Réunion Ordinaire de la SORBCOT
28.01.2023

CHU AMBROISE PARÉ

ULB

Analyse morphologique et volumétrique méniscale par reconstruction tridimensionnelle sur base d'IRM

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Introduction

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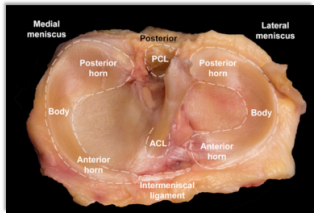
Ménisques

→ Rôle crucial dans le fonctionnement de l'articulation du genou

- Meilleure congruence articulaire
- Transmission des forces
- Proprioception
- Lubrification
- Stabilisation



Beaufils and Verdonk, « The Meniscus », *Springer*, 2010.
Makris et al., « The Knee Meniscus: Structure–Function, Pathophysiology, Current Repair Techniques, and Prospects for Regeneration », *Biomaterials*, 2011
Koh et al., « Orthopaedic Biomechanics in Sports Medicine, *Springer*, 2021

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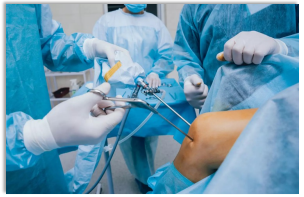
Introduction

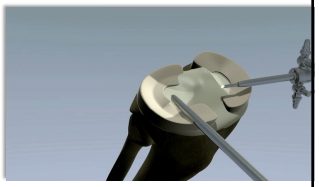
Arthroscopie de genou = une des interventions les plus fréquentes



→ 1 million/an aux Etats-Unis

→ 400 000 en Europe

Néamoins



Evolution arthrosique du genou après méniscectomie

→Insistance préservation maximale du capital méniscal

« SAVE the meniscus ! »

Pujol et Beaufils. « Save the Meniscus Again! », *KSSTA*, 2019

Toanen et al., « Polyurethane Meniscal Scaffold for the Treatment of Partial Meniscal Deficiency: 5-Year Follow-up Outcomes: A European Multicentric Study », *The American Journal of Sports Medicine*, 2020

Nakamura et al., « Advances in Knee Ligament and Knee Preservation Surgery », *Springer*, 2022

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Introduction - Tendances méniscectomie vs réparation

Long-term National Trends of Arthroscopic Meniscal Repair and Debridement

Jory N. Wasserburger,*† MD, Christopher L. Shultz,‡ MD, David A. Hankins,† MD, Lucas Korcek,† MD, David F. Martin,§ MD, Annunziato Amendola,‡ MD, Dustin L. Richter,† MD, Robert C. Schenck,† MD, and Gehron P. Treme,† MD
Investigation performed at University of New Mexico, Albuquerque, New Mexico, USA

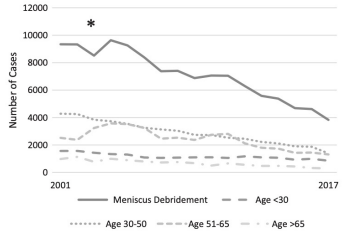

Figure 1. Meniscal debridement stratified by age.

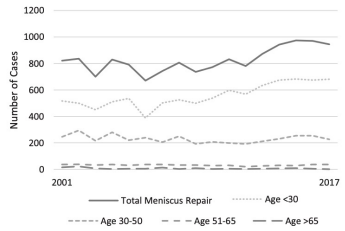

Figure 2. Meniscal repair trends stratified by age.

Wasserburger J.N. et al., « Long-term National Trends of Arthroscopic Meniscal Reair and Debridement », AJSM 2021

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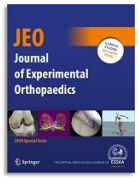
Introduction - Tendances méniscectomie vs réparation



Journal of Experimental Orthopaedics

MEETING REPORT — Open Access

Does practice of meniscus surgery change over time? A report of the 2021 'THE MENISCUS' Webinar

Christophe Jacquet[1], Caroline Mouton[1,2], Roland Becker[3], Hideyuki Koga[3], Matthieu Ollivier[1], Peter Verdonk[4], Philippe Beaufils[5] and Romain Seil[1,2,6*]

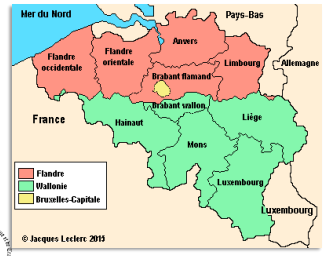


Table 1 National trends in meniscus surgery; APM: Arthroscopic Partial Meniscectomy; N/E: Not Evaluated

Countries	Period	APM	Repair
France	2005–2017	- 21.4% (rate)	+ 320% (rate)
Belgium	2007–2017	- 28.6% (rate)	N/E
Germany	2010–2017	- 30% (number)	+ 55% (number)
Japan	2011–2016	91% to 75% (ratio: APM/meniscus procedures)	9% to 25% (ratio: repair/meniscus procedures)

En 2019
Taux de méniscectomie plus élevé en région Flamande que Wallone

41.6/10.000 VS 24.9/10.000

Jacquet C. et al., « Does practice of meniscus surgery change over time ? A reportt of the 2021 'THE MENISCUS' Webinar », *JEO*, 2021

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Introduction

Malheureusement toutes les lésions ne sont pas réparables

→ **Challenge et développements de techniques**

- Allogreffe méniscale
- Implants méniscaux biodégradables (Menaflex©, Actifit®)

MAIS

Dimensionnement crucial

Beaufils and Verdonk, « The Meniscus », *Springer*, 2010
Lucidi et al., « Satisfactory Clinical Results and Low Failure Rate of Medial Collagen Meniscus Implant (CMI) at a Minimum 20 Years of Follow-Up ». *KSSTA*, 2021
Barlow et al., « Patient-Reported Outcome and Survival Following Meniscal Allograft Transplantation: An International Case Series ». *The Bone & Joint Journal*, 2022

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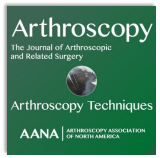
Introduction - Tendances Allogreffes



Trends in Meniscal Allograft Transplantation in the United States, 2007 to 2011

Gregory L. Cvetanovich, M.D., Adam B. Yanke, M.D., Frank McCormick, M.D., Bernard R. Bach Jr., M.D., and Brian J. Cole, M.D., M.B.A.

Procédure peu commune avec incidence faible

Peu d'évolution entre 2007 et 2011

Table 1. Annual Trends in Number of Meniscal Allograft Transplantation Procedures Performed from 2007 to 2011 in PearlDiver US Private Insurance Database, With Estimates of Total Number of MAT Procedures for US Population

Year	No. of MAT Procedures	No. of Patients in Database	Incidence (per 100,000 Patients)	Estimated No. of MAT Procedures for US Population
2007	60	25,525,000	0.24	640
2008	55	26,345,000	0.21	574
2009	62	24,625,000	0.25	697
2010	62	24,810,000	0.25	699
2011	63	25,870,000	0.24	675
Total	302	127,175,000	0.24	3,295
P value	NA	.38	.36	NA

MAT, meniscal allograft transplantation.

Cvetanovich et al., « Trends in Meniscal Allograft Transplant in the US», Arthroscopy: The Journal of Arthroscopic and Related Surgery , 2015

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Introduction - Tendances Allogreffes

Trends in Meniscal Allograft Transplant in the Republic of Korea, 2010-2018

An Analysis Based on the Korean National Health Insurance Claims Database

Jun-Gu Park,* MD, Seong-Il Bin,†‡ MD, PhD, Jong-Min Kim,† MD, PhD, Bum-Sik Lee,† MD, PhD, and Sang-Min Lee,§ MD

Investigation performed at Department of Orthopaedic Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Republic of Korea

Entre 2010 et 2018 → 4791 MAT

2010: 369 → Incidence / 100.000 hab-années: 0.75

2018: 774 → Incidence / 100.000 hab-années: 1.5

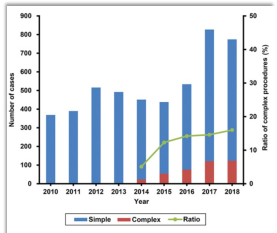

Figure 1. Number of meniscal allograft transplant (MAT) procedures between 2010 and 2018 in the Republic of Korea. "Simple" indicates isolated MAT, and "complex" indicates MAT combined with other procedures, where additional surgery is performed concurrently with MAT.

Park J-G. et al., « Trends in Meniscal Allograft Transplant in the Republic of Korea », *OJSM*, 2021

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Introduction - Tendances Allogreffes

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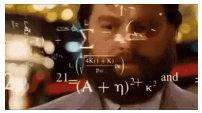
Peu d'études épidémiologiques
Difficile d'évaluer un véritable incidence …

Personal report
Human meniscal allograft transplantation
Ian McDermott, Neil P. Thomas

Calcul rapide du nombre estimé par an

5 millions d'habitants → entre 10 - 50 candidats pour MAT

Belgique = 22 à 110 candidats / an



McDermott I. & Thomas N.P., « Human allograft trasnplantation », *The Knee*, 2006
Milachowski K.A. et al., Homologous meniscus transplantation and clinical results, *International Orthopaedic*, 1989

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Introduction

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Buts de l'étude

1. Valider la méthodologie de segmentation tri-planaire manuelle
2. Effectuer une analyse comparative morphologique et volumétrique du ménisque sain
3. Montrer que les ménisques issus du genou controlatéral pourraient être utilisés comme référence dans le dimensionnement d'une greffe meniscale ou d'un scaffold.

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Matériels et Méthode

- Etude prospective monocentrique *(P2020 / 5252 - B40620200000200)*

Critères d'inclusion	Critères d'exclusion
Volontaires et consentant	Intervention chirurgicale préalable sur un genou
Majeurs (> 18 ans)	Antécédents de fractures, lésions méniscales ou ligamentaires au niveau du genou
Non gravides	Contre-indication à l'IRM
Pas de lésion méniscale connue	

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Matériels et Méthode

Paramètres d'acquisition données IRM

- **Résonnance magnétique** 1.5 Tesla (Philips Medical Systems, Best, Pays-Bas)
- **Séquence** : Volume Isotropic Turbo Spin Écho Acquisition (**VISTA-3D**) - T2

Tableau 1. Paramètres pour le protocole des séquences IRM

Paramètre IRM	Séquence sagittale TSE 3D VISTA
Temps de répétition (ms)	1300
Temps d'écho (ms)	29
Matrice (pixels)	280x228
Champ de vision (cm)	16
Épaisseur de coupe (mm)	0.5x0.5x0.35
Bande passante (kHz)	402.2
Train d'écho (n)	63
Nombre d'excitation (n)	1
Temps d'acquisition (min)	5

Wadhwa et al., « ISAKOS Classification of Meniscal Tears - Illustration on 2D and 3D Isotropic Spin Echo MR Imaging », *European Journal of Radiology*, 2016
Lim et al., « Clinical Value of Fat-Suppressed 3D VISTA Sequence Compared to 2D Sequence in Evaluating Internal Structures of the Knee », *Acta Radiologica*, 2016

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Matériels et Méthode

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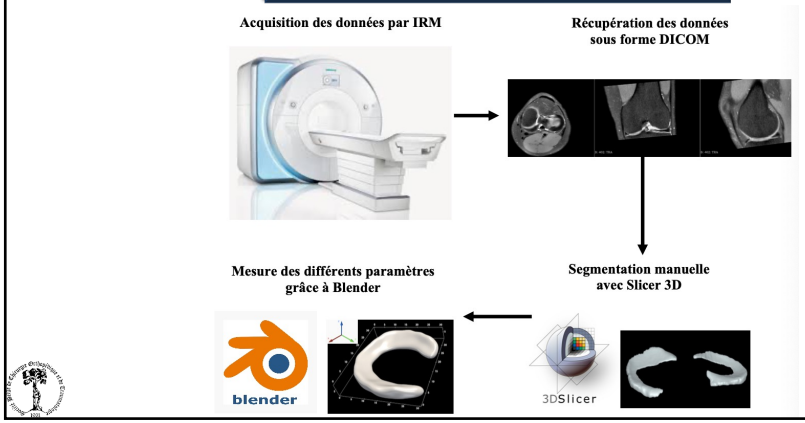
Reconstruction 3D du ménisque



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Matériels et Méthode

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Données recueillies - Données démographiques

Âge
Sexe
Taille
Poids
IMC
Côté dominant

Van Melick et al., « How to determine leg dominance: The agreement between self-reported and observed performance in healthy adults », PLoS ONE, 2017

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Matériels et Méthode

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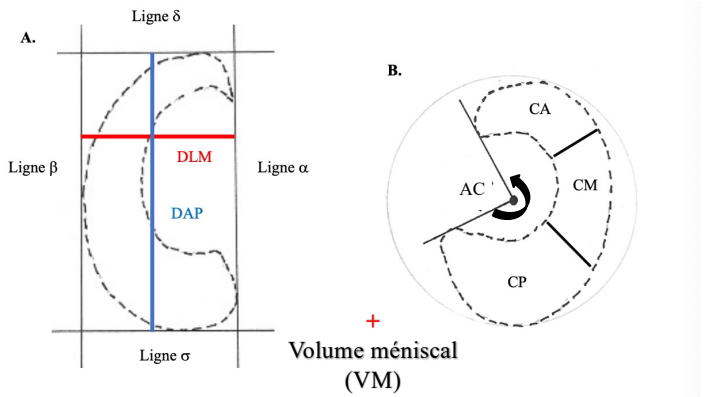
Données recueillies - Données anatomiques



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Matériels et Méthode

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Statistiques

- **Logiciel R®** version 4.2.0 (R Core Team, 2021)
- **Les analyses descriptives** = Moyennes ± IC95%
- Des tests de **T-Student** → Comparer les variables numériques quantitatives des différents groupes
- **La régression linéaire de Pearson** → Corrélations entre variables démographiques et paramètres anatomiques
- **p < 0,05** = Significatif
- **Effets inter et intra-observateurs** → Les coefficients de corrélation intra-classe (ICC)
- **« Test-Retest »** → Coefficient de corrélation de Pearson

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Résultats

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Données démographiques

70 patients

10 exclusions

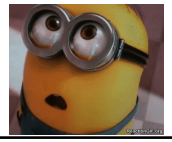
60 patients

♂: 28
♀: 32

39 ans ± 9 ans

Coté dominant — D: 78% / G: 22%

240 Ménisques



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Résultats

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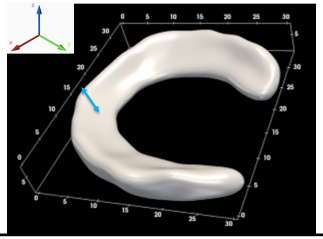
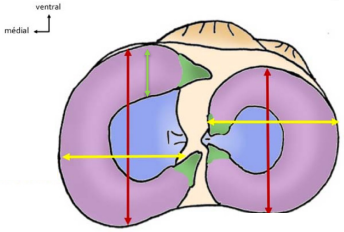
Ménisque « moyen »

Tableau 2. Mesures morphologiques entre les ménisques médial (n=120) et latéral (n=120).

Ménisque	Largeur			Hauteur			DAP	DLM	AC (°)	VM
	CA	CM	CP	CA	CM	CP				
Médial	8.01 ± 0.70	8.37±1.06	12.47± 0.92	6.92±0.62	6.79±0.62	6.99±0.66	45.33±2.99	33.55±2.11	266.7±9.58	1944 ± 284
Latéral	9.11±0.72	10.33±1.09	10.08±1.14	5.38±0.94	7.57±0.47	6.36±0.60	35.83±2.54	34.75±1.78	322.4±6.80	1694±274
p	< 0.001	< 0.001	< 0.001	< 0.001	< 0.004	< 0.001	< 0.023	< 0.001	< 0.001	< 0.001

CA : Corne antérieure (mm) ; CM : Corps méniscal (mm) ; CP : Corne postérieure (mm) ; DAP : distance antéropostérieure (mm) ; DLM : distance latéromédiale (mm) ; AC : angle de couverture (°) ; VM : Volume méniscale (mm³) ; p : valeur de significativité statistique





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Résultats

Comparaison ménisque latéral et médial genoux bilatéraux

P < 0.05

- Aucune différence statistiquement significative

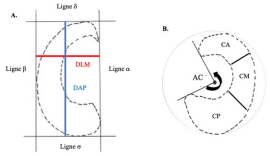
Dominance

P < 0.05

- Aucune différence statistiquement significative

Comparaison homme/femme - Ménisque latéral et médial genoux bilatéraux

- Aucune différence statistiquement significative pour AC
- Les ménisques → + large et haut chez ♂ que ♀
- DAP et DLM → + élevés chez ♂ que ♀



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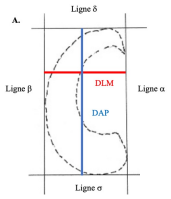
Résultats

Analyse de corrélation

- DAP et DLM → Corrélation +



- IMC
  - Ménisque médial (r = 0.68 ; r = 0.66 ; r = 0.65 et r = 0.63)
  - Ménisque latéral (r = 0.68 ; r = 0.69 ; r = 0.61 et r = 0.60)

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Discussion

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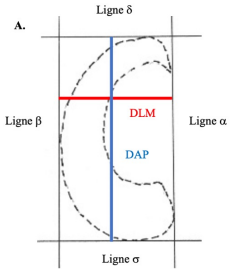
Nos résultats = résultats obtenus par ***Shen et al.*** *et* ***Beeler et al.***

- **Pour la largeur et la hauteur** → Pas de différence ménisque interne/externe lorsque l'on compare les genoux

Ménisque médial

- **AC** → + petit que latéral
- **DAP** → + grande
- **DLM** → + petite

→ forme « elliptique »



Ménisque latéral

- Ménisque latéral DAP et DLM similaires

Beeler et al., « Contralateral MRI Scan Can Be Used Reliably for Three-Dimensional Meniscus Sizing - Retrospective Analysis of 160 Healthy Menisci », *The Knee*, 2019
Beeler et al., « Three-Dimensional Meniscus Allograft Sizing - a Study of 280 Healthy Menisci », *Journal of Orthopaedic Surgery and Research*, 2020
Shen et al., « Morphological Analysis of Normal Meniscus on Magnetic Resonance Imaging (MRI)- Based Three-Dimensional Reconstruction Models in Healthy Chinese Adults », *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 2020

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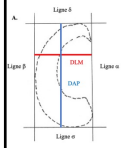
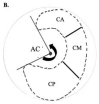
Ménisque médial

- **CP** + large que la CA et que le CM





→ + grande surface de contact pendant le chargement axial et en flexion
→ Expliquer l'incidence élevée des déchirures des CP et de la RP

Largeur et AC → Reflète la couverture du ménisque sur le cartilage articulaire de l'articulation du genou

→ AC + petit en médial
→ + haute susceptibilité à développer une arthrose du compartiment médial

→ Intérêt pour le chirurgien

Wenger et al., « Meniscus Body Position, Size, and Shape in Persons With and Persons Without Radiographic Knee Osteoarthritis: Quantitative Analyses of Knee Magnetic Resonance Images From the Osteoarthritis Initiative: Meniscus Position, Size, and Shape in OA », *Arthritis & Rheumatism*, 2013
Shen et al., « Morphological Analysis of Normal Meniscus on Magnetic Resonance Imaging (MRI)- Based Three-Dimensional Reconstruction Models in Healthy Chinese Adults », *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 2020
Koh et al., « Orthopaedic Biomechanics in Sports Medicine, *Springer*, 2021

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Discussion

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Avantages

- Trouver ménisque 3D le mieux ajusté
- S'adapter aux préférences chirurgicales → Choix de taille
- Améliorer la faisabilité fixation par « bone plugs » ou « bone bridge »
- Utilisation pour implants méniscaux biomimétiques imprimés en 3D

Samitier et al., « Meniscal Allograft Transplantation. Part 1: Systematic Review of Graft Biology, Graft Shrinkage, Graft Extrusion, Graft Sizing, and Graft Fixation », *KSSTA*, 2015
Beeler et al., « Contralateral MRI Scan Can Be Used Reliably for Three-Dimensional Meniscus Sizing - Retrospective Analysis of 160 Healthy Menisci », *The Knee*, 2019
Barlow et al., « Patient-Reported Outcome and Survival Following Meniscal Allograft Transplantation: An International Case Series ». *The Bone & Joint Journal*, 2022

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Discussion

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Limitations

- Les changements de forme du ménisque sous-estimés
  → non-appui
- La tranche d'âge de la population
  → relativement étroite
- Surcoût + perte de temps pour les banques de tissus
  Néanmoins → Avènement de l'IA
  → Gain de temps et d'argent

Tack et al., « Knee Menisci Segmentation Using Convolutional Neural Networks: Data from the Osteoarthritis Initiative », *Osteoarthritis and Cartilage*, 2018
Shen et al., « Morphological Analysis of Normal Meniscus on Magnetic Resonance Imaging (MRI)- Based Three-Dimensional Reconstruction Models in Healthy Chinese Adults », *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 2020

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Conclusions & Perspectives

- Validation méthodologie segmentation tri-planaire
- Descrip… …mal in vivo
- Démont… …ménisques gauche
- → …ement 3D

Développer des outils permettant une segmentation **semi-automatique** voire **automatique** grâce à l'avènement de l'**IA**

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Merci de votre attention

Des questions ?

?

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Perspectives actuelles

UNIVERSITÉ DU LUXEMBOURG

1. Développement d'une méthode de segmentation automatisée via IA

2. Comparer notre méthode aux méthodes standards

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Allogreffes Méniscales

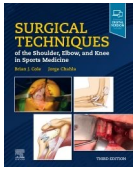
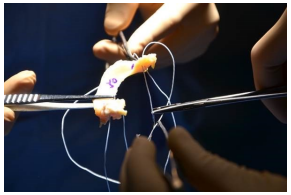


TABLE 1

Indications	Contraindications
Age < 50-55 y	Age > 55 y
Persistent unicompartmental pain, failure of non-operative treatments	Knee instability
Previous total or subtotal meniscectomy	Generalized/grade-IV degenerative compartmental cartilage changes
Outerbridge grade < 3 articular changes	Marked radiographic changes such as femoral condyle flattening and osteophyte formation
Correct alignment	Varus/valgus malalignment
No ligament laxity	Synovial disease Inflammatory arthritis Obesity



Verdonk P. et al., « Meniscus substitution: The European perspective on scaffolds, allografts & prosthetic implants», *Elsevier, 2022*

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Implants méniscaux

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Table 1
Overview scaffolds

Scaffold	Manufacturer, Country	Composition	Indication	Patient	Approval certificates	Surgical technique	Failure rate
Collagen Meniscal Implant	Ivy Sports Medicine, Germany	3D-collagen type 1 network derived from bovine Achilles tendon enriched with glycosaminoglycans	Postmeniscectomy syndrome Partial meniscectomy	<50 years ≤ICRS 3	FDA+CE	Arthroscopy	6.7%
Actifit	Orteq Sports Medicine, UK	Acellular synthetic polyurethane (20%) and polycapralactone (80%)	Postmeniscectomy syndrome Partial meniscectomy	<50 years ≤ICRS 3 Small defects with intact vascularised rim	FDA+CE	Arthroscopy	5.6%
NUsurface	Active Implants, USA	Medial, non-anchored implant PCU matrix embedded with UHMWPE reinforcement fibres	Partial meniscectomy Medial OA Partial meniscectomy Postmeniscectomy syndrome	30–60 years <ICRS 4 ≥2 mm meniscal rim	Available in Germany, Italy, Belgium, Israel and the UK Investigational device by FDA	Arthrotomy	Insufficient clinical research
MaioRegen	Fineramica, Italy	Trilayered structure; smooth chondral layer (type 1 collagen), intermediate layer (60% type 1 collagen and 40% hydroxyapatite) and a deeper mineralised subchondral bone layer (30% type 1 collagen and 70% hydroxyapatite).	Osteochondral defects	Circa 4 cm^2 ICRS <4 30–40 years	CE	Arthrotomy	Insufficient clinical research
Agili-C	CartiHeal, Israel	Cell-free, calcium carbonate in aragonate crystalline scaffold	Full-thickness symptomatic OCD Circa 2.5 cm^2	Circa 2.5 cm^2 <40 years	CE Investigational device by FDA	Arthrotomy	Insufficient clinical research

CE, Conformité Européenne; FDA, Food & Drug Administration; ICRS, International Cartilage Repair Society classification; OA, oesteoarthritis; OCD, osteochondral defect; PCU, polycarbonate-urethane; UHMWPE, ultrahigh molecular weight polyethylene.

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CMI & Actifit

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Table 2
Overview last 5 years of literature on Collagen Meniscal Implant (CMI)

Title	Study form	Level	Cohort	Follow-up	Results	Failure
Kovacs, 2019[23]	Case series	IV	57 patients Mean 43.6 years	3–8 years	Abnormal signal intensity postoperative on MRI not correlated with good clinical results	Not assessed
Marcheggiani Muccioli, 2020[19]	Case report	IV	34 years, patient	10 years	Positive 10-year follow-up results in professional soccer player treated with lateral CMI	Not assessed
Schenk, 2020[24]	Case series	IV	39 patients, mean age 34 years	3–7 years	Good to excellent clinical longer-term outcomes. Bone marrow oedema decreased from 1 year to longer term follow-up	Not assessed
Houck, 2018[27]	Systematic review	IV	658 patients 347 Actifit 311 CMI	44 months	CMI or Actifit scaffold improve clinical outcomes in association with concomitant procedures	Actifit 9.9% CMI 6.7%

Table 3
Overview last 5 years of literature on Actifit

Title	Study form	Level	Cohort	Follow-up	Results	Failure
Faivre, 2015[29]	Prospective case study	IV	20 patients Mean age 28.7 years	2 years	Preoperative meniscal extrusion in the coronal plane strongly predicts clinical and morphological outcomes.	15%
Rammuthu, 2019[25]	Systematic review	/	224 patients 121 Actifit 103 CMI Mean age 30–39 years	24–72 months	The scaffolds produce positive clinical outcomes Lack of higher-level evidence and the need for standardisation	0%–31.8%
Bulgheroni, 2016[18]	Comparative study	/	28 CMI 25 Actifit	≤2 years	Both scaffolds are effective in improving patients' symptoms and joint function at short-term follow-up.	7% CMI 36% Actifit
Filardo, 2015[25]	Systematic review	/	613 patients 444 CMI 169 Actifit	6–120 months	Safety and positive results have been shown for both scaffolds. Literature lacks randomised trials at long-term follow-up.	6.1%
Dangelmajer, 2017[32]	Systematic review	/	191 CMI 80 Actifit 926 MAT	12–133.2 months	Limited number of studies on both MAT and scaffolds with mainly short-term results.	5.6%, average 6.9% reoperation
Toanen, 2020[4]	Case series	IV	155 patients	≤5 years	Improvement of knee joint function and reduction pain in patients with segmental meniscal deficiency.	23 treatments
Schüttler, 2016[70]	Case series	IV	18 patients	48 months	Sustainable mid-term results in pain reduction and knee function.	Not assessed
Shin, 2018[31]	Meta-analysis	III	18 studies including 489 patients treated	12–72 months	Actifit is viable alternative for patients with partial meniscal defects. Further studies are needed.	Not assessed
Drobnič, 2019[71]	Literature review	IV			Short-term pain relief is provided by non-surgical management, mid-term pain relief by meniscus scaffolds and long-term relief by MAT, though each has differing indications	

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MaioRegen & NuSurface

Table 5
Overview last 5 years of literature on MaioRegen

Title	Study form	Level	Cohort	Follow-up	Results	Failure
Christensen, 2016[47]	Prospective study	IV	10 patients 6 knees/4 ankles Mean size 3.0 cm^2	2.5 years	Incomplete cartilage repair and poor subchondral bone repair at 1-year and 2.5-year follow-up.	20%
Guérin, 2020[48]	Retrospective study	III	17 patients Mean age 28 years Mean size 4.5 cm^2	2 years	A good option for large focal osteochondral defects. MRI does not provide satisfactory medium-term assessment.	Not assessed
Mathis, 2018[44]	Case series	IV	14 patients Mean age 33 years Mean size ≤3.5 cm^2	1 year	A significant clinical improvement at 1-year follow-up. Osseointegration was still ongoing at 12-month follow-up.	Not assessed
Perdisa 2018[41]	Case series	IV	27 patients Mean age 25.5 years Mean size 3.4 cm^2	≤5 years	Good, stable results up to 60 months for knee osteochondral defects. MRI showed abnormalities, but overall improvement over time.	Not assessed
Verdonk, 2015[72]	Case series	IV	38 patients Mean age 30.5 years Mean size 3.7 cm^2	2 years	Satisfactory clinical outcome and filling of the defect on MRI.	5.3%
D'Ambrosi, 2019[42]	Systematic review	I–IV	471 patients Mean age 34 years Mean size 3.6 cm^2	4 studies >24 months	Promising satisfactory and reliable results at mid-term. Low rate of complications and failure confirming the safety of this scaffold.	1.48%

Table 4
Overview last 5 years of literature on NuSurface

Title	Study form	Level	Cohort	Follow-up	Results	Failure
Shemesh, 2020[95]	Clinical trial	IV	Analysis of 72 knees implanted to simulate in cadaveric knees	24 months	Re-establishment of normal load distribution with medial NUsurface implant to 93%, without increasing load on lateral knee compartment.	Not assessed
Verhaeghe, 2018[97]	Case report	IV	55-year-old man	5 years	Suprapatellar luxation of NUsurface implant.	Not assessed
Elsner, 2015[34]	Clinical trial	IV	3 implants tested in knee simulator	5 million load cycles=5 years in vivo	Mild abrasion on micro-CT on superficial surfaces of implant.	Not assessed
Vrancken, 2017[96]	Controlled lab study	III	26 goats	12 months	Resistance to wear and deformation after physiological loading. Reinforcement of the implant horns to prevent horn failure. The progression of damage similar to allograft group.	One fixation failure

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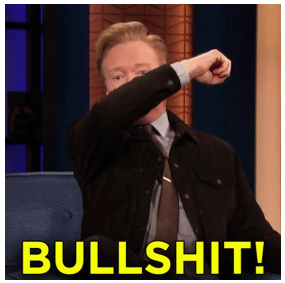
Meniscectomy VS Repair - Aspects financiers



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Introduction - Tendances Allogreffes

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Ok mais concrètement

Personal report

Human meniscal allograft transplantation

Ian McDermott, Neil P. Thomas

Calcul Rapide du nombre estimé par an

USA: 742 / an
Corée: 1125 / an

McDermott I. & Thomas N.P., « Human allograft trasnplantation », *The Knee*, 2006

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Meniscectomy VS Repair - Aspects financiers

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Meniscectomy VS Repair & knee OA

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Meniscectomy VS Repair & knee OA

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