



Autologous Cartilage Transfer

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Faculty/Course Disclosure

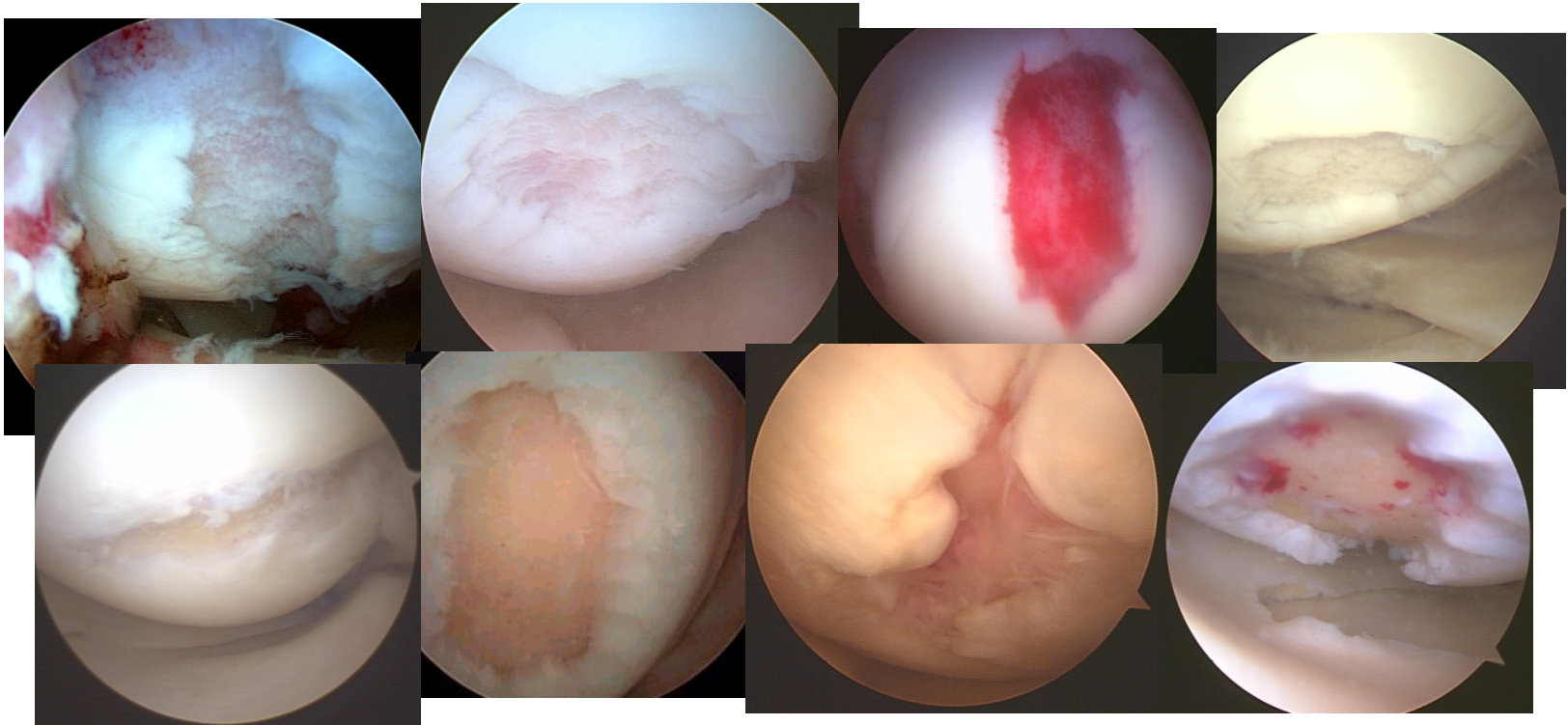
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Full Thickness Defects

Often Found Unexpectedly





Common Injury

- Articular cartilage injury with acute ACL injury: **16% – 46%** (systematic review)

Brophy et al. Arthroscopy 2010¹

Norwegian knee ligament registry

- 3475 pts: 26% cartilage lx; increased 1% per month elapsed from injury until surgery

Granan et al. AJSM, 2009²

¹ Arthroscopy. 2010 Jan;26(1):112-20. doi: 10.1016/j.arthro.2009.09.002.

Anterior cruciate ligament reconstruction and concomitant articular cartilage injury: incidence and treatment.

² Am J Sports Med. 2009 May;37(5):955-61. doi: 10.1177/0363546508330136. Epub 2009 Feb 26.

Timing of anterior cruciate ligament reconstructive surgery and risk of cartilage lesions and meniscal tears: a cohort study based on the Norwegian National Knee Ligament Registry.



Articular Cartilage Progression

- Damaged cartilage worsens with cyclic loading
 - Fibrillation →
 - Fragmentation →
 - Delamination





Classification

- Size classification:
 - Small < 2cm²;
 - Medium 2cm² to 4cm²;
 - Large > 4cm²
- Site: Condyle /Patella /Trochlea/Tibia
- Depth: bone loss? (OCD)
- Number: single or multiple sites





Arthroscopic Treatment Option

- Arthroscopic debridement
 - Removes tissue
- Marrow Stimulation (<1-2cm)
 - Develops new tissue (quality??)
- Autografting (1-4cm)
 - Transfers tissue





Surgical Treatment Frequency

- 1,959,007 cartilage procedures
- 5% annual growth 2004-2011
- Chondroplasty 2x> MFx
- Chondroplasty 50x> COR[®] Cartilage Transplant System plus ACI

Chondroplasty	MFx	Autograft	Allograft	ACI
63,557	25,161	444	465	309





Chondroplasty: First step



- Most common (esp. athletes)
- Partial or full-thickness lesions
- Quick recovery
- Debride unstable fragments
mechanical symptoms
- Burns no bridges

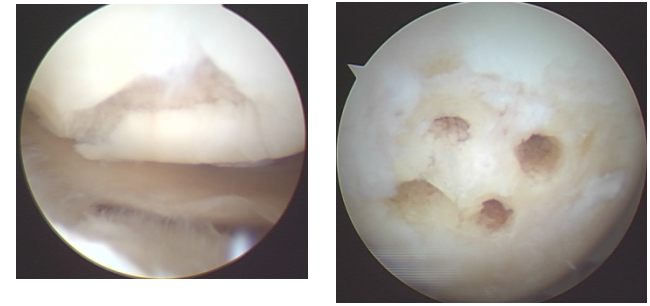
Marrow Stimulation



- Type 1 fibrocartilage patch
- 75% improved 3-5 yrs
- No Type 2 cartilage
- Does not prevent long-term DJD



Microfracture



- Systematic review: 28 studies; 3122 pts
- Avg F/U 41 months
- Improved knee function at 24 months
- MRI fill highly variable BUT correlated with clinical outcome
- Durability questionable

Mithoefer AJSM, 2009





Microfracture in Prof Athletes

- Primary Unilateral Microfracture
- Return-to-Play: 1 professional regular season game post surgery
- 131 players: 78.6% successful return
- Basketball/baseball players decreased performance post op
- Baseball players recovered seasons 2-3



MicroFx Outcomes

- 102 knees; BMI =26.3; defect size = 2.6cm²; 45% MFC, 21% Trochlea
- Mean FU 5.7 years
- defect size >3.6 cm² poor prognostic
- All PROs better (P<.05) except SF-12
- Toe-touch 2 weeks then gradual progression to full; CPM 6-8 hrs daily x 6 weeks; impact started 4 months



MFx vs ACI: Systematic Rev

- Level evidence 1-2
- 7 yr F/U
- Failures: ACI: 18.5% MFX: 17.1%
- No Significant Difference in outcomes for MFX or 1st/3rd generation ACI at midterm to long-term follow-up

Kraeutler et al. AJSM 2018





MFX can make you worse

- 640 ACL reconstructions with grades 3-4 cartilage lesions
- Debride (129); MFx (164); none (351)
- 2.1 yr F/U
- MFx significant negative F/U KOOS
- Debridement: no effect

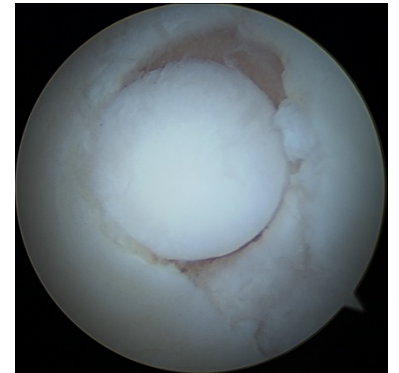
Rotterud et al. AJSM 2016

Norwegian and Swedish National Knee Ligament Registries

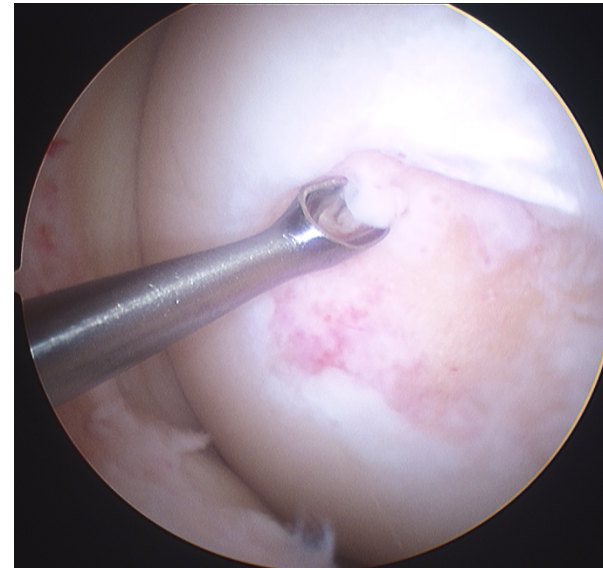
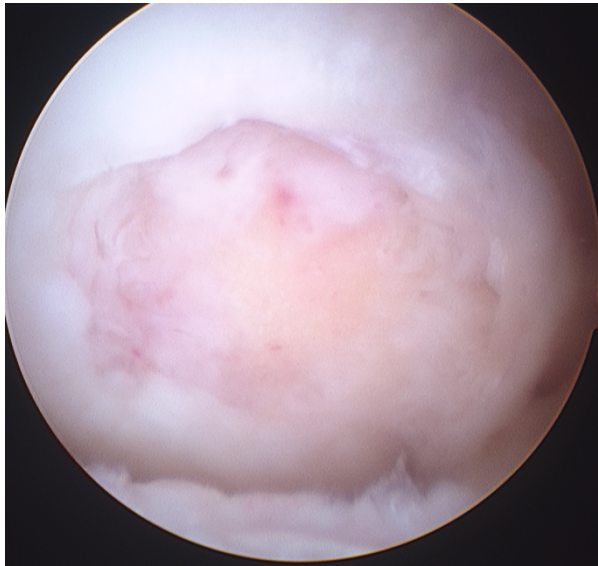


Osteochondral Autograft

- Full thickness up to 12 mm deep
- $<4.9 \text{ cm}^2$ defect (2.5 cm dia)
- Single lx; stable knee
- Normal alignment
- Pressure kills cartilage cells
- Insertion force of 800N killed 50% cartilage cells (Patil et al. AJSM 2008)



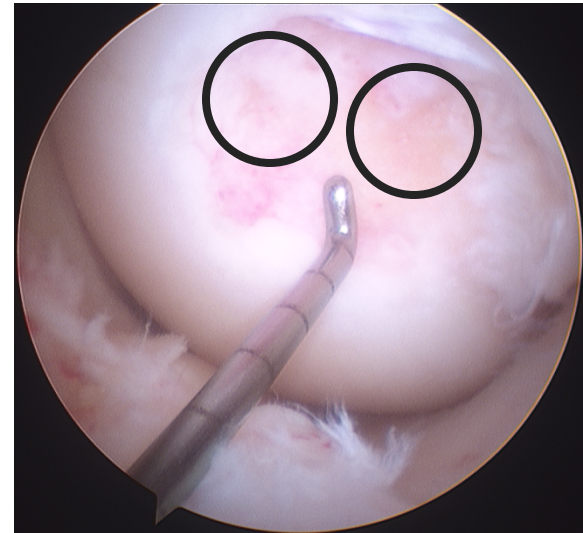
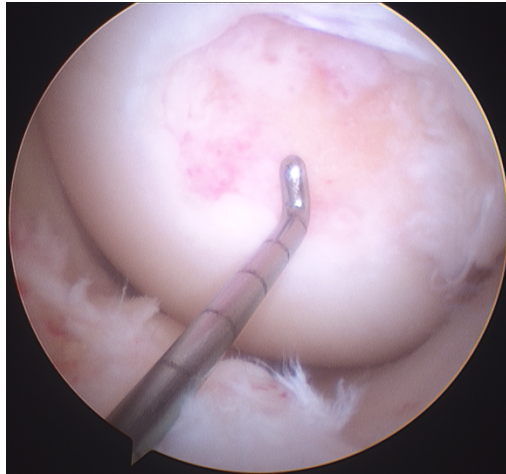
1. Prepare Lesion



Create vertical cartilage walls



2. Determine graft number

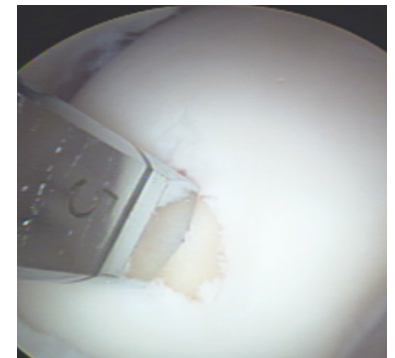
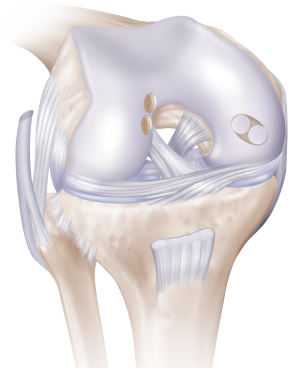


- Estimate graft number
- Graft size & depth



2. Determine graft number

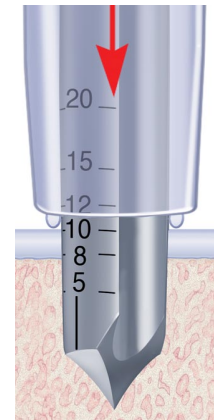
- Donor depth & recipient depth should match
- Drill diameters: 4, 6, 8, & 10 mm
- Why make a lx you would otherwise treat?
- Surface area is πr^2
- Squares of 2, 3, 4, 5?



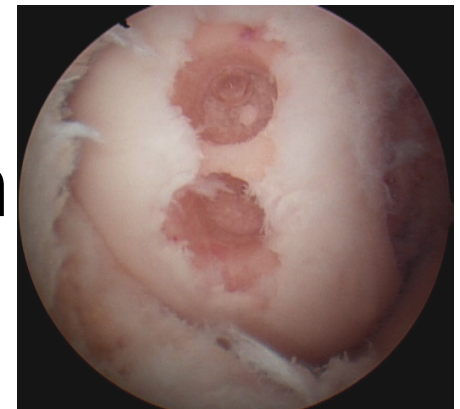
3. Prepare insertion site



- Align with perpendicularity guide

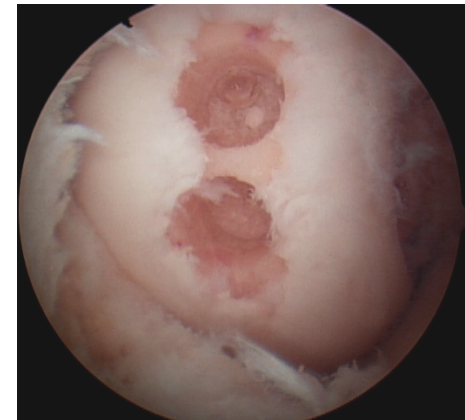
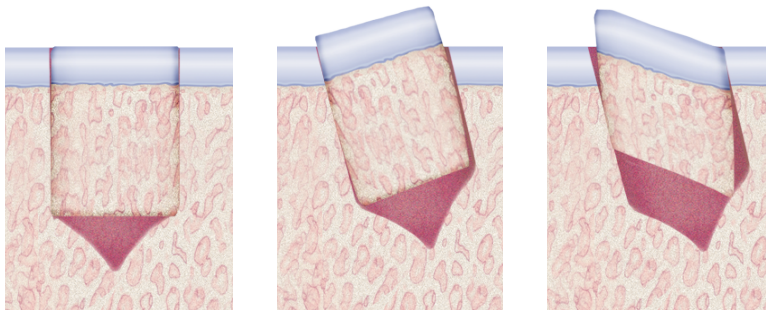
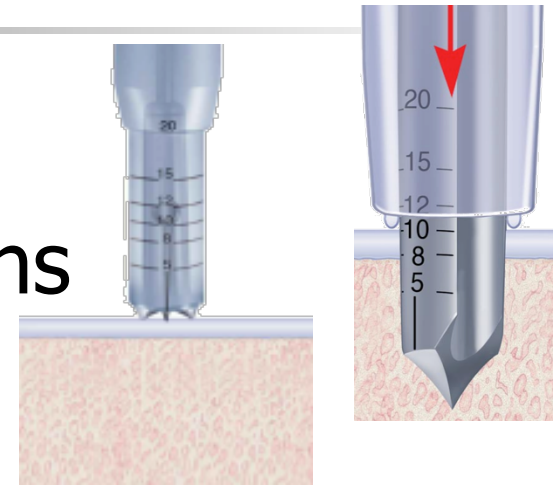


- Start adjacent to articular cartilage
- Leave bone bridge between sites



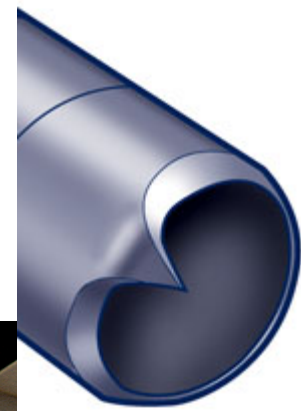
3. Prepare insertion site

- Drill to appropriate depth
- 10-12 mm; variable depths
- Maintain perpendicular alignment

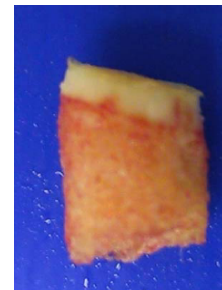
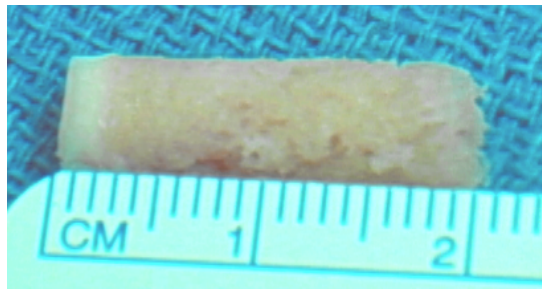


4. Harvest depth

- Harvest depth: same as recipient: 10-12 mm
- Variable: up to 20 mm
- Perpendicular
- Avoid oblique angles



**Tooth allows
precise depth**



No pressure is placed on Articular Cartilage!

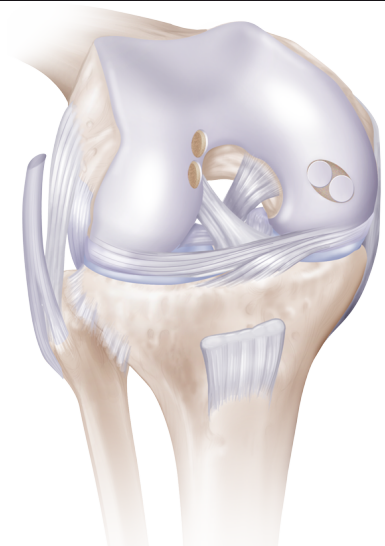
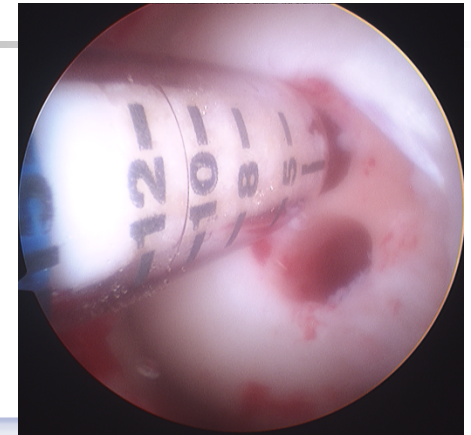
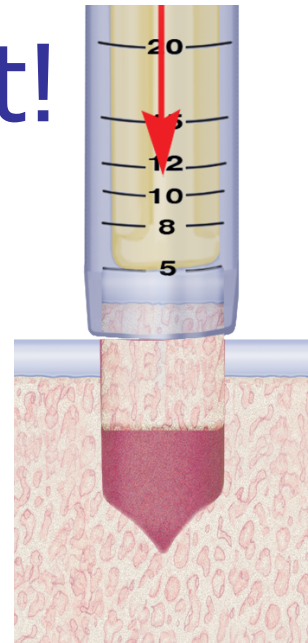
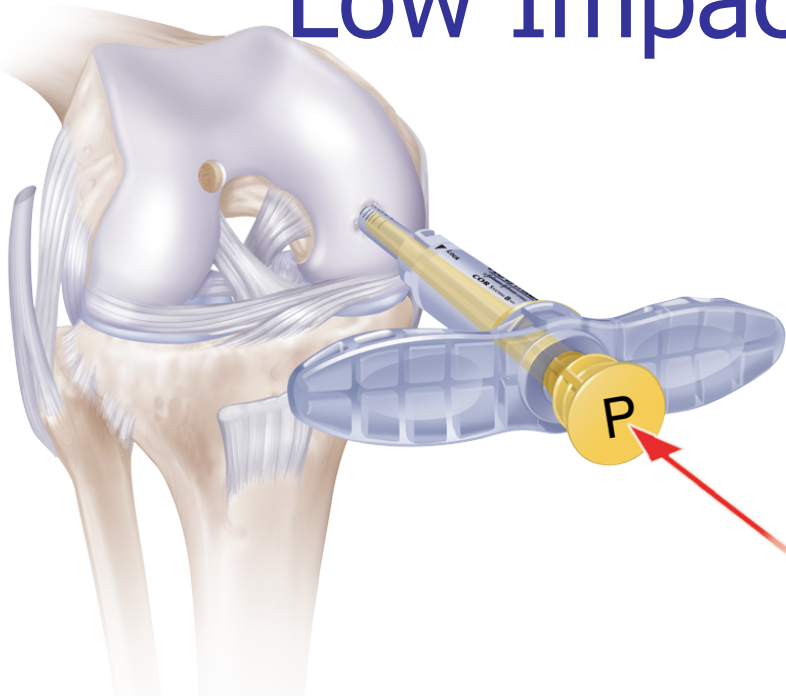
4. After harvest:

Transfer graft into inserter

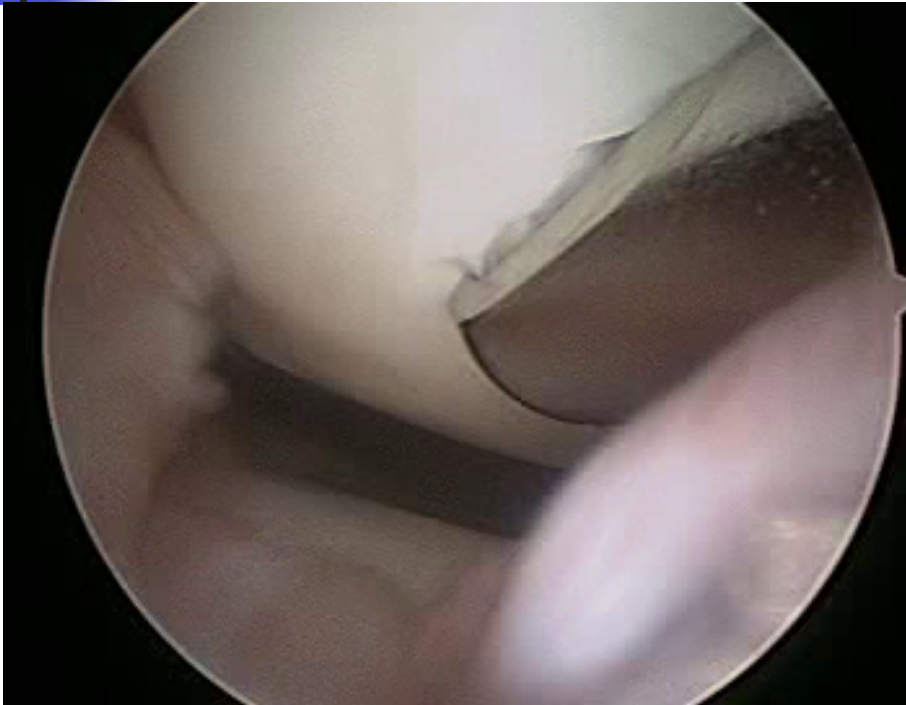
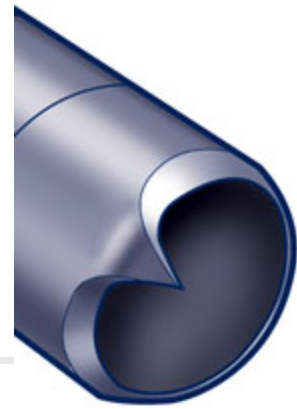


5. Graft placement

Low Impact!



Articular Cartilage Lesion



Vertical walls
Number of grafts
Create perpendicular
insertion sites
Harvest grafts
Deliver grafts
Low impact pressure





Technical Points: Graft depth

- Graft depth -Huang et al; AJSM 2004¹
 - Flush: good
 - Countersunk 1 mm: cartilage thickening
 - Countersunk 2 mm: cartilage necrosis and fibrous overgrowth
- Proud grafts are BAD! -Pearce; Arthroscopy 2001²
 - Fissuring
 - Fibroplasia
 - Subchondral cavitations

¹ Effects of Small Incongruities in a Sheep Model of Osteochondral Autografting

² An investigation of 2 techniques for optimizing joint surface congruency using multiple cylindrical osteochondral autografts - January 2001 Volume 17, Issue 1, Pages 50-55





Technical Points: Pressure

- Insertion force damages the articular cartilage –Cole J Knee Surg 2007¹ & Borazjani JBJS 2006²
- Cell death is higher in superficial layer and lasts at least 7 days –Cole J Knee Surg 2007¹
- Immature AC has greater cell death to impact than mature AC. –Torzilli 2006³
- Death varies logarithmically with impact energy; impact force more important than impact number –Whiteside JBJS Br 2005⁴

1 Osteochondral Tissue Cell Viability Is Affected by Total Impulse during Impaction Grafting. Paul Balash, Richard W. Kang, Thorsten Schwenke, Brian J. Cole, et al. Cartilage. 2010 Oct; 1(4): 270–275.

2 Effect of Impact on Chondrocyte Viability During Insertion of Human Osteochondral Grafts, JBJS: September 2006 - Volume 88 - Issue 9 - p 1934-1943

3 Effect of Compressive Strain on Cell Viability in Statically Loaded Articular Cartilage DOI:10.1007/s10237-006-0030-5

4 Impact loading of articular cartilage during transplantation of osteochondral autograft. R. A. Whiteside, et al. The Journal of Bone and Joint Surgery. British Vol. 87-B, No. 9

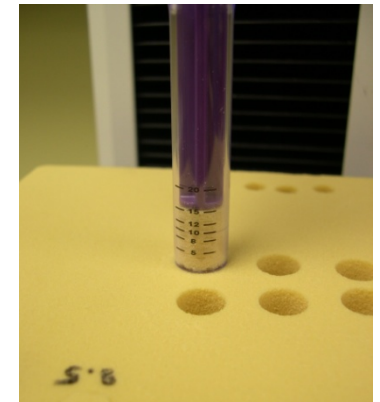


Pressure: Insertion Force

- Single impaction foam bone
- COR 6, 8, 10
- OATS 6, 8, 10
- Mosaicplasty 6.5 & 8.5

Barber et al. J Knee Surgery 2008

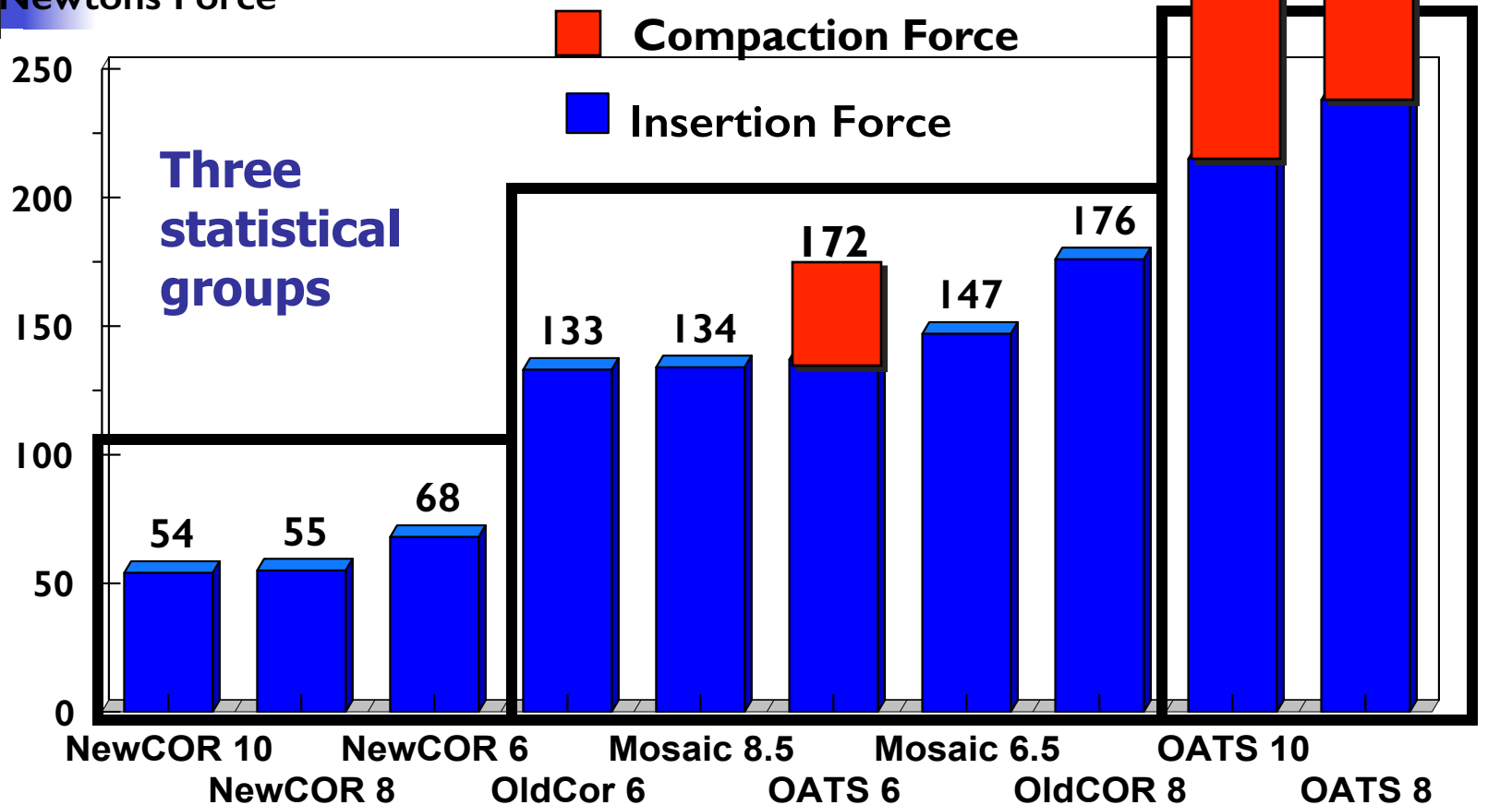
Insertion force of articular cartilage transplantation systems.



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Sports Medicine & Spine Center, P.A.

Insertion Force Groups

Newton's Force





Pearls: Graft harvest

- Central portal helpful
- Knee flexion control needed
- Drill & Harvester must be perpendicular to the articular cartilage
- Use probe & rotate scope to achieve perpendicularity
- Fluid back flow drop = perpendicular



Conclusions

- Factors: Age/ BMI/ alignment/ stability
- Primary treatment
 - $<1.0 \text{ cm}^2$; $<30\text{y/o}$: MFx
 - $1.0 \text{ cm}^2 - 4 \text{ cm}^2$ dia: Autografting
- Pressure Kills: Do not compact the grafts!
- $>4 \text{ cm}^2$: Allografts or cell based repairs





Thank You

