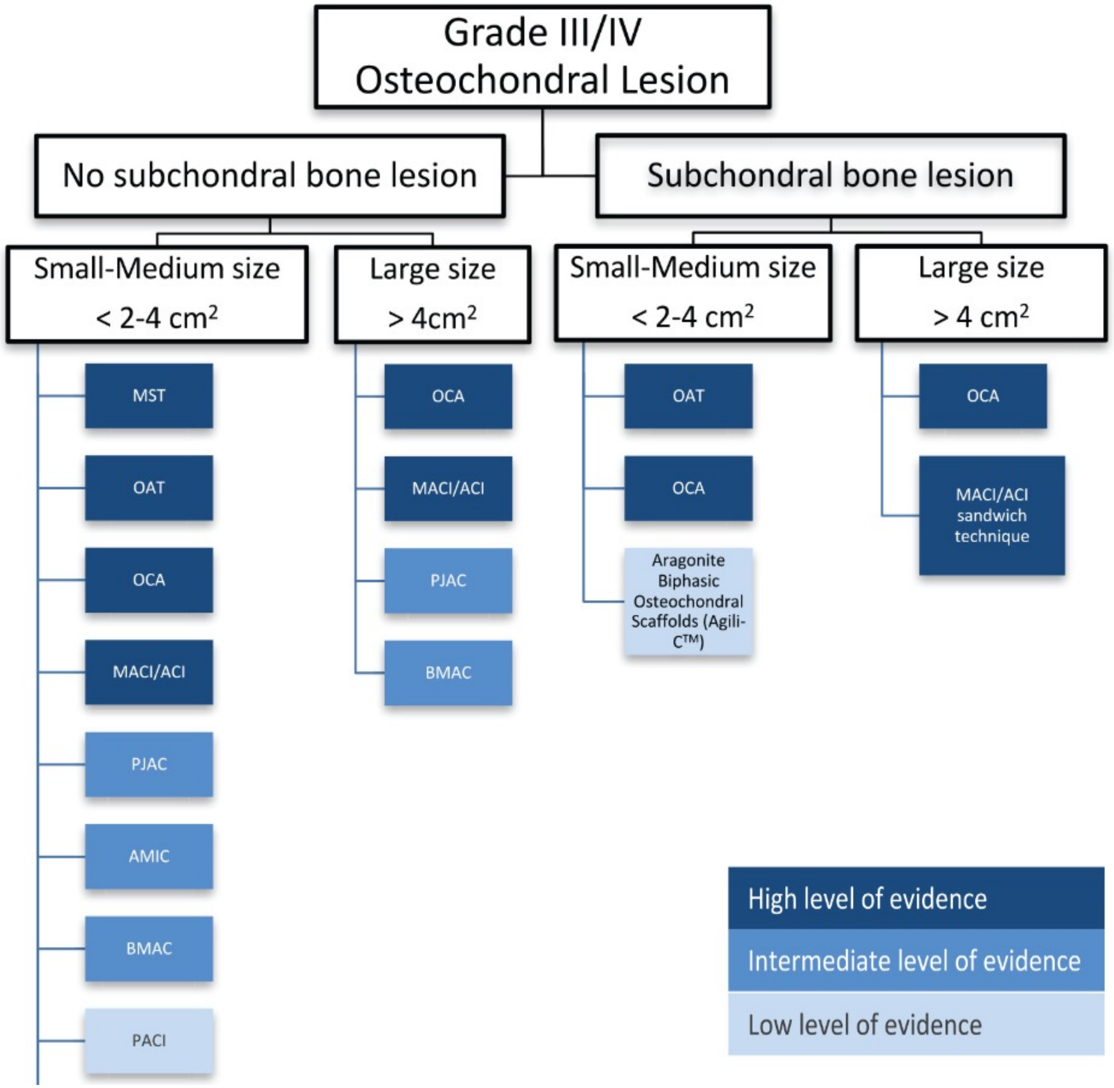
How to deal with varus? Osteochondral lesion with varus

M Thaunat, F Vassalo
Centre orthopédique Santy

Treatment algoritm



Meniscus

- Repaire/ Transplant

Malalignment

- Simple ou double Osteotomies

Instability

- Ligament Reconstruction

MST = bone-marrow stimulation; OAT = osteochondral autograft transfer; AMIC = autologous matrix-induced chondrogenesis, BMAC = bone marrow aspirate concentrate implantation; PJAC = particulated juvenile allograft cartilage; PACI = particulated autologous cartilage implantation; CVOCA = cryopreserved viable osteochondral allograft.

Algorithm for Treatment of Focal Cartilage Defects of the Knee: Classic and New Procedures. B. Hinckel, Cartilage 2021

HTO/DFO for cartilage repair?

- Osteotomies, including high tibial osteotomy (HTO) and distal femoral osteotomy (DFO)
    - can reduce contact pressure on the implanted graft
    - normalize mechanics
    - significantly unload the affected compartment of the knee, contributing to improved clinical outcomes and superior graft survivorship

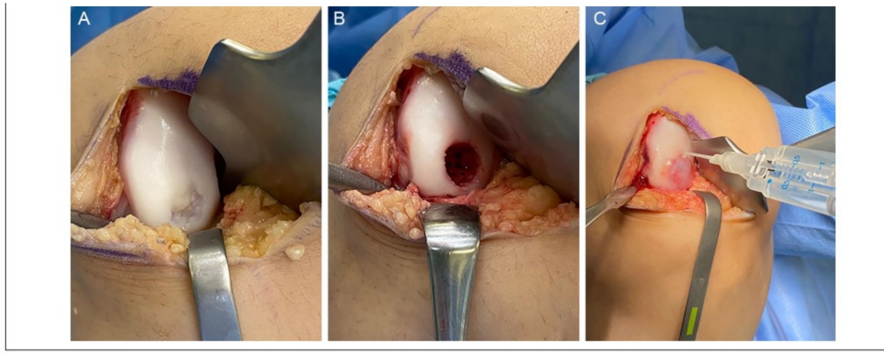


Figure 1. Autologous matrix-induced chondrogenesis (AMIC). (**A**) Chondral lesion in the lateral femoral condyle. (**B**) After debridement, microfracture is performed. (**C**) Lesion is covered with a collagen membrane and fixed with sutures or fibrin glue.

Algorithm for Treatment of Focal Cartilage Defects of the Knee: Classic and New Procedures. B. Hinckel, Cartilage 2021

HTO/DFO for cartilage repair?

The extent to which concomitant osteotomy provides an improvement in clinical outcomes after cartilage restoration procedures **is unclear**

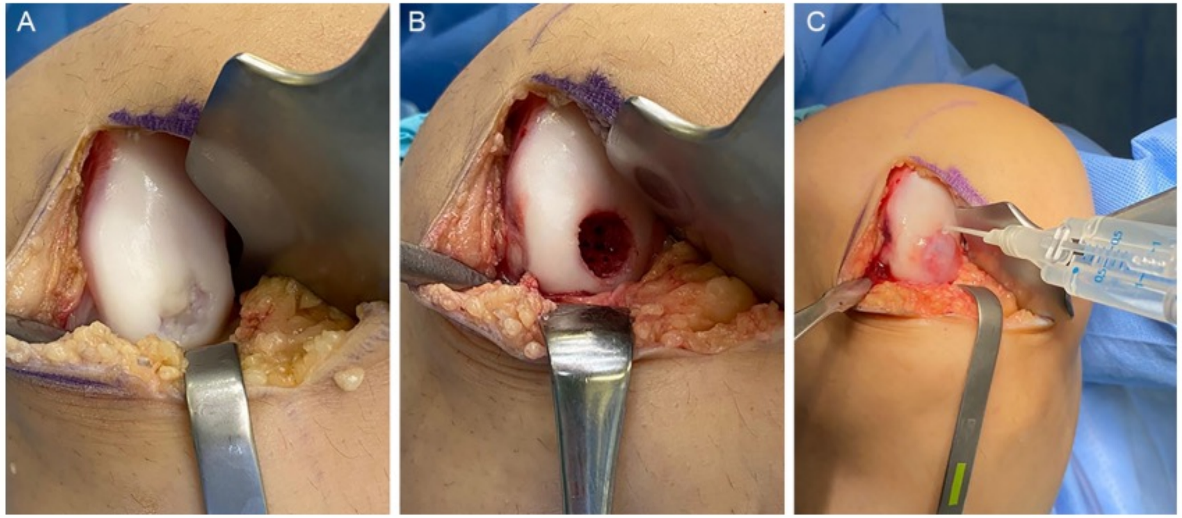


Figure 1. Autologous matrix-induced chondrogenesis (AMIC). (**A**) Chondral lesion in the lateral femoral condyle. (**B**) After debridement, microfracture is performed. (**C**) Lesion is covered with a collagen membrane and fixed with sutures or fibrin glue.

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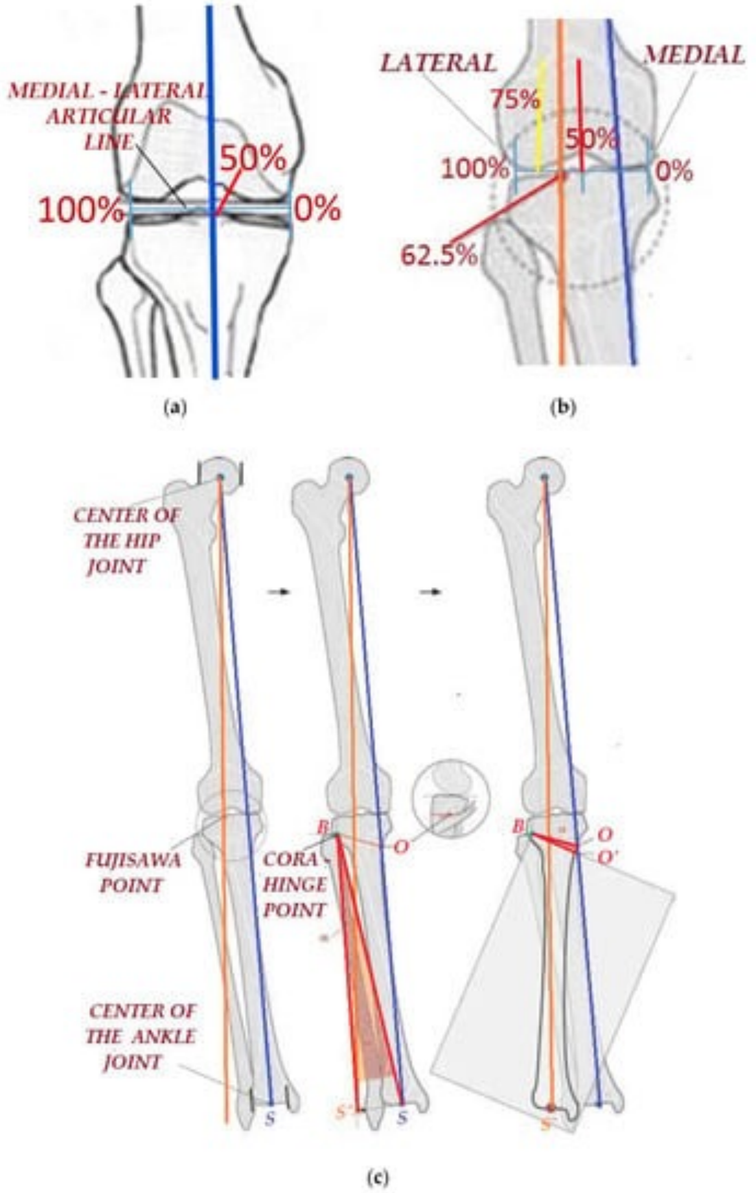
Rationale

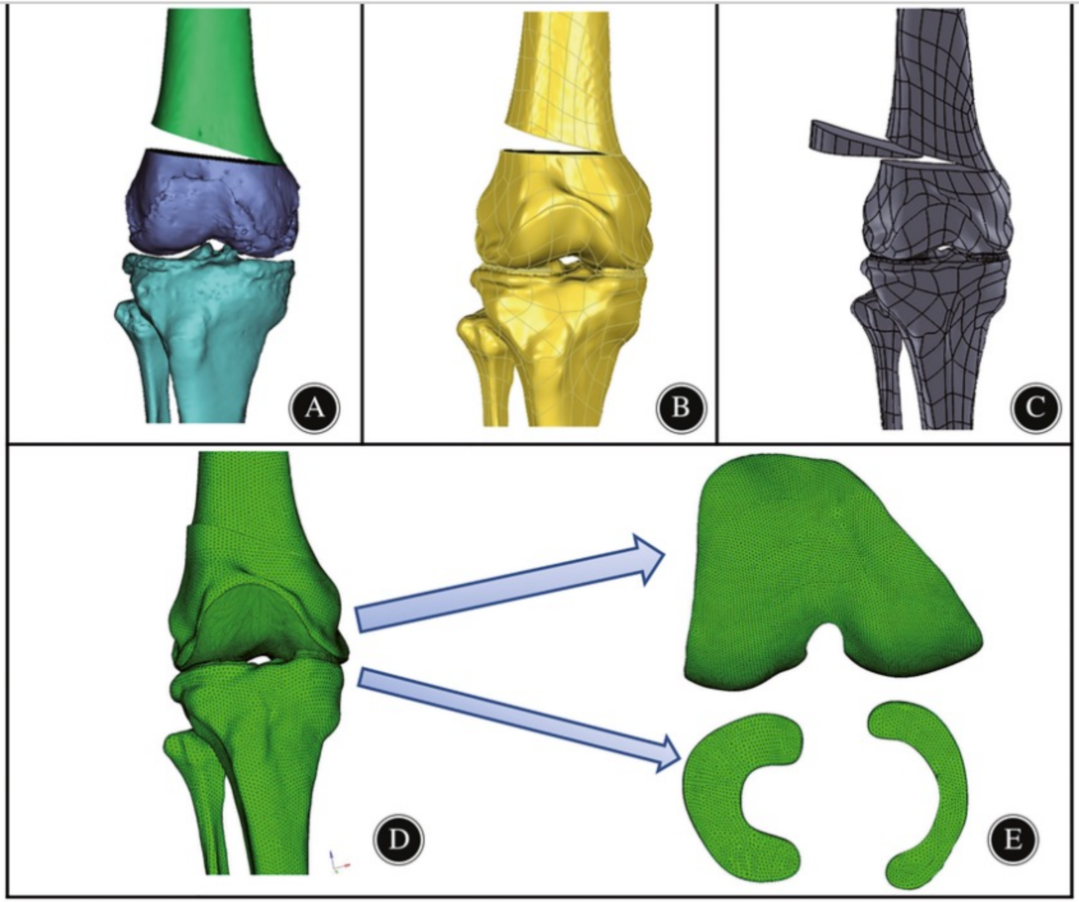
Several biomechanical studies have reported that varus malalignment of the lower extremity is associated with increased forces across the medial compartment of the knee, **with a deviation as little as 3°** resulting in significantly increased peak stresses

Agneskirchner JD, et al The effects of valgus medial opening wedge high tibial osteotomy on articular cartilage pressure of the knee: a biomechanical study. Arthroscopy. 2007

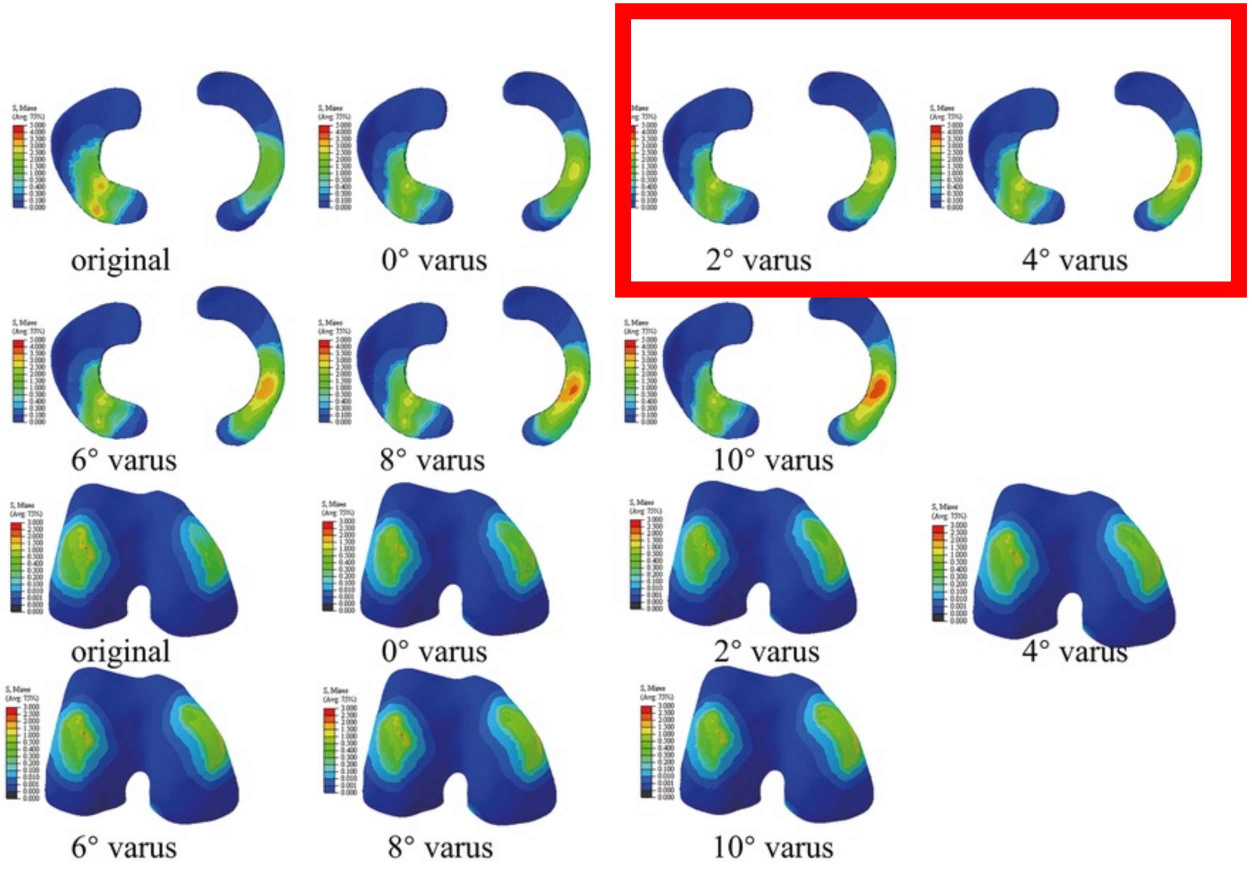


Geometrical Planning of the Medial Opening Wedge High Tibial Osteotomy—An Experimental Approach
Appl. Sci. **2022**,

Rationale



Finite element pre-processing step for the neutrally aligned knee. (A). the osteotomy model was constructed with Mimics software; (B). the reconstructed model was smoothed and converted to CAD models in Geomagic studio software; (C).bone graft was designed and assembled via SolidWorks; (D). the intact knee model was meshed in HyperMesh software using 4-node tetrahedron elements. (E). the subdivision of the mesh of cartilage and meniscus.



Computer-aided Design of Distal Femoral Osteotomy for the Valgus Knee and Effect of Correction Angle on Joint Loading by Finite Element Analysis Yanfei Wu Orthopaedic Surgery sept2022

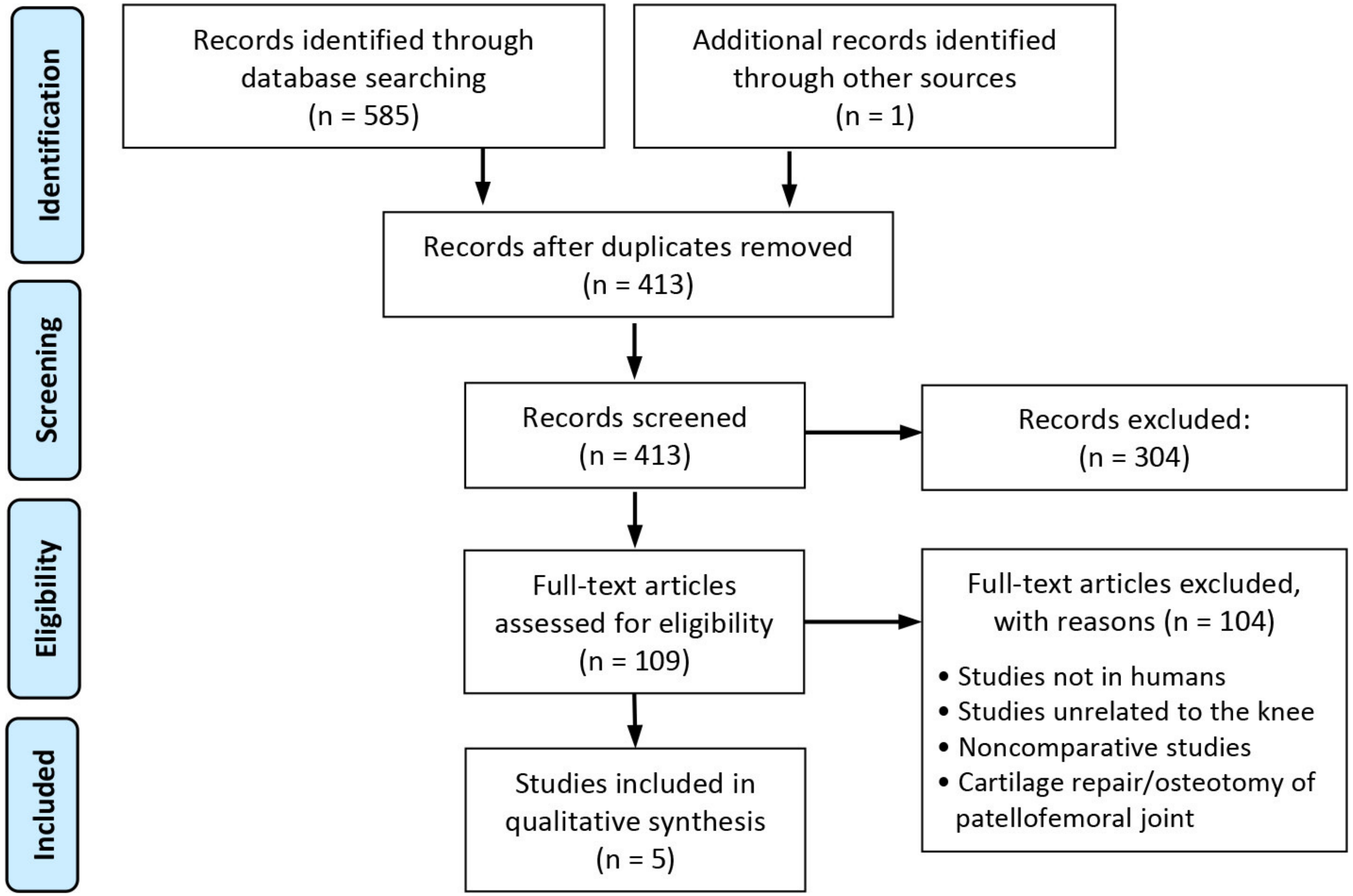
Rationale

Decreasing mechanical forces on degenerated joint surfaces can

- stimulate the formation of a new biologic articular surface [1].
- produce an anabolic response in chondrocytes such that cartilage shows increased thickness and proteoglycan content, and decreased proteoglycan degradation [2]

[1] Buckwalter JA, Martin JA, Brown TD. Perspectives on chondrocyte mechanobiology and osteoarthritis. *Biorheology*. 2006;
[2] Zuscik MJ, Hilton MJ, Zhang X, Chen D, O’Keefe RJ. Regulation of chondrogenesis and chondrocyte differentiation by stress. *J Clin Invest*. 2008

Cartilage repair alone VS. repair with concomitant osteotomy



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Published online 2023 Mar 20. doi: 10.1177/23259671231151707 PMID: 36970318

Cartilage Repair of the Tibiofemoral Joint With Versus Without Concomitant Osteotomy: A Systematic Review of Clinical Outcomes

Jaydeep Dhillon, BS,* Matthew J. Kraeutler, MD,†# Sydney M. Fasulo, MD,‡ John W. Belk, BA,§ Mary K. Mulcahey, MD,‖ Anthony J. Scillia, MD,‡¶ and Patrick C. McCulloch, MD†

Dhillon, OJSM 2023

Included in the review were 5 studies (1 level 2 study, 2 level 3 studies, 2 level 4 studies) with 1747 patients in group A and 520 patients in group B

TABLE 2
Cartilage Lesion Characteristics[a]

Study (Year)	Mean Defect Size, cm^2	Mean Preoperative Alignment, deg	Lesion Location	Type of Osteotomy	Type of Cartilage Repair
Bode et al (2013)[4]	Group A: 4.4 Group B: 4.9	Group A: 2.3 (varus) Group B: 3.5 (varus)	MFC: 43	HTO: 19	ACI: 24
Calcei et al (2021)[7]	NR	NR	NR	NR	ACI: 469; OCA: 644
Faber et al (2021)[10]	Group A: 3.9 Group B: 4.4	Group A: 1.8 (varus) Group B: 5.7 (varus)	MFC: 788	HTO: 250	BMS: 71; OCA: 13; ACI: 226; D: 21; O: 82; M: 21
Ackermann et al (2020)[1]	Group A: 4.1 Group B: 4.9	NR	MFC: 168	HTO: 41	ACI: 60; OCA: 108
Minas et al (2014)[19]	NR	NR	NR	HTO: 48; DFO: 3	ACI: 104
Total[b]	Group A: 4.0 Group B: 4.5	Group A: 1.8 (varus) Group B: 5.5 (varus)	MFC: 999	HTO: 358; DFO: 3	ACI: 883; OCA: 765; BMS: 71; D: 21; O: 82; M: 21

[a]Group A = cartilage repair alone. Group B = cartilage repair with osteotomy. ACI, autologous chondrocyte implantation; BMS, bone marrow stimulation; D, debridement; DFO, distal femoral osteotomy; HTO, high tibial osteotomy; M, multiple therapies; MFC, medial femoral condyle; NR, not reported; O, other; OCA, osteochondral allograft transplantation.

[b]Reported as weighted means.

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Literature

- Based on the results of this systematic there is:
  - a significantly **lower reoperation rate** for patients undergoing cartilage repair with concomitant osteotomy compared with cartilage repair alone.
  - **superior PROs** among patients undergoing cartilage repair with concomitant osteotomy in the domains of both function and pain at the short-term follow-up.
  - Furthermore, no significant differences were found between groups with regard to complication rates

Reoperation Rates[a]

Study	Group A	Group B	P
Calcei et al (2021)[7]	468/954 (49.1)	31/159 (19.5)	**<.05**
Bode et al (2013)[4]	10/24 (41.7)	2/19 (10.5)	**.02**
Minas et al (2014)[19]	35/104 (33.7)	6/48 (12.5)	**.01**
Total	513/1082 (47.4)	39/226 (17.3)	**<.0001**

[a]Data are reported as number of failures at the final follow-up/total number of knees (%). Group A = cartilage repair alone. Group B = cartilage repair with osteotomy. Boldface P values indicate a statistically significant difference between groups ($P < .05$).

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Discussion

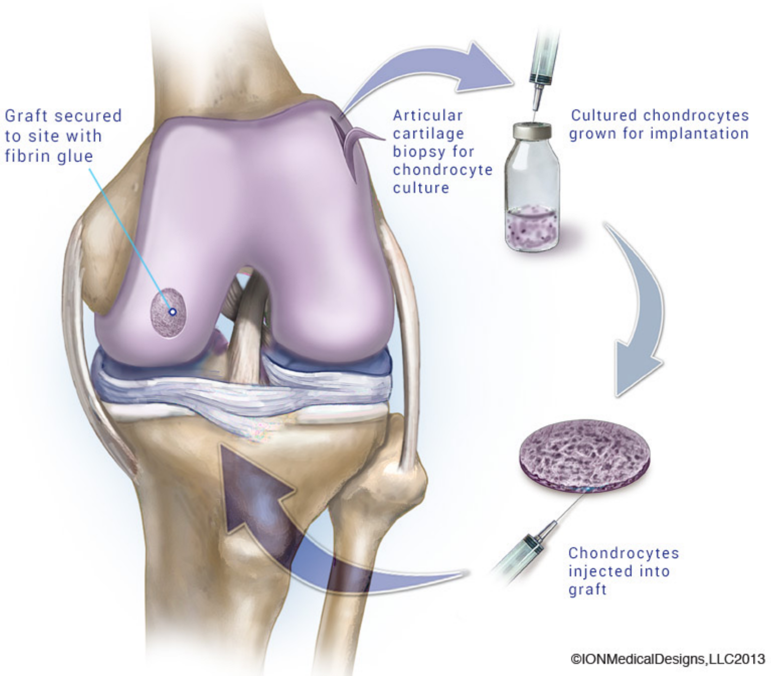
- a literature review conducted in 2017 [1] concluded that cartilage-restoration procedures performed in conjunction with HTO can lead to improved cartilage regeneration
- systematic review published in 2020 [2] concluded that when osteotomies were performed in conjunction with cartilage procedures, return to work occurred more quickly, as did an increased rate of healing at the chondral lesion site

[1]Thambiah MD, Tan MKL, Hui JHP. Role of high tibial osteotomy in cartilage regeneration—is correction of malalignment mandatory for success? Indian J Orthop. 2017;51(5):588–599.

[2]Nimkingratana P, Brittberg M. Returning to work after articular cartilage repair intervention: a systematic review. Orthop J Sports Med. 2020

Limits

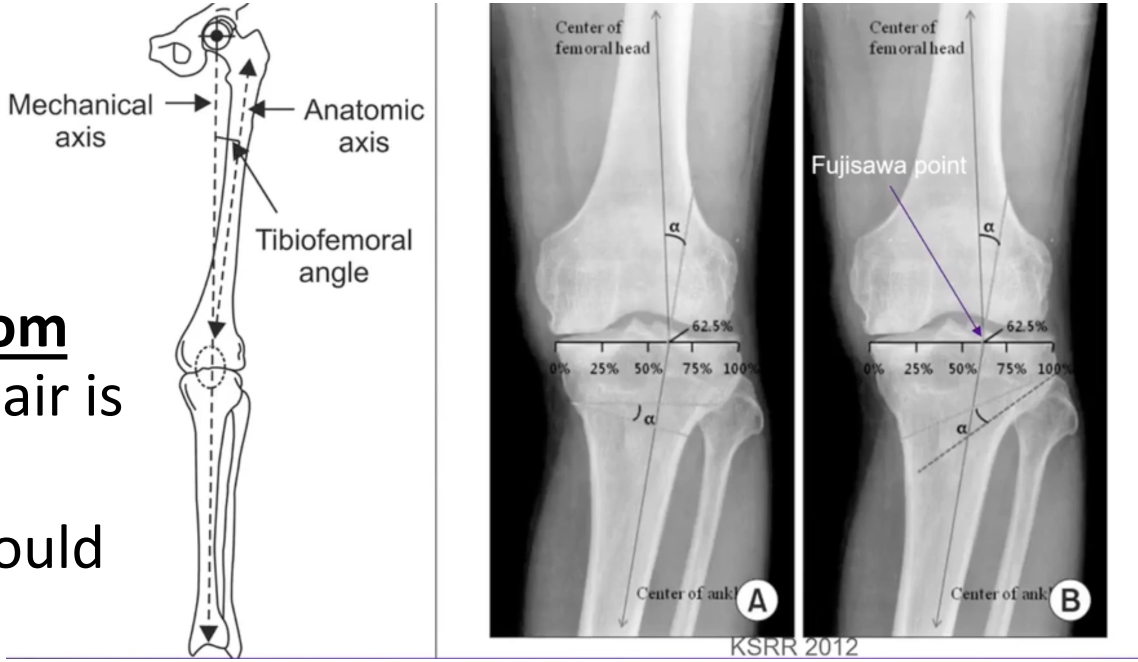
- Only 5 studies were included, and 4 were considered low levels of evidence (level 3 or 4)
- There was heterogeneity in the type of
  - cartilage- restoration procedures performed,
  - the definition of graft failure between studies,
  - the reported PROs between studies.



Dhillon J, et al. Cartilage Repair of the Tibiofemoral Joint With Versus Without Concomitant Osteotomy: A Systematic Review of Clinical Outcomes. Orthop J Sports Med. 2023 Mar 20;11(3)

Limits

- Groups A and B differed with regard to preoperative lower extremity alignment,
- **<u>therefore, it is difficult to state</u>**
  - **<u>a threshold malalignment that benefits from concomitant osteotomy</u>** when cartilage repair is performed.
  - **<u>degree of correction</u>**, the mechanical axis could be corrected
    - to that of the contralateral limb,
    - to the center of the knee
    - to the 62% point across the tibial width to “unload” the compartment, as is done in arthritis.



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Limits

METHODS

Study Cohort

After approval by the institutional review board, a retrospective review of a prospectively collected database was performed. The database was queried for patients undergoing concomitant OCA and HTO by the senior author [AQ1] between 2001 and 2015. Indications for concomitant OCA and HTO included patients younger than 50 years of age with focal chondral defects on the medial femoral condyle and varus deformity greater than 5° as measured on weightbearing, standard bilateral standing long leg length radiographs. Patients were included if they

Return to Sports After High Tibial Osteotomy With Concomitant Osteochondral Allograft Transplantation

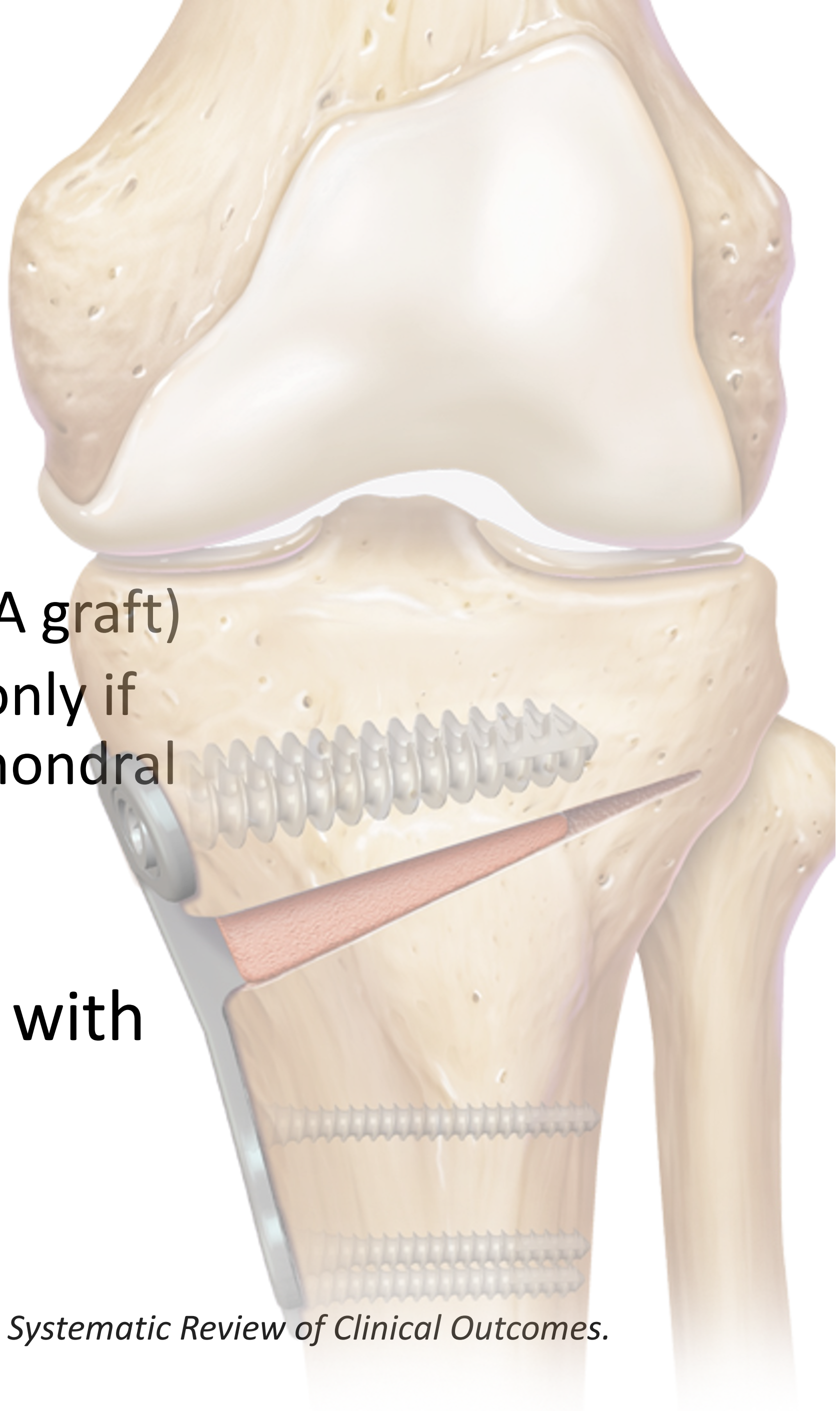
Joseph N. Liu,* MD, Avinesh Agarwalla,† MD, David R. Christian,‡ MD, Grant H. Garcia,§ MD, Michael L. Redondo,|| MD, Adam B. Yanke,¶ MD, PhD, and Brian J. Cole,¶# MD, MBA
Investigation performed at Midwest Orthopaedics at Rush, Chicago, Illinois, USA

AJSM 2020

Limits

- **Some surgeons will stage** the cartilage repair/osteotomy **procedures**
  - to do the osteotomy first (eg, while waiting for an OCA graft)
  - or, if not truly malaligned, to do the osteotomy later only if the patient gets insufficient improvement from the chondral resurfacing.

- There is both **surgeon and patient selection bias** with respect to who gets an osteotomy with the preponderance of HTOs in men.



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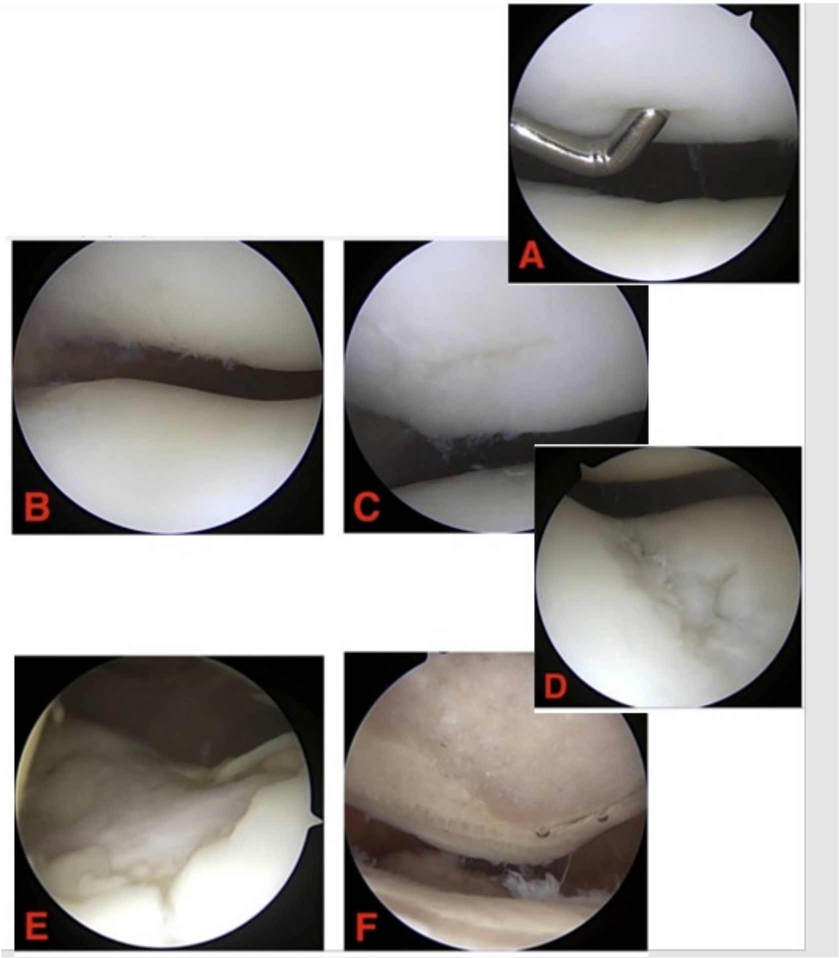
Limits

- Some patients may not be good candidates for osteotomy because of disease **in the other compartments.**
  - chondromalacia
  - relative **meniscal insufficiency,**
- Furthermore, most of the cartilage restoration procedures used in the included studies were either **ACI or OCA**, and thus these results cannot be applied to other cartilage procedures.



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Conclusion

- Osteotomies, including high tibial osteotomy (HTO) and distal femoral osteotomy (DFO)
  - can reduce contact pressure on the implanted graft
  - normalize mechanics

- **It is difficult to state a threshold malalignment that benefits from concomitant osteotomy (5°?)**
  - lots of Bias in clinical studies
  - Inherent limits of biomechanical studies

Thank you