

OSTEOCHONDRAL ALLOGRAFT RECONSTRUCTION FOR MASSIVE BONE DEFECT



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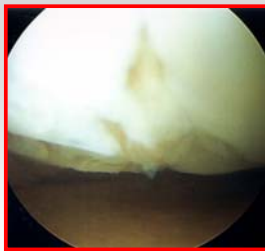
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- Associate Professor of UC College of Medicine
- Medical Director Holmes Sports Medicine



INTRODUCTION

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

Hunter, 1743



INTRODUCTION

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



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.



INTRODUCTION

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

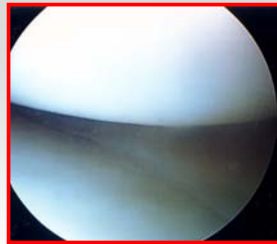


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INTRODUCTION

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

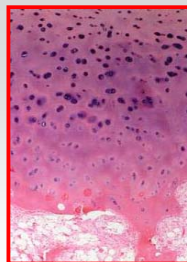


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ARTICULAR CARTILAGE - COMPOSITION

- 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

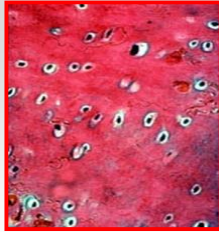


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ARTICULAR CARTILAGE - COMPOSITION

- 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**

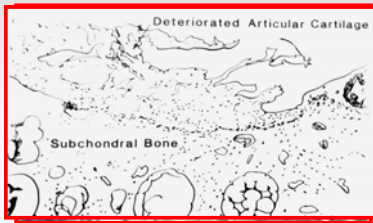


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ARTICULAR CARTILAGE LESIONS

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



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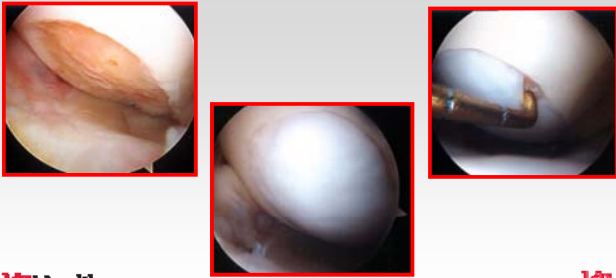
AVAILABLE SURGICAL OPTIONS

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

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FULL-THICKNESS INJURY



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AUTOLOGOUS OSTEOCHONDRAL TRANSPLANTATION (MOSAICPLASTY)



AUTOLOGOUS OSTEOCHONDRAL TRANSPLANTATION

- Mosaicplasty:
 - Osteochondral plugs transplanted from non-weight bearing articular cartilage to chondral defect in weight bearing area
 - Smaller lesions <3 cm
 - Minimal bone loss



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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
- Presized osteochondral allografts
 - OBI TruFit Plugs
 - Chondrofix Plugs

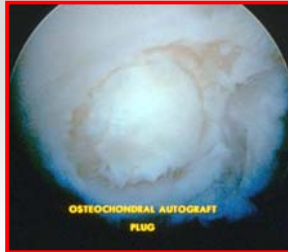


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OATS - MOSAICPLASTY

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

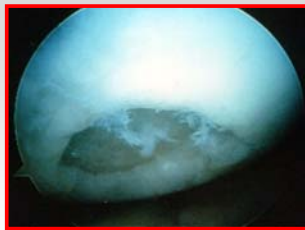


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INDICATIONS FOR OATS

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



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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)



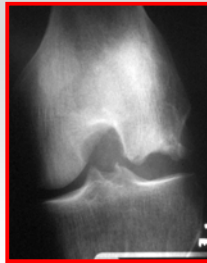
30 months s/p OATS



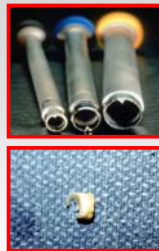
INDICATIONS FOR OATS

■ Contra-indications:

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

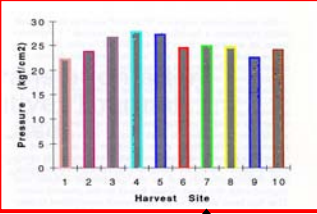
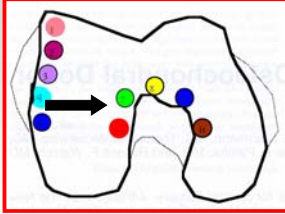


OATS - SURGICAL TECHNIQUE



OATS SURGICAL TECHNIQUE

■ Selection of donor site



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OATS SURGICAL TECHNIQUE

■ Donor core insertion

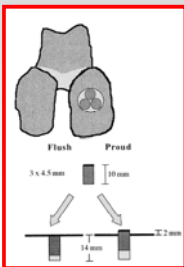


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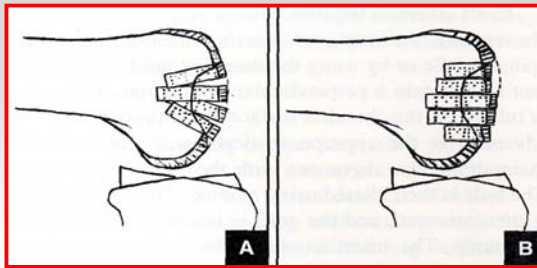
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OATS SURGICAL TECHNIQUE

■ Final donor core seating



OATS – Plug placement



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OATS SURGICAL VIDEO



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OATS SUMMARY

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



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OATS STUDY

Arthroscopic mosaicplasty: Long-term outcome and joint degeneration progression

- 26 patients
- Mean age 29
- Mean BMI 23
- Treated with arthroscopic mosaicplasty of the femoral condyle
- 12 year follow up
- Significant improvement in all scores at 12 years
- Better results in patients with higher pre-injury activity levels and those requiring fewer plugs
- Increased Kellgren-Lawrence scores and reduction of joint space with more plugs but did not affect the clinical outcomes



Filardo et al Elsevier The Knee 22 (2015) 36-40



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



OSTEOCHONDRAL ALLOGRAFTS

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



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OSTEOCHONDRAL ALLOGRAFTS

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



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OSTEOCHONDRAL ALLOGRAFTS

- Cell Viability
 - Fresh (99%)
 - Fresh Frozen (10-15%)
 - Cryopreserved (35-40%)
 - Use of cryoprotective agents increases chondrocyte viability compared to fresh frozen grafts
 - Cell viability decreases over time



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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



OSTEOCHONDRAL ALLOGRAFTS

■ Immunology

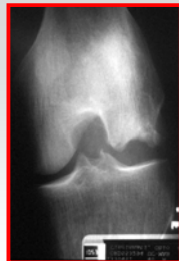
- Chondrocytes are immunoprivileged
- Humoral antibodies cannot penetrate into the matrix
- Rejection is insignificant
- Tissue typing and immunosuppressants are unnecessary
- Possibility of immune response to allograft cells and marrow



OSTEOCHONDRAL ALLOGRAFTS

■ Considerations:

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



OSTEOCHONDRAL ALLOGRAFTS

Indications:

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



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OSTEOCHONDRAL ALLOGRAFTS

Optimal Outcomes:

- Single defect
- >2cm
- 1 compartment
- No angular deformity



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OSTEOCHONDRAL ALLOGRAFTS

Contraindications:

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



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OSTEOCHONDRAL ALLOGRAFTS

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



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OSTEOCHONDRAL ALLOGRAFTS

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

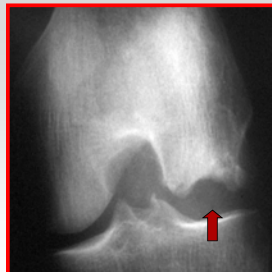


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OSTEOCHONDRAL ALLOGRAFTS

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

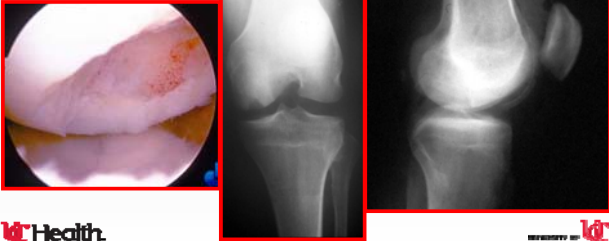


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OSTEOCHONDRAL ALLOGRAFT KS CASE

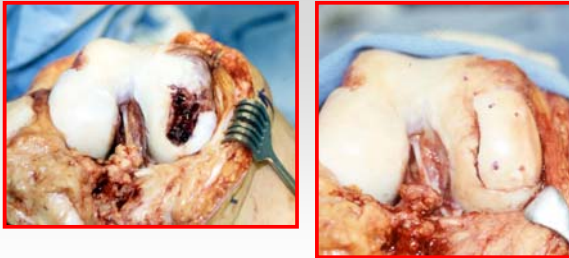
■ Pre-operative findings



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OSTEOCHONDRAL ALLOGRAFT KS CASE

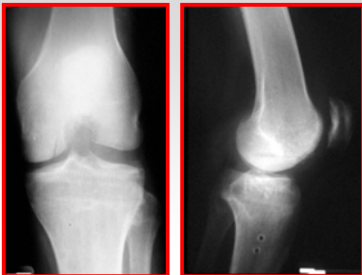


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OSTEOCHONDRAL ALLOGRAFT KS CASE

■ Follow-up at 6 weeks

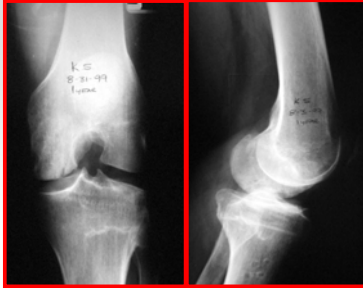


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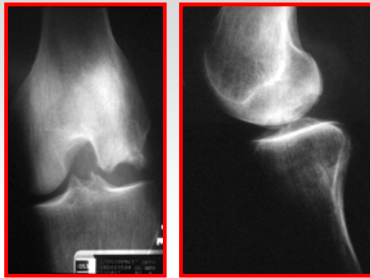
OSTEOCHONDRAL ALLOGRAFT KS CASE

■ Follow-up at 1 year



OSTEOCHONDRAL ALLOGRAFT MH CASE

■ Pre-operative radiographs



OSTEOCHONDRAL ALLOGRAFT MH CASE

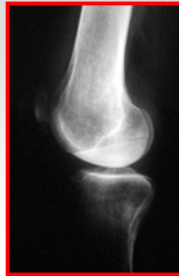
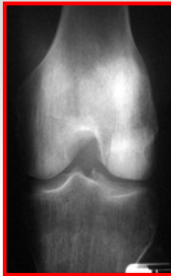


OSTEOCHONDRAL ALLOGRAFT MH CASE



OSTEOCHONDRAL ALLOGRAFT MH CASE

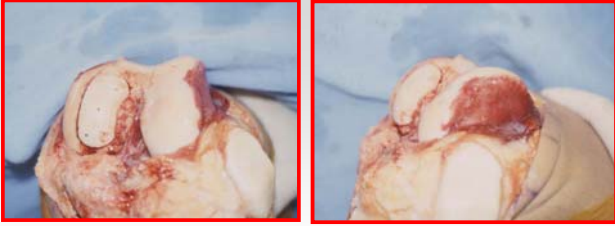
■ Follow-up 1 year



OSTEOCHONDRAL ALLOGRAFT NH CASE



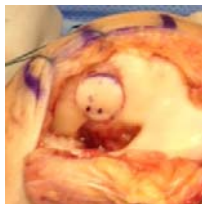
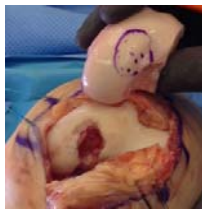
OSTEOCHONDRAL ALLOGRAFT NH CASE



OSTEOCHONDRAL ALLOGRAFT NH CASE

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





OSTEOCHONDRAL ALLOGRAFT KF CASE

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OSTEOCHONDRAL ALLOGRAFTS

■ Gross (1996): 92 fresh allografts for traumatic articular defects:

- 75% successful at 5 yrs
- 64% successful at 10 yrs
- 63% successful at 14 yrs



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OSTEOCHONDRAL ALLOGRAFTS

■ Garrett (1994)

- 17 patients with osteochondritis dissecans
- Ages 16-46
- Lateral femoral condylar defects
- All had fresh frozen allografts



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OSTEOCHONDRAL ALLOGRAFTS

■ Garrett (1994)

- Transplantation within 4 days of harvest
- Herbert screw fixation and NWB 6 weeks
- Follow-up 2 to 9 years
- 16/17 (94%) had successful results



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OSTEOCHONDRAL ALLOGRAFTS

Long-Term Followup of Fresh Osteochondral Allografts Prospective non-randomized

- 60 patients with femoral grafts
- Average followup 10 years
- 12 grafts failed
 - 3 grafts removed
 - 9 patients converted to TKR
- Kaplan-Meier
 - 95% graft survivorship at 5 years
 - 85% graft survivorship at 10 years
- 65 patients-tibial plateau grafts
- Average followup of 11.8 years
- 21 knees converted to TKR
- Kaplan-Meier
 - 95% graft survivorship at 5 years
 - 80% graft survivorship at 10 years
 - 65% graft survivorship at 15 years



Gross et al, June 2005 Clinical Orthop Vol 435 pp 79-87

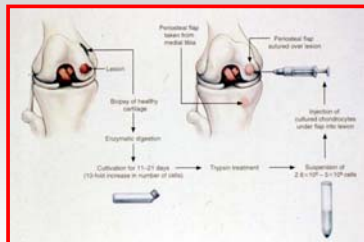


AUTOLOGOUS CHONDROCYTE IMPLANTATION



AUTOLOGOUS CHONDROCYTE IMPLANTATION

- Introduced in Sweden (1987) and US (1995)
- Two stage procedure
- Open procedure
- Laboratory dependant



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
- Minimal bone loss



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)



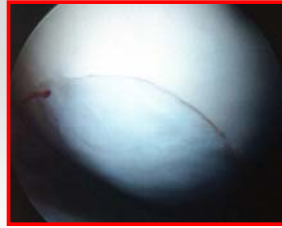
ARTICULAR CARTILAGE KEY POINTS

- 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



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



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SUMMARY

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



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THANK YOU!