
  - Age < 50-55
  - Only femoral lesions are FDA approved
  - Osteochondritis dissecans
  - Concomitant correction of instability or malalignment

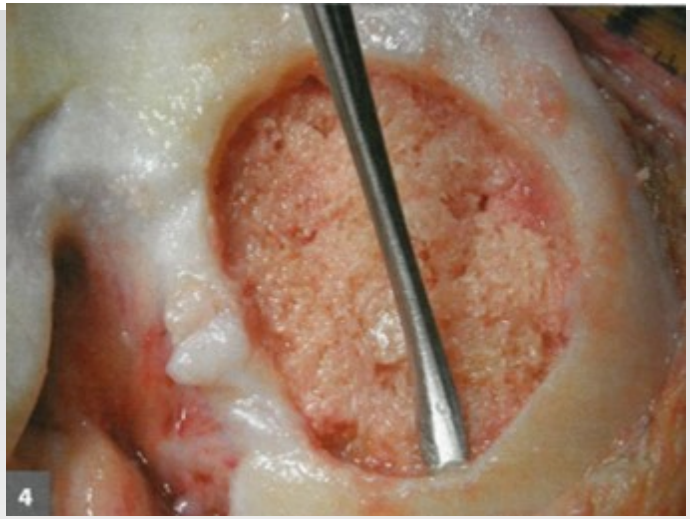


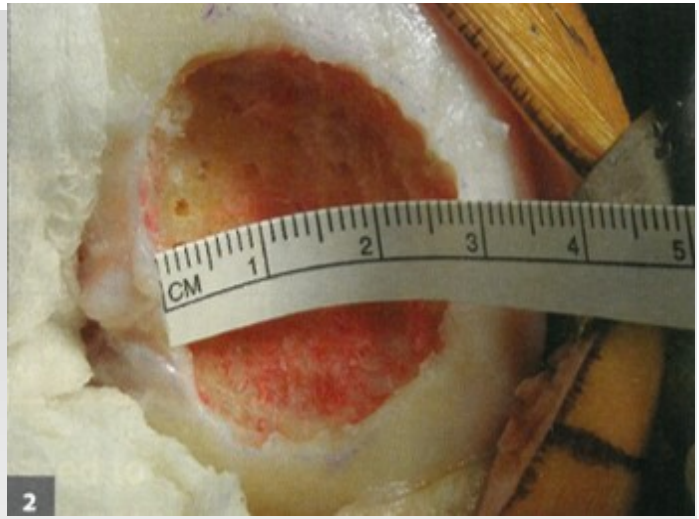
UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

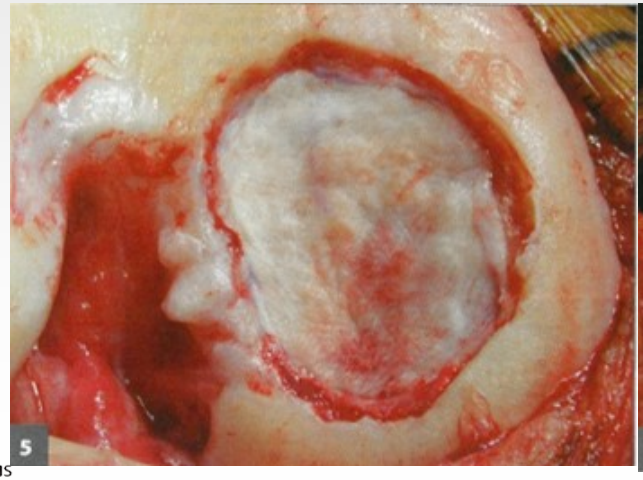
UNIVERSITY OF Cincinnati

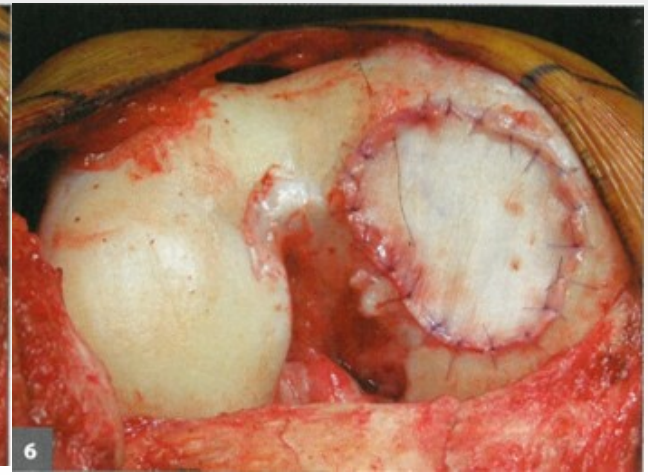
ACI – SANDWICH TECHNIQUE











UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

MACI PATCH

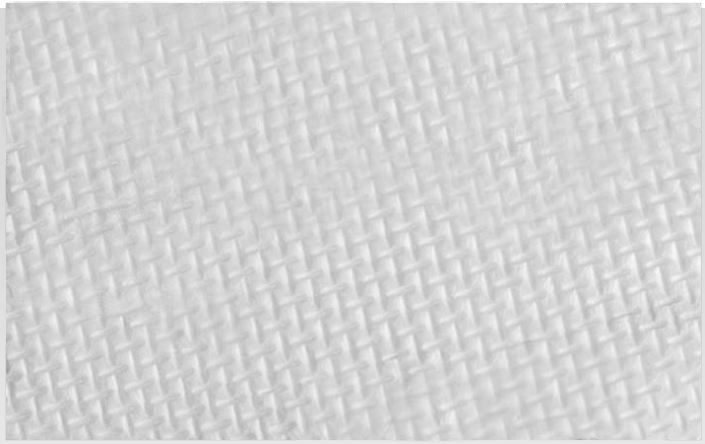
- Approved by FDA December 2016
  - Currently only for knees
- Cellular sheet 3 cm x 5 cm
- ACI cells on a resorbable porcine collagen membrane
  - Type I/III collagen
  - At least 500,000 cells/cm^2

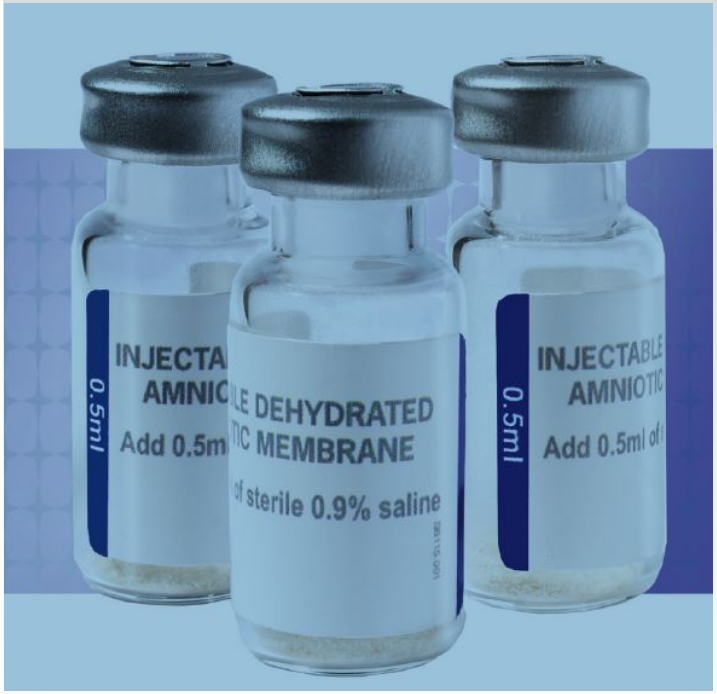
- Clinical Outcomes
  - SUMMIT Trial
  - 144 patients (18-54)
  - MACI vs MFX
  - 137 pts with FU @ 2years
  - KOOS scales
  - MACI was clinically and statistically better for treating symptomatic cartilage defects than MFX

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

DEHYDRATED HUMAN AMNIOTIC/CHORIONIC MEMBRANE





UNIVERSITY OF Cincinnati

FUTURE CONSIDERATIONS

- Growth Factors
  - Insulin-Like Growth Factor-1(ILGF-1)
  - Fibroblast Growth Factor (FGF)
  - Transforming Growth Factor-beta (TGF-beta)
  - Hepatocyte Growth Factor (HGF)
  - Platelet-Derived Growth Factor (PDGF)
  - Bone Morphogenetic Proteins (BMP)
  - Interleukin-1 Receptor Antagonist (ILRA)

ARTICULAR CARTILAGE KEY POINTS

- Hyaline cartilage lasts longer than fibrocartilage
- Hyaline cartilage restores the normal function and durability of the joint
- Hyaline cartilage is better able to redistribute joint stress

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

ARTICULAR CARTILAGE KEY POINTS

- Fibrocartilage will fill the defect and promote relief of symptoms up to a given point in time
- Fibrocartilage lacks the composition, structure and durability of normal hyaline cartilage

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

SUMMARY

- Challenging problem
- Traditional treatment allows for only temporary relief
- New attempts at regeneration not reliable
- Studies must be > 6 mo. F/U

UC Health
UNIVERSITY OF CINCINNATI PHYSICIANS

UNIVERSITY OF Cincinnati

THANK YOU!