

Literaturverzeichnisse 2024

Inhaltsverzeichnis

[01-2024: Literaturverzeichnis Koehl, Rueth, Dietrich, Wittmann, Schuh](#)

[01-2024: Literaturverzeichnis Rueth, Koehl, Schuh](#)

[01-2024: Literaturverzeichnis Schuh, Koehl, Pulido, Unterpaintner, Benditz](#)

[01-2024: Literaturverzeichnis Ullrich, Scheyerer, Spiegl, Mendel, Schnake](#)

[01-2024: Literaturverzeichnis Spiegl, Scheyerer, Ullrich, Schnake](#)

[01-2024: Literaturverzeichnis Michalke](#)

[01-2024: Literaturverzeichnis Benditz](#)

[02-2024: Literaturverzeichnis Frebel](#)

[02-2024: Literaturverzeichnis Heikenfeld](#)

[02-2024: Literaturverzeichnis Eberle](#)

[02-2024: Literaturverzeichnis Hückstädt, Schipper, Fischer, Langwald, Mendel, Klauke, Kobbe](#)

[02-2024: Literaturverzeichnis Reumann, Ohmann, Glombitza, von Engelhardt](#)

[02-2024: Literaturverzeichnis von Engelhardt](#)

[03-2024: Literaturverzeichnis Thier, Becher, Zimmerer](#)

[03-2024: Literaturverzeichnis Hoburg, Plaaß, Steens](#)

[03-2024: Literaturverzeichnis Steens, Roessler](#)

[03-2024: Literaturverzeichnis Diemer, Benitz, Schoch](#)

[03-2024: Literaturverzeichnis Werry](#)

[03-2024: Literaturverzeichnis Leutheuser, Zellner, Buhs, Ruhnau](#)

Literaturverzeichnisse 2024

Inhaltsverzeichnis

Literatur zum Beitrag

Philipp Koehl, Markus-Johannes Rueth, Maria Dietrich, Mathias Wittmann, Alexander Schuh:

Symphysisitis und Symphysenlockerung

1. Angoules AG. Osteitis pubis in elite athletes: Diagnostic and therapeutic approach. *World J Orthop.* 2015 Oct 18;6(9):672–679
2. Becker I, Woodley SJ, Stringer MD. The adult human pubic symphysis: a systematic review. *J Anat.* 2010 Nov;217(5):475–487
3. Chang JL, Wu V. External fixation of pubic symphysis diastasis from post-partum trauma. *Orthopedics.* 2008 May;31(5):493
4. Chawla JJ, Arora D, Sandhu N, Jain M, Kumari A. Pubic Symphysis Diastasis: A Case Series and Literature Review. *Oman Med J.* 2017 Nov;32(6):510–514
5. Devlieger B, Wagner D, Hopf J, Rommens PM. Surgical debridement of infected pubic symphysis supports optimal outcome. *Arch Orthop Trauma Surg.* 2021 Nov;141(11):1835–1843
6. Fridrich F, Bába V, Džupa V. Infekční zánět symfýzy (symphysisitis pubis purulenta): pět kazuistik a pohled literatury [Infectious Inflammation of Pubic Symphysis (Symphysisitis Pubis Purulenta): Five Case Reports and Literature View]. *Acta Chir Orthop Traumatol Cech.* 2016;83(6):411–417
7. Gaudino F, Weber MA. Osteitis pubis oder Symphysisitis pubis. *Radiologe.* 2019 Mar;59(3):218–223
8. Gräf C, Sellei RM, Schrading S, Bauerschlag DO. Treatment of parturition-induced rupture of pubic symphysis after spontaneous vaginal delivery. *Case Rep Obstet Gynecol.* 2014;2014:485916
9. Hagen R. Pelvic girdle relaxation from an orthopaedic point of view. *Acta Orthop Scand.* 1974;45(4):550–563
10. Herren C, Dienstknecht T, Siewe J, Kobbe P, Pape HC, Hildebrand F. Die Chronische Symphyseninstabilität: Ätiologie, Diagnostik und Behandlungsmanagement. *Unfallchirurg.* 2016 May;119(5):433–446
11. Hierholzer C, Ali A, Toro-Arbelaez JB, Suk M, Helfet DL. Traumatic disruption of pubis symphysis with accompanying posterior pelvic injury after natural childbirth. *Am J Orthop (Belle Mead NJ).* 2007 Nov;36(11):E167–170
12. Kelm J, Ludwig O, André J, Maas S, Hopp S. Was wissen wir über die Osteitis pubis bei Sporttreibenden? *Sportverletz Sportschaden.* 2018 Feb 8. German. doi: 10.1055/s-0043–122763
13. Kubitz RL, Goodlin RC. Symptomatic separation of the pubic symphysis. *South Med J* 1986; 79:578–580
14. Müller M, Greve F, Zyskowski M, Wurm M, Biberthaler P, Kirchhoff C. Fixateure externe zur Behandlung der intrapartalen Symphysensprengung: Fallbericht und Diskussion. *Unfallchirurg.* 2021 Aug;124(8):673–677
15. Parker JM, Bhattacharjee M. Images in clinical medicine. Peripartum diastasis of the symphysis pubis. *N Engl J Med.* 2009 Nov 5;361(19):1886
16. Petsatodis G, Stavridis SI, Karataglis D, Christodoulou A. Surgical treatment of a twice recurrent chondrosarcoma of the pubic symphysis: a case report and review of the literature. *Cases J.* 2009 Jun 29;2:6769
17. Schmal H, Klemm C, Südkamp N. Chirurgische Anatomie von Beckenring und Azetabulum, osteoligamentäre Strukturen, neurovaskuläre Strukturen und Weichteile. *OP-Journal* 2003; 19: 94–98
18. Schoellner C, Szöke N, Siegburg K. Der schwangerschaftsassozierte Symphysenschaden aus orthopädischer Sicht – Untersuchungen zu Veränderungen an der Symphysis pubica in der Schwangerschaft, unter der Geburt und post partum. *Z Orthop Ihre Grenzgeb.* 2001 Sep-Oct;139(5):458–462
19. Serner A, Arnaiz J, Mosler A et al.. Classifying radiographic changes of the pubic symphysis in male athletes: Development and reproducibility of a new scoring protocol. *Eur J Radiol.* 2021 Jan;134:109452
20. Shnaekel KL, Magann EF, Ahmadi S. Pubic Symphysis Rupture and Separation During Pregnancy. *Obstet Gynecol Surv.* 2015 Nov;70(11):713–8
21. Shu HT, Elhessy AH, Conway JD, Burnett AL, Shafiq B. Orthopedic management of pubic symphysis osteomyelitis: a case series. *J Bone Jt Infect.* 2021 Jul 16;6(7):273–281
22. Weber MA. Sportlerleiste – „Sportsmen’s groin“. *Radiologie (Heidelb).* 2023 Apr;63(4):268–274
23. Zimmerer A, Ramirez L, Astarita E, Bellotti V, Cárdenas C, Ribas M. Arthroskopisch assistierte minimal-invasive Symphysioplastik zur Behandlung des schambeinbezogenen Leistenbeschmerzes. *Oper Orthop Traumatol.* 2022 Apr;34(2):109–116

Literatur zum Beitrag

Markus-Johannes Rueth, Philipp Koehl, Alexander Schuh

Verletzungen Ischiofemorale

Immer konservativ?

- Ahmad SS, Konrads C, Niemann M, Stöckle U, Windhagen H, Giebel GM. The Female Pelvis Is Associated with a Lateralized Ischium and a Reduced Ischiofemorale Space. *J Clin Med*. 2023 Feb 17;12(4):1603
- Albtoush OM, Bani-Issa J, Zitzelsberger T, Springer F. Avulsion Injuries of the Pelvis and Hip. *Rofo*. 2020 May;192(5):431–440
- Anders A, Vitale K. Rare case of hip pain due to iliopsoas tendon rupture; a case report and review of the literature. *J Rehabil Med Clin Commun*. 2022 Aug 18;5:2541
- Anderson K, Strickland SM, Warren R. Hip and groin injuries in athletes. *Am J Sports Med* 2001;29:521–533
- Bano A, Karantanas A, Pasku D, Datsaris G, Tzanakakis G, Katonis P. Persistent sciatica induced by quadratus femoris muscle tear and treated by surgical decompression: a case report. *J Med Case Rep*. 2010 Aug 2;4:236
- Bech NH, Haverkamp D. Impingement around the hip: beyond cam and pincer. *EFORT Open Rev*. 2018 Feb 21;3(2):30–38
- Best R, Meister A, Huth J, Becker U, Meier M. Surgical repair techniques, functional outcome, and return to sports after apophyseal avulsion fractures of the ischial tuberosity in adolescents. *Int Orthop*. 2021 Jul;45(7):1853–1861
- Biedert RM. Surgical management of traumatic avulsion of the ischial tuberosity in young athletes. *Clin J Sport Med*. 2015 Jan;25(1):67–72
- Bonshahi AY, Knowles D, Hodgson SP. Isolated lesser trochanter fractures in elderly – a case for prophylactic DHS fixation. A case series. *Injury*. 2004 Feb;35(2):196–198
- Bui KL, Ilaslan H, Recht M, Sundaram M. Iliopsoas injury: an MRI study of patterns and prevalence correlated with clinical findings. *Skeletal Radiol*. 2008 Mar;37(3):245–249
- Calderazzi F, Nosenzo A, Galavotti C, Menozzi M, Pogliacomi F, Ceccarelli F. Apophyseal avulsion fractures of the pelvis. A review. *Acta Biomed*. 2018 Nov 15;89(4):470–476
- Cho HS, Lee YK, Yoon BH, Park JW, Ha YC, Koo KH. Isolated Avulsion Fracture of the Lesser Trochanter in Adults. *In Vivo*. 2020 Nov-Dec;34(6):3519–3526
- Davey N, Soh J, Heffernan E, O’Shea D. Spontaneous Iliopsoas tendon rupture: a rare cause of hip pain in an older person. *Age Ageing*. 2017 Nov 1;46(6):1015
- DePasse JM, Varner K, Cosculluela P, Incavo S. Atraumatic avulsion of the distal iliopsoas tendon: an unusual cause of hip pain. *Orthopedics*. 2010 Aug 11;33(8)
- Di Maria F, Testa G, Sammartino F, Sorrentino M, Petrantonio V, Pavone V. Treatment of avulsion fractures of the pelvis in adolescent athletes: A scoping literature review. *Front Pediatr*. 2022 Sep 23;10:947463
- Dimon JH 3rd. Isolated fractures of the lesser trochanter of the femur. *Clin Orthop Relat Res* 1972;82:144–148
- Domínguez-Gasca LG, Alcocer-Maldonado JL, Magaña-Reyes J, Domínguez-Carrillo LG. Quadratus femoris muscle tear. *Acta Ortop Mex*. 2016 Sep-Oct;30(5):264–266
- Ejnisman L, Andrade-Silva FB, Pontin PA, Ottoni JJ, Magliocca GD, Safran MR. Nonoperative Treatment of Psoas Tendon Avulsion in a Professional Athlete: A Case Report and Evidence Based Review. *JBS Case Connect*. 2020 Apr-Jun;10(2):e0490
- Emam M, Farmakidis C, Lee SW, Wainapel SF. Spontaneous Iliopsoas Tendon Rupture: An Uncommon Cause of Hip Pain in Elderly Patients. *PM R*. 2016 Jan;8(1):75–77
- Fasting OJ. Avulsion of the lesser trochanter. *Arch Orthop Trauma Surg*. 1978, 91:81–83
- Freire V, Bureau NJ, Deslandes M, Moser T. Iliopsoas tendon tear: clinical and imaging findings in 4 elderly patients. *Can Assoc Radiol J*. 2013 Aug;64(3):187–192
- Gollwitzer H, Banke JJ, Schauwecker J, Gerdesmeyer L, Suren C. How to address ischiofemorale impingement? Treatment algorithm and review of the literature. *J Hip Preserv Surg*. 2017 Aug 31;4(4):289–298
- Johnson KA. Impingement of the lesser trochanter on the ischial ramus after total hip arthroplasty. Report of three cases. *J Bone Joint Surg Am*. 1977 Mar;59(2):268–169
- Khemka A, Raz G, Bosley B, Ludger G, Al Muderis M. Arthroscopically assisted fixation of the lesser trochanter fracture: A case series. *J Hip Preserv Surg* 2014;1:27–32
- Kheterpal AB, Harvey JP, Hussein JS, Martin SD, Torriani M, Bredella MA. Hip abductor tears in ischiofemorale impingement. *Skeletal Radiol*. 2020 Nov;49(11):1747–1752
- Lecouvet FE, Demondion X, Leemrijse T, Vande Berg BC, Devogelaer JP, Malghem J. Spontaneous rupture of the distal iliopsoas tendon: clinical and imaging findings, with anatomic correlations. *Eur Radiol*. 2005 Nov;15(11):2341–2346
- Linni K, Mayr J, Höllwarth ME. Apophysenfrakturen des Beckens und des Trochanter minor bei 20 Adoleszenten und 2 Kleinkindern. *Unfallchirurg*. 2000 Nov;103(11):961–964
- Liu H, Zhang Y, Rang M, et al.. Avulsion Fractures of the Ischial Tuberosity: Progress of Injury, Mechanism, Clinical Manifestations, Imaging Examination, Diagnosis and Differential Diagnosis and Treatment. *Med Sci Monit*. 2018 Dec 27;24:9406–9412
- Lohrer H. Avulsionsverletzungen der Adduktoren und des Iliopsoas. *Unfallchirurg*. 2021 Jul;124(7):550–559
- López-Royo MP, Valero-Tena E, Roca M. Anatomical analysis of the pelvis to identify any predisposing anatomical factors for ischiofemorale space pathology: a retrospective study. *Br J Radiol*. 2020 Apr;93(1108):20190556
- Maheshwari AV, Malhotra R, Kumar D, Pitcher JD Jr. Rupture of the iliopsoas tendon after a total hip arthroplasty: an unusual cause of radio-lucency of the lesser trochanter simulating a malignancy. *J Orthop Surg Res*. 2010 Feb 5;5:6
- McKinney BI, Nelson C, Carrion W. Apophyseal avulsion fractures of the hip and pelvis. *Orthopedics*. 2009, 32:42
- McMillan T, Rehman H, Mitchell M. Lesser trochanter avulsion fracture in an adolescent after seizure. *J Emerg Med* 2016;51:457–460
- Miyake Y, Mitani S, Namba Y, Kikuoka R. An Avulsion Fracture of the Lesser

- Trochanter of the Femur with Prodromal Symptoms in an adult: A Case Report and Review of Literature. *J Orthop Case Rep.* 2022 Aug;12(8):1–4
35. Nauta HJA, van der Made AD, Tol JL, Reurink G, Kerkhoffs GM. Satisfactory clinical outcome of operative and non-operative treatment of avulsion fracture of the hamstring origin with treatment selection based on extent of displacement: a systematic review. *Knee Surg Sports Traumatol Arthrosc.* 2021 Jun;29(6):1813–1821
 36. O'Brien SD, Bui-Mansfield LT. MRI of quadratus femoris muscle tear: another cause of hip pain. *AJR Am J Roentgenol.* 2007 Nov;189(5):1185–1189
 37. Palczewski P, Sułkowska K, Świątkowski J, Kocoń H, Gołębiowski M. Ischiofemoral Impingement Syndrome: A Case Report and a Review of Literature. *Pol J Radiol.* 2015 Nov 5;80:496–498
 38. Pallis D, Tsvilekas K, Ampadiotaki MM, Nikolakakos P, Papadakis SA. Isolated Avulsion Fracture of the Lesser Trochanter in an Adolescent: A Case Report and Review of the Literature. *Cureus.* 2023 Mar 26;15(3):e36693
 39. Papavasiliou KA, Stamiris D, Stamiris S, Bintoudi A, Tsiridis E. Quadratus Femoris Partial Tear Secondary to Occult Ischiofemoral Impingement. *J Orthop Case Rep.* 2021 Sep;11(9):7–11
 40. Quarrier NF, Wightman AB. A ballet dancer with chronic hip pain due to a lesser trochanter bony avulsion: The challenge of a differential diagnosis. *J Orthop Sports Phys Ther* 1998;28:168–173
 41. Rajakulasingam R, Azzopardi C, Dutton P, Beale D, Botchu R. Spontaneous Isolated Iliopsoas Tendon Tear in Elderly-Case Report and Review of Literature. *Indian J Radiol Imaging.* 2021 Sep 7;31(3):719–720
 42. Reintgen C, Bruner M, Smith MS, Moser M. Traumatic Obturator Internus and Quadratus Femoris Injury in a Pediatric Patient: A Case Report. *Sports Health.* 2021 Jul-Aug;13(4):387–389
 43. Rubio M, Rodriguez M, Patnaik S, Wang P. Spontaneous Iliopsoas Tendon Tear: A Rare Cause of Hip Pain in the Elderly. *Geriatr Orthop Surg Rehabil.* 2016 Mar;7(1):30–32
 44. Ruffing T, Danko T, Muhm M, Arend G, Winkler H. Traumatische Apophysenlösung des Trochanter minor. *Unfallchirurg.* 2012 Jul;115(7):653–655
 45. Rutetzki K, Palm HG, Friemert B et al.. Avulsion Fractures of the Ischial Tuberosity and Resulting Ischiofemoral Impingement – a Case Report with Literature Review. *Z Orthop Unfall.* 2019 Jun;157(3):308–315
 46. Schenkel M, Kaniewska M, Bühler T, Anderson S, Eid K. No difference in flexion power despite iliopsoas fatty degeneration in healed hip fractures with large lesser trochanter displacement. *Eur J Orthop Surg Traumatol.* 2018 Oct;28(7):1313–1319
 47. Schulze A, Schmittenebecher PP. Apophysenaurisse in der Beckenregion im Kindes- und Adoleszentenalter. *Unfallchirurg.* 2021 Jul;124(7):519–525
 48. Sellén E, Brink O, Zejden A. A rarely diagnosed cause of acute hip and groin pain in an 86-year-old woman. *Ugeskr Laeger.* 2020 Oct 5;182(41):V09190522
 49. Singer AD, Subhawong TK, Jose J, Tresley J, Clifford PD. Ischiofemoral impingement syndrome: a meta-analysis. *Skeletal Radiol.* 2015 Jun;44(6):831–837
 50. Singh P, Kumar A, Shekhawat V, Singh P. Nonpathological Lesser Trochanter Fracture in Adult: Case Report and Brief Review of Literature. *J Clin Diagn Res.* 2015 Nov;9(11):RD04–5
 51. Sinikumpu JJ, Hetsroni I, Schilders E, Lempainen L, Serlo W, Orava S. Operative treatment of pelvic apophyseal avulsions in adolescent and young adult athletes: a follow-up study. *Eur J Orthop Surg Traumatol.* 2018 Apr;28(3):423–429
 52. Smith N, Fackrell R, Henderson E. Ciprofloxacin-associated bilateral iliopsoas tendon rupture: a case report. *Age Ageing.* 2016 Sep;45(5):737–738
 53. Somville F, Vriends D, Feyen J. Traumatic avulsion fracture of the ischial tuberosity in an elderly patient. *Acta Orthop Belg.* 2011 Feb;77(1):122–124
 54. Spencer-Gardner L, Bedi A, Stuart MJ, Larson CM, Kelly BT, Krych AJ. Ischiofemoral impingement and hamstring dysfunction as a potential pain generator after ischial tuberosity apophyseal fracture non-union/malunion. *Knee Surg Sports Traumatol Arthrosc.* 2017 Jan;25(1):55–61
 55. Stafford GH, Villar RN. Ischiofemoral impingement. *J Bone Joint Surg Br* 2011;93:1300–1302
 56. Stark J. Spontaneous iliopsoas tendon rupture: a case report and brief review. *Arch Orthop Trauma Surg.* 2021 Oct;141(10):1633–1637
 57. Sun Q, Ge W, Hu H et al.. The Influence of Position of the Displaced Lesser Trochanter on Clinical Outcome of Unstable Trochanteric Femur Fractures in the Elderly. *Biomed Res Int.* 2018 Oct 21;2018:5013646
 58. Suren C, Burgkart R, Banke IJ, Hertel G, Schauwecker J, von Eisenhart-Rothe R, Gollwitzer H. Chirurgische Therapie des ischiofemorale Impingements mittels lateralisierender intertrochantärer Korrekturosteotomie. *Oper Orthop Traumatol.* 2018 Apr;30(2):98–110
 59. Sussman WI, Han E, Schuenke MD. Quantitative assessment of the ischiofemoral space and evidence of degenerative changes in the quadratus femoris muscle. *Surg Radiol Anat.* 2013 May;35(4):273–281
 60. Tahir T, Manzoor QW, Gul IA, Bhat SA, Kangoo KA. Isolated Avulsion Fractures of Lesser Trochanter in Adolescents – A Case Series and Brief Literature Review. *J Orthop Case Rep.* 2019 Jan-Feb;9(1):11–14
 61. Ten B, Beger O, Balci Y, Duce MN, Beger B. Ischiofemoral space dimensions for ischiofemoral impingement: is it different in children? *Skeletal Radiol.* 2022 Mar;51(3):625–635
 62. Theologis TN, Epps H, Latz K, Cole WG. Isolated fractures of the lesser trochanter in children. *Injury* 1997;28:363–364
 63. Tzaveas A, Anastasopoulos N, Paraskevas G, Natsis K. A Rare Case of Quadratus Femoris Muscle Rupture After Yoga Exercises. *Clin J Sport Med.* 2016 Sep;26(5):e105–107
 64. Uzun E, Çirakli A, Günay AE and Mutlu M: Trochanter minor avulsion fracture in an old patient: Greater care in the diagnosis of hip pain in the elderly. *Akademik Acil Tip Olgu Sunumları Dergisi* 2016; 7(4): 77–79
 65. Volpi A, Matzko C, Fegghi D, Matheney T, Bharam S. Conservative Treatment of Avulsion Injuries of the Lesser Trochanter in Adolescent Athletes. *Cureus.* 2021 Jun 14;13(6):e15638
 66. Willick SE, Lazarus M, Press JM. Quadratus femoris strain. *Clin J Sport Med.* 2002 Mar;12(2):130–131
 67. Wirth T. Avulsionsverletzungen der Hüftregion des Jugendlichen. *Orthopäde.* 2016 Mar;45(3):213–218
 68. Yang AL, Mao W, Wu JG et al.. When to Reduce and Fix Displaced Lesser Trochanter in Treatment of Trochanteric Fracture: A Systematic Review. *Front Surg.* 2022 Mar 25;9:855851
 69. Zhang Q, Han D, Ying L et al.. Arthroscopic Lesser Trochanter Osteoplasty, Quadratus Femoris Debridement, and Sciatic Neurolysis via Posterior Approach for Ischiofemoral Impingement. *Front Surg.* 2022 Feb 16;9:805866
 70. Zibis AH, Fylos AH, Karantanas AH, Raoulis V, Karachalios TS, Arvanitis DL. Quadratus femoris tear as an unusual cause of hip pain: a case report. *Hip Int.* 2016 Feb 8;26(1):e7–9

Literatur zum Beitrag

Alexander Schuh, Philipp Koehl, Loreto C. Pulido, Inge Unterpaintner, Achim Benditz:

Das Iliosakralgelenk Von der Anatomie zur Therapie

1. Laux CJ, Osterhoff G, Werner CM. Das schmerzhafte ISG – diagnostischer Algorithmus und therapeutische Möglichkeiten. *Praxis* 2015; 104 (1): 33–39
2. Schenker A, Schiltenwolf M, Schwarze M, Pepke W, Hemmer S, Akbar M. Schmerzquelle Iliosakralgelenk: Funktionelle Anatomie, Symptome und klinische Bedeutung. *Orthopade*. 2020 Nov;49(11):1000–1005
3. Schneider M. Das schmerzhafte Iliosakralgelenk. Historie und neue Erkenntnisse. *Schmerzmedizin* 2021; 37 (4):31–35
4. Schwarze M, Schenker A, Schiltenwolf M, Akbar M. Iliosakralgelenk und Schmerz. *Schmerz*. 2020 Aug;34(4):357–368.
5. Völker A, Steinke H, Heyde CE. The Sacroiliac Joint as a Cause of Pain – Review of the Sacroiliac Joint Morphology and Models for Pain Genesis. *Z Orthop Unfall*. 2022 Oct;160(5):507–516
6. Pieroh P, Fakler J, Heyde CE, Nowak T, Rommens P, Wagner D: Sakrumfrakturen – Fragilitätsfrakturen. *Die Wirbelsäule* 2021; 5: 172–179
7. Bornemann R, Pflugmacher R, Koch EMW, Roessler PP, Rommelspacher Y, Wirtz DC, Frey SP. Moderne Diagnostik und minimalinvasive Operationsmethoden bei Patienten mit schmerzhaftem Iliosakralgelenksyndrom. *Z Orthop Unfall*. 2017 Jun;155(3):281–287
8. Janka M, Füssel S, Unterpaintner I, Schuh A. Sacroiliac joint fusion: indication and results. *MMW Fortschr Med*. 2017 Feb;159(2):49–52
9. Matias CM, Velagapudi L, Montenegro TS, Heller JE. Minimally Invasive Sacroiliac Fusion—a Review. *Curr Pain Headache Rep*. 2022 Mar;26(3):173–182
10. Paparella I, LeBlanc ARH, Doschak MR, Caldwell MW. The iliosacral joint in lizards: an osteological and histological analysis. *J Anat*. 2020 Apr;236(4):668–687
11. Wahisi SW. Fusion der Iliosakralgelenke 4-Jahresresultate mit klinischen und radiologischen Befunden nach minimal-invasiven Operationen. Inauguraldissertation 2022
12. Ashby K, Yilmaz E, Mathkour M et al.. Ligaments stabilizing the sacrum and sacroiliac joint: a comprehensive review. *Neurosurg Rev*. 2022 Feb;45(1):357–364
13. Mohadjer S. Diagnose und Therapie des „Iliosakralgelenk-Syndroms“. Inauguraldissertation 2008
14. Steinke H, Saito T, Kuehner J et al.. Sacroiliac innervation. *Eur Spine J*. 2022 Nov;31(11):2831–2843
15. Badr S, Khizindar H, Boulil Y, Abou Diwan R, Demondion X, Cotten A. Anatomical Variants of the Sacroiliac Joint. *Semin Musculoskelet Radiol*. 2023 Apr;27(2):221–225
16. El Rafei M, Badr S, Lefebvre G et al.. Sacroiliac joints: anatomical variations on MR images. *Eur Radiol*. 2018 Dec;28(12):5328–5337
17. Vereecke E, Morbée L, Laloo F et al.. Anatomical variation of the sacroiliac joints: an MRI study with synthetic CT images. *Insights Imaging*. 2023 Feb 8;14(1):30
18. Neuhoff J, Schlag H, Kandziora F. Die Untersuchung der Lendenwirbelsäule. *Orthopädie und Unfallchirurgie up2date* 2021; 16(06): 583 – 603
19. Wiechert K, Redder A, Lohmann J. Infiltrationen und Radiofrequenztherapie der lumbalen und zervikalen Facettengelenke und der Iliosakralgelenke: Überblick, Evidenz und Ergebnisse. *Die Wirbelsäule* 2020; 04: 182–192
20. Janka M, Merkel A, Schuh A. Diagnostik an der Lendenwirbelsäule. *MMW Fortschr Med*. 2019 Jan;161(1):55–58
21. Schütz UHW. Therapeutische Injektion und Manuelle Medizin beim tiefen Rückenschmerz : Bimodale Synergien zwischen Evidenz und Empirie. *Orthopade*. 2022 Apr;51(4):307–324
22. Schultz T. Die manuelle Behandlung des Iliosakralgelenks nach Operation an Lendenwirbelsäule und Hüftgelenk. *Manuelle Medizin* 2019; 57:111–115
23. Grage-Roßmann B, Auler S, Schmitt E. Orthetische Versorgung der Wirbelsäule. *Phys Med Rehab Kuror* 2020; 30: 37–52
24. Bresnahan JJ, Ng AT. Review of Sacroiliac Joint Injection Techniques. *Curr Pain Headache Rep*. 2022 May;26(5):385–390
25. Faber F, Benditz A, Boluki D, Grifka J. Anwendung Bildwandler-gestützter Injektionen bei Zervikal- und Lumbalsyndromen. *Z Rheumatol*. 2020 May;79(4):367–378
26. Scheuer R. Minimalinvasive Schmerztherapie rund um die Wirbelsäule. *Manuelle Medizin* 2018 · 56:49–53
27. Kasliwal PJ, Kasliwal S. Fluoroscopy-Guided Sacroiliac Joint Injection: Description of a Modified Technique. *Pain Physician*. 2016 Feb;19(2):E329–38
28. AWMF Leitlinie „Radiofrequenz-Denervation der Facettengelenke und des ISG“ https://register.awmf.org/assets/guidelines/151-004I_S3_Radiofrequenz-Denervation-Facettengelenke-des-ISG_2023-07_01.pdf
29. Loh E, Burnham TR, Burnham RS. Sacroiliac Joint Diagnostic Block and Radiofrequency Ablation Techniques. *Phys Med Rehabil Clin N Am*. 2021 Nov;32(4):725–744
30. Abbas A, Du JT, Toor J, Versteeg A, Finkelstein JA. The efficacy of primary sacroiliac joint fusion for low back pain caused by sacroiliac joint pathology: a systematic review and meta-analysis. *Eur Spine J*. 2022 Oct;31(10):2461–2472
31. Amer MH, Elnahal WA, Khaled SA et al.. Minimally invasive sacroiliac fusion, a case series, and a literature review. *SICOT J*. 2022;8:42
32. Bornemann R, Pflugmacher R, Webler M, Koch EM, Dengler J, Wirtz DC, Frey SP. Klinische Studie zur Prüfung des iFuse Implant Systems® bei Patienten mit Iliosakralgelenksyndrom: 1-Jahres-Ergebnisse. *Z Orthop Unfall*. 2016 Dec;154(6):601–605
33. Kasapovic A, Ali T, Jaenisch M et al.. Minimal-invasive Arthrodesse des Iliosakralgelenks (ISG). *Oper Orthop Traumatol*. 2022 Apr;34(2):98–108
34. Benditz A, Koehl P, Pulido LC, Unterpaintner I, Schuh A. Iliosakralgelenk. *MMW Fortschr Med*. 2023;165(18): 46 – 49

Literatur zum Beitrag

Bernhard Wilhelm Ullrich, Max Joseph Scheyerer, Ulrich Albert Joseph Spiegl, Thomas Mendel, Klaus John Schnake

Die OF-Pelvis Klassifikation für osteoporotische Sakrum- und Beckenringfrakturen

1. Lourie H: Spontaneous osteoporotic fracture of the sacrum: an unrecognized syndrome of the elderly. *Jama* 1982;248 (6):715–717
2. Rupp M, Walter N, Pfeifer C et al.: The incidence of fractures among the adult population of Germany: an analysis from 2009 through 2019. *Deutsches Ärzteblatt International* 2021;118 (40):665
3. Breuil V, Roux CH, Carle GF: Pelvic fractures: epidemiology, consequences, and medical management. *Current opinion in rheumatology* 2016;28 (4):442–447
4. Rommens PM, Hofmann A: Comprehensive classification of fragility fractures of the pelvic ring: Recommendations for surgical treatment. *Injury* 2013;44 (12):1733–1744
5. Bakker G, Hattingen J, Stuetzer H, Isenberg J: Sacral insufficiency fractures: how to classify? *Journal of Korean Neurosurgical Society* 2018;61 (2):258
6. Bellabarba C, Schroeder GD, Kepler CK et al.: The AOSpine sacral fracture classification. *Global Spine Journal* 2016;6 (1_suppl):s-0036–1582696-s-1580036–1582696
7. Ma Y, Mandell JC, Rocha T, Mendicuti MA, Weaver MJ, Khurana B: Diagnostic accuracy of pelvic radiographs for the detection of traumatic pelvic fractures in the elderly. *Emergency Radiology* 2022;29 (6):1009–1018
8. Cabarrus MC, Ambekar A, Lu Y, Link TM: MRI and CT of insufficiency fractures of the pelvis and the proximal femur. *American Journal of Roentgenology* 2008;191 (4):995–1001
9. Audige L, Bhandari M, Hanson B, Kellam J: A concept for the validation of fracture classifications. *J Orthop Trauma* 2005;19 (6):401–406
10. Landis JR, Koch GG: (1977) The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–174
11. Ullrich BW, Schnake KJ, Spiegl UJA et al.: OF-Pelvis classification of osteoporotic sacral and pelvic ring fractures. *BMC Musculoskeletal Disorders* 2021;22:992
12. Mendel T, Ullrich BW, Hofmann GO et al.: Progressive instability of bilateral sacral fragility fractures in osteoporotic bone: a retrospective analysis of X-ray, CT, and MRI datasets from 78 cases. *Eur J Trauma Emerg Surg* 2021;47:11–19
13. Rommens P, Arand C, Hopf J, Mehling I, Dietz S, Wagner D: Progress of instability in fragility fractures of the pelvis: An observational study. *Injury* 2019;50 (11):1966–1973

Literatur zum Beitrag

Ulrich Albert Joseph Spiegel, Max Joseph Scheyerer, Bernhard Wilhelm Ullrich, Klaus John Schnake

Der OF-Pelvis-Score

1. Rupp M, Walter N, Pfeifer C et al.: The Incidence of Fractures Among the Adult Population of Germany-an Analysis From 2009 through 2019. *Deutsches Arzteblatt international* 2021;118:665–669
2. Gericke L, Fritz A, Osterhoff G, Josten C, Pieroh P, Höch A: Percutaneous operative treatment of fragility fractures of the pelvis may not increase the general rate of complications compared to non-operative treatment. *European journal of trauma and emergency surgery : official publication of the European Trauma Society* 2022;48:3729–3735
3. Hotta K, Kobayashi T: Functional treatment strategy for fragility fractures of the pelvis in geriatric patients. *European journal of trauma and emergency surgery : official publication of the European Trauma Society* 2021;47:21–27
4. Rommens PM, Hopf JC, Arand C, Handrich K, Boudissa M, Wagner D: Prospective assessment of key factors influencing treatment strategy and outcome of fragility fractures of the pelvis (FFP). *European journal of trauma and emergency surgery: official publication of the European Trauma Society* 2022;48:3243–3256
5. Blattert TR, Schnake KJ, Gonschorek O et al.: Nonsurgical and Surgical Management of Osteoporotic Vertebral Body Fractures: Recommendations of the Spine Section of the German Society for Orthopaedics and Trauma (DGOU). *Global Spine Journal* 2018;8:50S-55S
6. Ullrich BW, Schnake KJ, Spiegel UJA et al.: OF-Pelvis classification of osteoporotic sacral and pelvic ring fractures. *BMC musculoskeletal disorders* 2021;22:992
7. Welford P, Jones CS, Davies G et al.: The association between surgical fixation of hip fractures within 24 hours and mortality: a systematic review and meta-analysis. *The bone & joint journal* 2021;103-B:1176–1186
8. Yagi M, Michikawa T, Hosogane N et al.: The 5-Item modified frailty index is predictive of severe adverse events in patients undergoing surgery for adult spinal deformity. *Spine* 2019;44:E1083-E1091
9. Owens WD, Felts JA, Spitznagel EL, Jr: ASA physical status classifications: a study of consistency of ratings. *Anesthesiology* 1978;49:239–243
10. Subramaniam S, Aalberg JJ, Soriano RP, Divino CM: New 5-Factor Modified Frailty Index Using American College of Surgeons NSQIP Data. *Journal of the American College of Surgeons* 2018;226:173–181 e178
11. Spiegel UJ, Ullrich BW, Scheyerer MJ et al.: Entwicklung des OF-Pelvis Scores auf Grundlage der OF-Pelvis-Klassifikation – Retrospektive Evaluation der Therapieempfehlung anhand von 107 Patienten. Abstract 370: Vortrag auf der DKOU 2022 am 25.10.2022, Berlin <https://sepla.intercongress.de/BVB4ESALC8gbXIPkl1xWwAMhvya/>

Literatur zum Beitrag

Daniela Michalke:

Transkutane elektrische Nervenstimulation (TENS) in der interdisziplinären multimodalen Schmerztherapie (IMST)

1. Baron R., Koppert W., Strumpf M., Willweber-Strumpf A.: in Praktische Schmerzmedizin: Kap. 15 Interventionelle Verfahren in der Schmerztherapie
2. Diener H. Ch., Maier Ch.: Das Schmerztherapie Buch Kap. 4.5 Elektrotherapie
3. Drexel H., Hildebrandt G., Schlegel K.-F. und Weimann G.: Physikalische Medizin Band 4: Elektro- und Lichttherapie Kap. 7
4. Emrich O. in Junker/Nolte: Grundlagen der Speziellen Schmerztherapie Kap. 15 Die transkutane elektrische Nervenstimulation (TENS)
5. Gozani S. N.: Remote Analgesic Effects Of Conventional Transcutaneous Electrical Nerve Stimulation: A Scientific And Clinical Review With A Focus on Chronic Pain; Journal of Pain Research 2019;12 3185–3201
6. Gschiel B., Kager H., Pipam W., Weichart K., Likar R: Analgetische Effizienz von transkutaner elektrischer Nervenstimulation (TENS-Therapie) bei Patienten mit Gonarthrose-eine prospektive, randomisierte, placebo-kontrollierte, doppelblinde Studie; Der Schmerz 5 2010
7. Johnson M.I.: Review: Resolving Long-Standing Uncertainty about the Clinical Efficacy of Transcutaneous Electrical Nerv Stimulation (TENS) to Relieve Pain: A Comprehensive Review of Factors Influencing Outcome, : Medicina 2021, 57, 378
8. Johnson Prof. M.: Transcutaneous electrical nerve stimulation: mechanisms, clinical application and evidence: Reviews in Pain Vol. 1, No 1
9. Novak, S.: Nemeth, W.C. How clinically relevant is a meta-analysis of electrical nerve stimulation when based on heterogeneous disease states? Pain 2007, 131, 228–229
10. Pothmann R. und Kollegen: TENS in der Schmerztherapie, Kap. 1–3
11. Reichenbach S. und Kollegen: Effect of transcutaneous electrical nerve stimulation (TENS) on knee pain and physical function in patients with symptomatic knee osteoarthritis: the ETRELKA randomized clinical trail: Osteoarthritis and Cartilage, Volume 30, Issue 3, March 2022, 426–435
12. Thoden U.: in Zenz,/Jurna Lehrbuch der Schmerztherapie: Kapitel Transkutane elektrische Nervenstimulation (TENS)
13. Vance C. Dailey D. L., Rakei B. A., Sluka K. A.: Using TENS for pain control: the state of the evidence. Pain Management 2014, 4 (3), 197–209

Literatur zum Beitrag

Achim Benditz:

Coccygodynie

Ein Überblick

1. Simpson J. Coccygodynia and disseses and deformities of the coccyx. *Med Times Gaz* 1859;40:1–7
2. Garg B, Ahuja K. Coccydynia-A comprehensive review on etiology, radiological features and management options. *J Clin Orthop Trauma* 2021;12:123–9
3. Maigne J-Y, Lagauche D, Doursounian L. Instability of the coccyx in coccydynia. *J Bone Joint Surg Br* 2000;82-B:1038–41
4. Woon JTK, Stringer MD. Clinical anatomy of the coccyx: A systematic review. *Clin Anat* 2012;25:158–67
5. Mabrouk A, Alloush A, Foye P. Coccyx Pain. 2021
6. Kerr EE, Benson D, Schrot RJ. Coccygectomy for chronic refractory coccygodynia: clinical case series and literature review. *J Neurosurg Spine* 2011;14:654–63
7. Lirette LS, Chaiban G, Tolba R, Eissa H. Coccydynia: an overview of the anatomy, etiology, and treatment of coccyx pain. *Ochsner J* 2014;14:84–7
8. Benditz A, König MA. Therapy-resistant coccygodynia should no longer be considered a myth : The surgical approach. *Orthopade* 2019;48:92–5
9. Maigne JY, Doursounian L, Chatellier G. Causes and mechanisms of common coccydynia: role of body mass index and coccygeal trauma. *Spine (Phila Pa 1976)* 2000;25:3072–9
10. Pennekamp PH, Kraft CN, Wallny T, Schmitt O, Diedrich O. Coccygectomy in the treatment of coccygodynia. *Z Orthop Ihre Grenzgeb* 2003;141:578–82
11. Schapiro S. Low back and rectal pain from an orthopedic and proctologic viewpoint with a review of 180 cases. *The American Journal of Surgery* 1950;79:117–28
12. Maigne JY, Guedj S, Straus C. Idiopathic coccygodynia: Lateral roentgenograms in the sitting position and coccygeal discography. *Spine (Phila Pa 1976)* 1994;19:930–4
13. Balain B, Eisenstein SM, Alo GO, Darby AJ, Cassar-Pullicino VN, Roberts SE et al. Coccygectomy for coccydynia: case series and review of literature. *Spine (Phila Pa 1976)* 2006;31:E414–20
14. Bayne O, Bateman JE, Cameron HU. The influence of etiology on the results of coccygectomy. *Clin Orthop Relat Res* 1984:266–72
15. Mechri M, Riahi H, Sboui I, Bouaziz M, Vanhoenacker F, Ladeb M. Imaging of Malignant Primitive Tumors of the Spine. *J Belg Soc Radiol* 2018;102:56
16. Blocker O, Hill S, Woodacre T. Persistent coccydynia – the importance of a differential diagnosis. *BMJ Case Rep* 2011;2011
17. Thiele GH. Coccygodynia: Cause and treatment. *Dis Colon Rectum* 1963;6:422–36
18. White WD, Avery M, Jonely H, Mansfield JT, Sayal PK, Desai MJ. The interdisciplinary management of coccydynia: A narrative review. *PM R* 2021
19. Woon JTK, Maigne J-Y, Perumal V, Stringer MD. Magnetic resonance imaging morphology and morphometry of the coccyx in coccydynia. *Spine (Phila Pa 1976)* 2013;38:E1437–45
20. Woon JTK, Perumal V, Maigne J-Y, Stringer MD. CT morphology and morphometry of the normal adult coccyx. *Eur Spine J* 2013;22:863–70
21. Maigne JY, Tamalet B. Standardized radiologic protocol for the study of common coccygodynia and characteristics of the lesions observed in the sitting position. Clinical elements differentiating luxation, hypermobility, and normal mobility. *Spine (Phila Pa 1976)* 1996;21:2588–93
22. König MA, Grifka J, Benditz A. A novel radiological classification for displaced os coccyx: the Benditz-König classification. *Eur Spine J* 2021
23. Fogel GR, Cunningham PY, Esses SI. Coccygodynia: evaluation and management. *J Am Acad Orthop Surg* 2004;12:49–54
24. Maigne J-YY, Chatellier G, Faou M Le, Archambeau M. The treatment of chronic coccydynia with intrarectal manipulation: a randomized controlled study. *Spine (Phila Pa 1976)* 2006;31:E621–7
25. Cha YD, Yang CW, Han JU, Song JH, Na W, Oh S et al. Transsacrococcygeal approach to ganglion impar block for treatment of chronic coccygodynia after spinal arachnoid cyst removal: A case report. *Medicine (Baltimore)* 2016;95:e5010
26. Agarwal-Kozlowski K, Lorke DE, Habermann CR, Am Esch JS, Beck H. CT-guided blocks and neuroablation of the ganglion impar (Walther) in perineal pain: anatomy, technique, safety, and efficacy. *Clin J Pain* 2009;25:570–6
27. Usmani H, Dureja GP, Andleeb R, Tauheed N, Asif N. Conventional Radiofrequency Thermocoagulation vs Pulsed Radiofrequency Neuromodulation of Ganglion Impar in Chronic Perineal Pain of Nononcological Origin. *Pain Med* 2018;19:2348–56
28. Datir A, Connell D. CT-guided injection for ganglion impar blockade: a radiological approach to the management of coccydynia. *Clin Radiol* 2010;65:21–5
29. Lee DW, Lai A. Sacral Burst Neuromodulation via Caudal Approach as a Treatment for Chronic Coccydynia. *Neuromodulation* 2019;22:992–4
30. Giordano NL, van Helmond N, Chapman KB. Coccydynia Treated with Dorsal Root Ganglion Stimulation. *Case Rep Anesthesiol* 2018;2018:5832401
31. Lin S-F, Chen Y-J, Tu H-P, Lee C-L, Hsieh C-L, Wu W-L et al. The Effects of Extracorporeal Shock Wave Therapy in Patients with Coccydynia: A Randomized Controlled Trial. *PLoS One* 2015;10:e0142475
32. Marwan Y, Dahrab B, Esmaeel A, Ibrahim SA, Al-Failakawi J. Extracorporeal shock wave therapy for the treatment of coccydynia: a series of 23 cases. *Eur J Orthop Surg Traumatol* 2017;27:591–8
33. Gáspár L, Jónás Z, Kiss L, Vereb G, Csernátóy Z. Coccygectomy has a favorable effect on the intensity, manifestation, and characteristics of pain caused by coccygodynia: a retrospective evaluation of 34 patients followed for 3–18 years. *European Journal of Orthopaedic Surgery & Traumatology* 2009;19:403–7
34. Ersen O, Ekinci S, Koca K, Akyıldız F, Bilgic S. Coccygectomy as a Surgical Option in the Treatment of Chronic Traumatic Coccygodynia. *Asian Spine J* 2015;9:492

35. Hanley EN, Ode G, III JBJ, Seymour R. Coccygectomy for patients with chronic coccydynia. *Bone Joint J* 2016;98-B:526–33
36. Ramieri A, Domenicucci M, Cellocco P, Miscusi M, Costanzo G. Acute traumatic instability of the coccyx: results in 28 consecutive coccygectomies. *Eur Spine J* 2013;22 Suppl 6:S939–44
37. Antoniadis A, Ulrich NH-B, Senyurt H. Coccygectomy as a surgical option in the treatment of chronic traumatic coccygodynia: a single-center experience and literature review. *Asian Spine J* 2014;8:705–10
38. Key J. Operative treatment OF coccygodynia. *JBJS* 1937;19:759–64
39. Kulkarni AG, Tapashetti S, Tambwekar VS. Outcomes of Coccygectomy Using the “Z” Plasty Technique of Wound Closure. *Global Spine J* 2019;9:802–6
40. Nagappa S, Alshameeri Z, Elmajee M, Hashmi Y, Bowry A, Jones M et al. Clinical Outcome of Coccygectomy Using a Paramedian Curvilinear Skin Incision in Adults and Children With Meta-Analysis of the Literature Focusing on Postoperative Wound Infection. *Global Spine J* 2021
41. Mulpuri N, Reddy N, Larsen K, Patel A, Diebo BG, Passias P et al. Clinical Outcomes of Coccygectomy for Coccydynia: A Single Institution Series With Mean 5-Year Follow-Up. *Int J Spine Surg* 2022;16:11–9
42. Sagoo NS, Haider AS, Palmisciano P, Vannabouathong C, Gonzalez R, Chen AL et al. Coccygectomy for refractory coccygodynia: a systematic review and meta-analysis. *Eur Spine J* 2022;31:176–89
43. Manfre L, Gil I, Baptista T, Calvão Pires P, de Vivo AE, Masala S et al. Coccygeoplasty: preliminary experience with this new alternative treatment of refractory coccydynia in patients with coccyx hypermobility. *J Neurointerv Surg* 2022
44. Roa JA, White S, Barthélemy EJ, Jenkins A, Margetis K. Minimally invasive endoscopic approach to perform complete coccygectomy in patients with chronic refractory coccydynia: illustrative case. *Journal of Neurosurgery: Case Lessons* 2022;3

Literatur zum Beitrag

Antonia Frebel:

Femurkopf-Lebendspenden

Prozess und Logistik in der orthopädischen Chirurgie

1. Barbeck M, Donkiewickz P, Blume O et al. (2017) Allogene Knochenersatzmaterialien, Update zum aktuellen wissenschaftlichen Stand. *Implantologie Journal* 7/8:20–24
2. Barbeck M, Donkiewickz P, Blume O et al. (2017) Allogene Knochenersatzmaterialien, Update zum aktuellen wissenschaftlichen Stand. *Implantologie Journal* 7/8:20–24
3. Bundesamt für Justiz (2023) Gesetz über den Verkehr mit Arzneimitteln (Arzneimittelgesetz – AMG) § 20b Erlaubnis für die Gewinnung von Gewebe und die Laboruntersuchungen, https://www.buzer.de/20b_AMG.htm, Zugegriffen: 07.01.2024
4. Bundesamt für Justiz (2023) Gesetz über den Verkehr mit Arzneimitteln (Arzneimittelgesetz – AMG) § 20c Erlaubnis für die Be- oder Verarbeitung, Konservierung, Prüfung, Lagerung oder das Inverkehrbringen von Gewebe oder Gewebesubereitungen. https://www.gesetze-im-internet.de/amg_1976/__20c.html. Zugegriffen: 29.12.2023
5. Bundesamt für Justiz Gesetz über den Verkehr mit Arzneimitteln (Arzneimittelgesetz – AMG) § 20d Ausnahme von der Erlaubnispflicht für Gewebe und Gewebesubereitungen. https://www.gesetze-im-internet.de/amg_1976/__20d.html. Zugegriffen: 29.12.2023
6. Bundesregierung, Europäisches Parlament und Rat (2007) Gesetz über Qualität und Sicherheit von menschlichen Geweben und Zellen (GewebeG). <https://www.buzer.de/gesetz/7833/index.htm>. Zugegriffen: 29.12.2023
7. Bundesregierung, Europäisches Parlament und Rat (2007) Gesetz über die Spende, Entnahme und Übertragung von Organen und Geweben (Transplantationsgesetz – TPG). G. v. 20.07.2007 BGBl. I S. 1574 (Nr. 35); zuletzt geändert durch Artikel 17 G. v. 09.08.2019 BGBl. I S. 1202 Geltung ab 01.08.2007; FNA: 212–2/1
8. Fölsch C, Jahnke A, Groß A et al. (2018) Einfluss der Thermodesinfektion auf die Impaktion spongioser Knochen: Ein In-vitro-Modell für das femorale Impaction-Bone-Grafting. *Orthopäde* 47:39–51
9. Heinemann S, Gelinsky M, Worch H, Hanke T (2011) Resorbierbare Knochenersatzmaterialien. *Orthopäde* 40:761–773
10. Hoppe J-DH, Sewing K-F (2001) Richtlinien zum Führen einer Knochenbank, *Deutsches Ärzteblatt*, Jg 98, Heft 15, 13. April 2001, A 1011–A 1016
11. Jung S, Wernerus D, Reichel H (2012) Zulassung einer klinik-eigenen Knochenbank – Ein Erfahrungsbericht. *Orthopäde* 41:217–224
12. Lang S, Klute L, Rupp M, Alt V (2022) Knochenaufbau und Knochenersatzmaterialien. *Orthopädie und Unfallchirurgie up2date* 17:337–358
13. Lang S, Klute L, Rupp M, Alt V (2022) Knochenaufbau und Knochenersatzmaterialien. *Orthopädie und Unfallchirurgie up2date* 17:337–358
14. Linhart W, Meenen M, Meenen M, RJM (2000) Knochenersatzmaterialien: Neue Möglichkeiten und Techniken, *OP-JOURNAL* 2000; 16: 294–298
15. Lohmann CH, Andreacchio D, Köster G et al. (2001) Tissue response and osteoinduction of human bone grafts in vivo. *Arch Orthop Trauma Surg* 121:583–590
16. Paul-Ehrlich-Institut (PEI) B für I und biomedizinische A (2023) Arzneimittel, Sektion Gewebesubereitung, Knochenpräparationen, <https://www.pei.de/DE/arzneimittel/gewebesubereitungen/knochenpraeparationen/knochenpraeparationen-node.html>, Eingesehen: 07.01.2024
17. Pruss A, Hansen A, Kao M et al. (2001) Comparison of the efficiency of virus inactivation methods in allogeneic avital bone tissue transplants. *Cell Tissue Bank* 2:201–215
18. Pruß A, von Versen R (2007) Einfluss europäischer Regulativa auf Qualität, Sicherheit und Verfügbarkeit allogener Zell- und Gewebetransplantate in Deutschland. *Handchirurgie – Mikrochirurgie – Plastische Chirurgie* 39:81–87
19. Pruß A, Von Versen R (2007) Einfluss europäischer regulativa auf qualität, sicherheit und verfügbarkeit allogener zell- und gewebetransplantate in Deutschland. *Handchirurgie Mikrochirurgie Plastische Chirurgie* 39:81–87
20. Rupp M, Kerschbaum M, Klute L et al. (2021) Bone transplantation or biomaterials?: An analysis of 99,863 surgical procedures in orthopedic and trauma surgery in Germany from 2018. *Unfallchirurg* 124:146–152
21. Rupp M, Klute L, Baertl S et al. (2022) The clinical use of bone graft substitutes in orthopedic surgery in Germany—A 10-years survey from 2008 to 2018 of 1,090,167 surgical interventions. *J Biomed Mater Res B Appl Biomater* 110:350–357
22. Telos GmbH Marburg (2023) Anamnesebogen V11 Femurkopfspenden (1), <https://www.telos-marburg.de/Eingesehen>: 07.01.2024
23. Telos GmbH Marburg (2023) Kurzanleitung Spenderprozess, <https://www.telos-marburg.de/Eingesehen>: 07.01.2024
24. Telos GmbH Marburg (2023) CTBA Inaktivierungsprozess, <https://www.telos-marburg.de/>. Eingesehen: 07.01.2024

Literatur zum Beitrag

Roderich Heikenfeld:

Glenoiddefekte in der Primär- und Revisionsendoprothetik des Schultergelenks

Metallischer oder knöcherner Aufbau mittels Allo- und Autograft

1. Antuna SA, Sperling JW, Cofield RH et al.: Glenoid revision surgery after total shoulder arthroplasty. *J Shoulder Elbow Surg* 2001; 10(3):217–224
2. Bercik MJ, Kruse K, Yalozis M, Gauci MO, Chaoui J, Walch G: A modification to the Walch classification of the glenoid in primary glenohumeral osteoarthritis using three-dimensional imaging. *J Shoulder Elbow Surg* 2016; 25:1601–1606
3. Berliner JL, Regalado-Magdos A, Ma CB, Feeley BT: Biomechanics of reverse total shoulder arthroplasty. *J Shoulder Elbow Surg* 2015; 24(1):150–160
4. Contreras ES, Kingery MT, Zuckerman JD, Virk MS: Treatment of Glenoid Wear with the Use of Augmented Glenoid Components in Total Shoulder Arthroplasty: A Scoping Review. *JBJS Rev.* 2023 Oct 18;11(10)
5. Denard PJ, Walch G: Current concepts in the surgical management of primary glenohumeral arthritis with a biconcave glenoid. *J Shoulder Elbow Surg.* 2013 Nov;22(11):1589–1598
6. Gohlke F, Werner B: Humerale und glenoidale Knochendefekte in der Schulterendoprothetik: Klassifikation und Behandlungsprinzipien [Humeral and glenoid bone loss in shoulder arthroplasty: Classification and treatment principles]. *Orthopade.* 2017 Dec;46(12):1008–1014
7. Malhas A, Rashid A, Copas D, Bale S, Trail I: Glenoid bone loss in primary and revision shoulder arthroplasty. *Shoulder Elbow.* 2016 Oct;8(4):229–240
8. Mizuno N, Denard PJ, Raiss P, Walch G: Reverse total shoulder arthroplasty for primary glenohumeral osteoarthritis in patients with a biconcave glenoid. *J Bone Joint Surg Am.* 2013 Jul 17;95(14):1297–1304
9. Neer CS 2nd, Morrison DS: Glenoid bone-grafting in total shoulder arthroplasty. *J Bone Joint Surg Am.* 1988 Sep;70(8):1154–1162
10. Singh J, Odak S, Neelakandan K, Walton MJ, Monga P, Bale S, Trail I: Survivorship of autologous structural bone graft at a minimum of 2 years when used to address significant glenoid bone loss in primary and revision shoulder arthroplasty: a computed tomographic and clinical review. *J Shoulder Elbow Surg.* 2021 Mar;30(3):668–678
11. Virk M, Yip M, Liuzza L, Abdelshahed M, Paoli A, Grey S, Wright T, Flurin PH, Roche C, Zuckerman JD: Clinical and radiographic outcomes with a posteriorly augmented glenoid for Walch B2, B3, and C glenoids in reverse total shoulder arthroplasty. *J Shoulder Elbow Surg.* 2020 May;29(5):e196–e204
12. Viswanath A, Newell AK, Cunningham LJ, Walton M, Monga P, Bale S, Trail IA: Survivorship of Allologous Structural Bone Graft at a Minimum of 2 Years When Used to Address Significant Glenoid Bone Loss in Revision Shoulder Arthroplasty: A Computed Tomographic and Clinical Review. *J Shoulder Elb Arthroplast.* 2023 May 11;7:24715492231172371
13. Williams GR Jr, Iannotti JP: Options for glenoid bone loss: composites of prosthetics and biologics. *J Shoulder Elbow Surg.* 2007 Sep-Oct;16(5 Suppl):S267–272

Literatur zum Beitrag

Christian Eberle:

Verwendung von allogenem Knochen in der Vorderen Kreuzbandchirurgie

1. Wright RW, Gill CS, Chen L, Brophy RH, Matava MJ, Smith MV, Mall NA: Outcome of revision anterior cruciate ligament reconstruction: a systematic review. *J Bone Joint Surg Am*. 2012 Mar 21;94(6):531–536
2. Wright R, Spindler K, Huston L, Amendola A, Andrish J, Brophy R, Carey J, Cox C, Flanigan D, Jones M, Kaeding C, Marx R, Matava M, McCarty E, Parker R, Vidal A, Wolcott M, Wolf B, Dunn W: Revision ACL reconstruction outcomes: MOON cohort. *J Knee Surg*. 2011 Dec;24(4):289–294
3. MARS, Wright RW, Huston LJ et al.: 2010 Descriptive epidemiology of the Multicenter ACL Revision Study (MARS) cohort. *Am J Sports Med* 38: 1979–1986
4. Multiple ACL Revision: Failure Analysis and Clinical Outcomes: Dini F, Tecame A, Ampollini A, Adravanti P. *J Knee Surg*. 2021 Jul;34(8):801–809
5. Andriolo L, Filardo G, Kon E, Ricci M, Della Villa F, Della Villa S, Zaffagnini S, Marcacci M: Revision anterior cruciate ligament reconstruction: clinical outcome and evidence for return to sport. *Knee Surg Sports Traumatol Arthrosc*. 2015 Oct;23(10):2825–2845
6. de Beus A, Koch JE, Hirschmann A, Hirschmann MT: How to evaluate bone tunnel widening after ACL reconstruction – a critical review. *Muscles Ligaments Tendons J*. 2017 Sep 18;7(2):230–239
7. Magnusson RA et al.: A CT-based classification of prior ACL femoral tunnel location for planning revision ACL surgery. *Knee Surg Sports Traumatol Arthrosc*. 2012 Jul;20(7):1298–1306
8. Byrne KJ, Hughes JD, Gibbs C, Vaswani R, Meredith SJ, Popchak A, Lesniak BP, Karlsson J, Irrgang JJ, Musahl V: Non-anatomic tunnel position increases the risk of revision anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2022 Apr;30(4):1388–1395
9. Tapasvi S, Shekhar A: Revision ACL reconstruction: Principles and Practice. *Indian J Orthop*. 2021 Jan 19;55(2):263–275
10. Salem HS, Axibal DP, Wolcott ML, Vidal AF, McCarty EC, Bravman JT, Frank RM: Two-Stage Revision Anterior Cruciate Ligament Reconstruction: A Systematic Review of Bone Graft Options for Tunnel Augmentation. *Am J Sports Med*. 2020 Mar;48(3):767–777
11. Kim DH, Bae KC, Kim DW, Choi BC: Two-stage revision anterior cruciate ligament reconstruction. *Knee Surg Relat Res*. 2019 Sep 18;31(1):10
12. Erickson BJ, Cvetanovich G, Waliullah K, Khair M, Smith P, Bach B Jr, Sherman S: Two-Stage Revision Anterior Cruciate Ligament Reconstruction. *Orthopedics*. 2016 May 1;39(3)
13. Pioger C, Saithna A, Rayes J, Haidar IM, Fradin T, Ngbilo C, Vieira TD, Cavagnac E, Sonnery-Cottet B: Influence of Preoperative Tunnel Widening On the Outcomes of a Single Stage-Only Approach to Every Revision Anterior Cruciate Ligament Reconstruction: An Analysis of 409 Consecutive Patients From the SANTI Study Group. *Am J Sports Med*. 2021 May;49(6):1431–1440
14. Wolfson TS, Alaia MJ: Bone Tunnel Management in Modern Revision Anterior Cruciate Ligament Reconstruction. *Bull Hosp Jt Dis* (2013). 2020;78(1):53–64
15. Prall WC, Kusmenkov T, Schmidt B, Fürmetz J, Haasters F, Naendrup JH, Böcker W, Shafizadeh S, Mayr HO, Pfeiffer TR: Cancellous allogenic and autologous bone grafting ensure comparable tunnel filling results in two-staged revision ACL surgery. *Arch Orthop Trauma Surg*. 2020 Sep;140(9):1211–1219
16. Erickson BJ, Cvetanovich GL, Frank RM, Riff AJ, Bach BR Jr: Revision ACL Reconstruction: A Critical Analysis Review. *JBSJ Rev*. 2017 Jun;5(6)
17. Prall WC, Kusmenkov T, Fürmetz J et al.: Outcomes of revision anterior ligament reconstruction secondary to reamer-irrigator-aspirator harvested bone grafting. *Injury*. 2019;50(2):467–475
18. Said HG, Baloch K, Green M: A new technique for femoral an tibial tunnel bone grafting using the OATS harvester in revision anterior cruciate ligament reconstruction. *Arthroscopy*. 2006;22(7):796.e1–796.e3
19. Chahla J, Dean CS, Cram TR et al.: Two-Stage revision anterior cruciate ligament reconstruction: bone grafting technique using an allograft bone matrix. *Arthrosc Tech*. 2016;5(1):e189–e195
20. Gerrit J Van de Pol, Fiona Bonar, Lucy J Salmon, Justin P Roe, Leo A Pinczewski: Supercritical Carbon Dioxide-Sterilized Bone Allograft in the Treatment of Tunnel Defects in 2-Stage Revision Anterior Cruciate Ligament Reconstruction: A Histologic Evaluation. *Arthroscopy*. 2018 Mar;34(3):706–713
21. Justin J Mitchell, Jorge Chahla, Chase S Dean, Mark Cinque, Lauren M Matheny, Robert F LaPrade: Outcomes After 1-Stage Versus 2-Stage Revision Anterior Cruciate Ligament Reconstruction. *Am J Sports Med*. 2017 Jul;45(8):1790–1798
22. Salem HS, Axibal DP, Wolcott ML, Vidal AF, McCarty EC, Bravman JT, Frank RM: Two-Stage Revision Anterior Cruciate Ligament Reconstruction: A Systematic Review of Bone Graft Options for Tunnel Augmentation. *Am J Sports Med*. 2020 Mar;48(3):767–777
23. Cancellous allogenic and autologous bone grafting ensure comparable tunnel filling results in two-staged revision ACL surgery. Prall WC, Kusmenkov T, Schmidt B, Fürmetz J, Haasters F, Naendrup JH, Böcker W, Shafizadeh S, Mayr HO, Pfeiffer TR. *Arch Orthop Trauma Surg*. 2020 Sep;140(9):1211–1219
24. Condello V, Beaufileis P, Becker R, Ahmad SS, Bonomo M, Dejour D, Eriksson K, Filardo G, Feucht MJ, Grassi A, Wilson A, Menetrey J, Pujol N, Rathcke M, Seil R, Strauss MJ, Tischer T: Management of anterior cruciate ligament revision in adults: the 2022 ESSKA consensus: part II-surgical strategy. *Knee Surg Sports Traumatol Arthrosc*. 2023 Nov;31(11):4652–4661
25. van de Wall BJM, Beerens FJP, Rompen IF, Link BC, Babst R, Schoeneberg C, Michelitsch C, Nebelung S, Pape HC, Gueorguiev B, Knobe M: RIA versus iliac crest bone graft harvesting: A meta-analysis and systematic review. *Injury*. 2022 Feb;53(2):286–293

26. Calori GM, Colombo M, Mazza EL, Mazzola S, Malagoli E, Mineo GV: Incidence of donor site morbidity following harvesting from iliac crest or RIA graft. *Injury*. 2014 Dec;45 Suppl 6:S116–20
27. Barone A, Ricci M, Mangano F, Covani U: Morbidity associated with iliac crest harvesting in the treatment of maxillary and mandibular atrophies: a 10-year analysis. *J Oral Maxillofac Surg*. 2011 Sep;69(9):2298–2304
28. Rippke JN, Eberle C, Ellermann A, Fritz T, Sobau C, Balcarek P, Mengis N: Comparison of allogenic bone graft versus autologous corticocancellous graft in tunnel filling at two stage ACL revision surgery. *Radiological results of a prospective randomized trial, ESKKA Poster*; 2022
29. Suarez LS, Richmond JC: Overview of procurement, processing, and sterilization of soft tissue allografts for sports medicine. *Sports Med Arthrosc Rev*. 2007 Sep;15(3):106–113
30. Katz J: The effects of various cleaning and sterilization processes on allograft bone incorporation. *J Long Term Eff Med Implants*. 2010;20(4):271–276
31. Boyce T, Edwards J, Scarborough N: Allograft bone. The influence of processing on safety and performance. *Orthop Clin North Am*. 1999 Oct;30(4):571–581
32. Lind M et al.: Incidence and outcome after revision anterior cruciate ligament reconstruction: results from the Danish registry for knee ligament reconstructions. *Am J Sports Med*. 2012
33. Chahla J., Dean CS, Cram TR et al.: Two-Stage revision anterior cruciate ligament reconstruction: bone grafting technique using an allograft bone matrix. *Arthrosc Tech*. 2016;5(1):e189-e195
34. Gerrit J Van de Pol, Fiona Bonar, Lucy J Salmon, Justin P Roe, Leo A Pinczewski: Supercritical Carbon Dioxide-Sterilized Bone Allograft in the Treatment of Tunnel Defects in 2-Stage Revision Anterior Cruciate Ligament Reconstruction: A Histologic Evaluation. *Arthroscopy*. 2018 Mar;34(3):706–713
35. von Recum J, Schwaab J, Guehring T, Grützner PA, Schnetzke M: Bone incorporation of silicate-substituted calcium phosphate in 2-stage revision anterior cruciate ligament reconstruction: a histologic and radiographic study. *Arthroscopy*. 2017;33(4):819–827

Literatur zum Beitrag

Marc Hückstädt, Sandra Schipper, Christian Fischer, Steffen Langwald, Thomas Mendel, Friederike Klauke, Philipp Kobbe:

Rekonstruktion großer Knochendefekte durch RIA-Spongiosa und Spenderknochen in Masquelet-Technik

1. Blum AL, BongioVanni JC, Morgan SJ et al.: Complications associated with distraction osteogenesis for infected nonunion of the femoral shaft in the presence of a bone defect: a retrospective series. *J Bone Joint Surg Br* 2010; 92(4):565–750
2. Baumgart R, Schuster B, Baumgart T: Kallusdistraction und Segmenttransport zur Behandlung von Knochen-
defekten. *Der Orthopäde*; 46: 673–680
3. Masquelet AC, Beque T: The concept of induced membrane for reconstruction of large bone defects. *Orthop Clin North Am* (2010); 41:27–37
4. Morelli I, Drago L, George DA et al.: Masquelet technique: myth or reality? A systematic review and meta-analysis. *Injury* 47 Suppl 6 2016; S68-S76
5. Mi M, Papakostidis C, Wu X et al.: Mixed results with the Masquelet technique: A fact or a myth? *Injury* (2020); 51(2):132–135
6. Giannoudis PV, Einhorn TA, Marsh D: Fracture healing: the diamond concept. *Injury* 38 Suppl 4 2007; S3–6

Literatur zum Beitrag

Jan Philipp Reumann, Tobias Ohmann, Martin Glombitza, Lars Victor von Engelhardt:

Infektionen bei operativ versorgten Tibiakopffrakturen

Wie ist das Langzeit-Outcome und welche Einflussfaktoren sind klinisch relevant?

1. Bachoura A, Guitton TG, Smith RM: Infirmity and Injury Complexity are Risk Factors for Surgical-site Infection after Operative Fracture Care. *Clinical Orthopaedics and Related Research* 2011; 469: 2621–2630
2. Castillo RC, Bosse MJ, Mackenzie EJ: Impact of smoking on fracture healing and risk of complications in limb-threatening open tibia fractures. *J Orthop Trauma* 2005; 19: 151–157
3. Collins NJ, Misra D, Felson DT et al. (2011) Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS). *Arthritis Care Res* 2011; 63: 208–228
4. Cooper RA: Surgical site infections: epidemiology and microbiological aspects in trauma and orthopaedic surgery. *Int Wound J* 2013; 10: 3–8
5. Diefenbeck M, Abitzsch D, Hofmann GO: Joint infections. *Der Unfallchirurg* 2012; 115: 489–495
6. Durand F, Berthelot P, Cazorla C: Smoking is a risk factor of organ/space surgical site infection in orthopaedic surgery with implant materials. *International Orthopaedics* 2013; 37: 723–727
7. Elsoe R, Larsen P, Shekhrayka N et al.: The outcome after lateral tibial plateau fracture treated with percutaneous screw fixation show a tendency towards worse functional outcome compared with a reference population. *Eur J Trauma Emerg Surg* 2016; 42: 177–184
8. Gristina AG: Biomaterial-centered infection: microbial adhesion versus tissue integration. *Science* 1987; 237: 1588–1595
9. Gruner A, Hockertz T, Reilmann H: Die proximale Tibiafraktur. *Der Unfallchirurg* 2000; 103: 668–684
10. Henkelmann R, Frosch K-H, Glaab R: Infection following fractures of the proximal tibia – a systematic review of incidence and outcome. *BMC musculoskeletal disorders* 2017; 18: 481
11. Heppert V, Rheinwalt K, Winkler H: Infection of the proximal tibia after fractures – An avoidable complication. *European Journal of Orthopaedic Surgery & Traumatology* 1997; 7: 195–198
12. Hirsch T, Spielmann M, Zuhaili B: Enhanced susceptibility to infections in a diabetic wound healing model. *BMC surgery* 2008; 8: 5–5
13. Jansen H, Frey SP, Doht S: Medium-term results after complex intra-articular fractures of the tibial plateau. *J Orthop Sci* 2013; 18: 569–577
14. Korol E, Johnston K, Waser N: A systematic review of risk factors associated with surgical site infections among surgical patients. *PLoS One* 2013; 8: e83743
15. Lin S, Mauffrey C, Hammerberg EM: Surgical site infection after open reduction and internal fixation of tibial plateau fractures. *European Journal of Orthopaedic Surgery & Traumatology* 2014; 24: 797–803
16. Lysholm J, Gillquist J: Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med* 1982; 10: 150–154
17. Ma J-L, Xu Y-Q, Shen TG: Analysis of risk factors of infection for complex tibial plateau fractures after operation. *Zhongguo Gu Shang* 2017; 30: 896–900
18. Manidakis N, Dosani A, Dimitriou R: Tibial plateau fractures: functional outcome and incidence of osteoarthritis in 125 cases. *International Orthopaedics* 34:565–570
19. Rixen D, Mester B: Tibial plateau fractures. *Trauma und Berufskrankheit* 2016; 18: 26–32
20. Rodriguez-Merchan EC: Knee instruments and rating scales designed to measure outcomes. *J Orthop Traumatol* 2012; 13: 1–6
21. Roos EM, Roos HP, Lohmander LS: Knee Injury and Osteoarthritis Outcome Score (KOOS) – development of a self-administered outcome measure. *J Orthop Sports Phys Ther* 1998; 28: 88–96
22. Schmidt H, Diefenbeck M, Krenn V: Klassifikation der Osteomyelitis und Osteitis. *Zeitschrift für Orthopädie und Unfallchirurgie* 2014; 152: 334–342
23. Schulz AP, Gerlach U, Seide K: Osteitis and Septic Arthritis after Tibial Head Fracture: Results of a Radical Treatment Regime. *European Journal of Trauma and Emergency Surgery* 2007; 33: 626–634
24. Spellberg B, Guidos R, Gilbert D: The epidemic of antibiotic-resistant infections: a call to action for the medical community from the Infectious Diseases Society of America. *Clin Infect Dis* 2008; 46: 155–164
25. Statistisches Bundesamt: Mikrozensus-Studie 2013
26. Walter G, Kemmerer M, Kappler C: Behandlungsalgorithmen der chronischen Osteomyelitis. *Deutsches Ärzteblatt* 2012; 14: 258–264
27. Zura R, Browne J, Black M: Current management of high-energy tibial plateau fractures. *Current Orthopaedics* 2007; 21: 229–235

Literatur zum Beitrag

Lars Victor von Engelhardt:

Akute und chronische Kniescheibeninstabilität Diagnostik, konservative Therapie und chirurgische Konzepte von Schäden des MPFL, von Trochleadysplasien sowie anderen knöchernen Pathologien

- Ahmad CS, McCarthy M, Gomez JA, Shubin Stein BE: The moving patellar apprehension test for lateral patellar instability. *Am J Sports Med* 2009; 37(4): 791–796
- Amis AA, Firer P, Mountney J, Senavongse W et al.: Anatomy and biomechanics of the medial patellofemoral ligament. *The Knee* 2003; 10: 215–220
- Amis AA, Senavongse W, Bull AM: Patellofemoral kinematics during knee flexion-extension: an in vitro study. *J Orthop Res* 2006; 24(12): 2201–2211
- Balcarek P, Oberthür S, Hopfensitz S et al.: Which patellae are likely to redislocate? *Knee Surg. Sports Traumatol Arthrosc* 2014; 22: 2308–2314
- Balcarek P, Rehn S, Howells NR et al.: Results of medial patellofemoral ligament reconstruction compared with trochleoplasty plus individual extensor apparatus balancing in patellar instability caused by severe trochlear dysplasia: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2017; 25(12): 3869–3877
- Balcarek P, Zimmermann F: Deepening trochleoplasty and medial patellofemoral ligament reconstruction normalize patellochlear congruence in severe trochlear dysplasia. *Bone Joint J* 2019; 101 (3): 325–330
- Banke IJ, Kohn LM, Meidinger G et al.: Combined trochleoplasty and MPFL reconstruction for treatment of chronic patellofemoral instability: a prospective minimum 2-year follow-up study. *Knee Surg Sports Traumatol Arthrosc* 2014; 22: 2591–2598
- Batty L, Getgood A: Combined Biplanar Medial Closing-Wedge Distal Femoral Osteotomy and Quadriceps Tendon Medial Patellofemoral Ligament Reconstruction. *Arthrosc Tech* 2021; 10(7): 1685–1694
- Blønd L, Barfod KW: Trochlear Shape and Patient-Reported Outcomes After Arthroscopic Deepening Trochleoplasty and Medial Patellofemoral Ligament Reconstruction: A Retrospective Cohort Study Including MRI Assessments of the Trochlear Groove. *Orthop J Sports Med* 2023; 11(5): 23259671231171378
- Blønd L, Haugegaard M: Combined arthroscopic deepening trochleoplasty and reconstruction of the medial patellofemoral ligament for patients with recurrent patella dislocation and trochlear dysplasia. *Knee Surg Sports Traumatol Arthrosc* 2014; 22: 2484–2490
- Camathias C, Studer K, Kiapour A, Rutz E, Vavken P: Trochleoplasty as a Solitary Treatment for Recurrent Patellar Dislocation Results in Good Clinical Outcome in Adolescents. *Am J Sports Med* 2016; 44: 2855–2863
- Dejour D, Saggin P: The sulcus deepening trochleoplasty-the Lyon's procedure. *Int Orthop* 2010; 34(2): 311–316
- Dejour H, Walch G, Nove-Josserand L, Guier C: Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc* 1994; 2(1): 19–26
- De Leissègues T, Gunst S, Batailler C, Kolhe G, Lustig S, Servien E: Prevalence of trochlear dysplasia in symptomatic isolated lateral patellofemoral osteoarthritis: Transverse study of 101 cases. *Orthop Traumatol Surg Res* 2021; 107(7): 102895
- Deng X, Li L, Zhou P et al.: Medial patellofemoral ligament reconstruction combined with biplanar supracondylar femoral derotation osteotomy in recurrent patellar dislocation with increased femoral internal torsion and genu valgum: a retrospective pilot study. *BMC Musculoskelet Disord* 2021; 22(1): 990
- Dhinsa BS, Bhamra JS, James C, Dunnet W, Zahn H: Patella fracture after medial patellofemoral ligament reconstruction using suture anchors. *Knee* 2013; 20: 605–608
- Donell ST, Joseph G, Hing CB, Marshall TJ: Modified Dejour trochleoplasty for severe dysplasia: operative technique and early clinical results. *Knee* 2006; 13: 266–273
- Ewald F, Klasan A, Putnis S, Farizon F, Philippot R, Neri T: After MPFL reconstruction, femoral tunnel widening and migration increase with poor tunnel positioning and are related to poor clinical outcomes. *Knee Surg Sports Traumatol Arthrosc* 2023; 31(6): 2315–2322
- Fithian DC, Paxton EW, Stone ML et al.: Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med* 2004; 32(5): 1114–1121
- Flanigan DC, Shemory S, Lundy N, Stitgen M, Long JM, Magnussen RA: Medial patellofemoral ligament reconstruction with allograft versus autograft tissue results in similar recurrent dislocation risk and patient-reported outcomes. *Knee Surg Sports Traumatol Arthrosc* 2020; 28(7): 2099–2104
- Frings J, Dust T, Meyer J et al.: The Influence of Surgical Realignment Procedures on Dynamic Patellar Tracking: A Dynamic Magnetic Resonance Imaging-Controlled Feasibility Study. *Diagnostics* 2022; 12(11): 2761
- Frosch S, Balcarek P, Walde TA et al.: Die Therapie der Patellaluxation: eine systematische Literaturanalyse [The treatment of patellar dislocation: a systematic review]. *Z Orthop Unfall* 2011; 149(6): 630–645
- Fucentese SF, Schöttle PB, Pfirrmann CW, Romero J: CT changes after trochleoplasty for symptomatic trochlear dysplasia. *Knee Surg Sports Traumatol Arthrosc* 2007; 15: 168–174
- Fucentese SF, Zingg PO, Schmitt J, Pfirrmann CW, Meyer DC, Koch PP: Classification of trochlear dysplasia as predictor of clinical outcome after trochleoplasty. *Knee Surg Sports Traumatol Arthrosc*. 2011; 19(10): 1655–1661
- Grelsamer RP, Dejour D, Gould J: The pathophysiology of patellofemoral arthritis. *Orthop Clin North Am* 2008; 39: 269–274
- Hawi H, Kaireit TF, Krettek C, Lioudakis E: Clinical assessment of tibial torsion differences. Do we always need a computed tomography? *Eur J Trauma Emerg Surg* 2022; 48(4): 3229–3235

27. Herschel R, Hasler A, Tscholl PM, Fucentese SF: Visual-palpatory versus fluoroscopic intraoperative determination of the femoral entry point in medial patellofemoral ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2017; 25(8): 2545–2549
28. Hiemstra LA, Peterson D, Youssef M, Soliman J, Banfield L, Ayeni OR: Trochleoplasty provides good clinical outcomes and an acceptable complication profile in both short and long-term follow-up. *Knee Surg Sports Traumatol Arthrosc* 2019; 27(9): 2967–2983
29. Hysing-Dahl T, Inderhaug E, Faleide AGH, Magnussen LH: Patients' experiences of living with patellar instability before and after surgery: a qualitative interview study. *BMJ Open* 2023; 13(6): 072141
30. Jing L, Wang X, Qu X, et al.: Closing-wedge distal femoral osteotomy combined with medial patellofemoral ligament reconstruction for recurrent patellar dislocation with genu valgum. *BMC Musculoskelet Disord* 2021; 22(1): 668
31. Jos S, Shankar S, Anand R, Thomas Manathara L, Paulose B: Outcomes of MPFL reconstruction with tibial tubercle transfer for recurrent patellar instability with high grade trochlear dysplasia in Indian population. *J Clin Orthop Trauma* 2021; 20: 101490
32. Kluczynski MA, Miranda L, Marzo JM: Prevalence and Site of Medial Patellofemoral Ligament Injuries in Patients With Acute Lateral Patellar Dislocations: A Systematic Review and Meta-analysis. *Orthop J Sports Med* 2020; 8(12): 2325967120967338
33. Köhlitz T, Scheffler S, Jung T et al.: Prevalence and patterns of anatomical risk factors in patients after patellar dislocation: a case control study using MRI. *Eur Radiol* 2013; 23: 1067–1074
34. Kruckeberg BM, Wilbur RR, Song BM et al.: Comparison of Failure Rates at Long-term Follow-up Between MPFL Repair and Reconstruction for Recurrent Lateral Patellar Instability. *Orthop J Sports Med* 2024; 12(1): 23259671231221239
35. Lee DY, Kang DG, Jo HS, Heo SJ, Bae JH, Hwang SC: A systematic review and meta-analysis comparing conservative and surgical treatments for acute patellar dislocation in children and adolescents. *Knee Surg Relat Res* 2023; 35(1): 18
36. Lind M, Nielsen T, Miller L, Sørensen OG, Mygind-Klavsen B, Faunø P: No Difference in Outcome Between Femoral Soft-Tissue and Screw Graft Fixation for Reconstruction of the Medial Patellofemoral Ligament: A Randomized Controlled Trial. *Arthroscopy* 2019; 35(4): 1130–1137
37. Maenpaa H, Lehto MU: Patellofemoral osteoarthritis after patellar dislocation. *Clin Orthop Relat Res* 1997; 339:156–162
38. Maggioni DM, Giorgino R, Messina C, Albano D, Peretti GM, Mangiavini L: Framing Patellar Instability: From Diagnosis to the Treatment of the First Episode. *J Pers Med* 2023; 13(8): 1225
39. Marín Fermín T, Migliorini F, Kalifis G et al.: Hardware-free MPFL reconstruction in patients with recurrent patellofemoral instability is safe and effective. *J Orthop Surg Res* 2022; 17(1): 121
40. Matic GT, Magnussen RA, Kolovich GP, Flanigan DC: Return to activity after medial patellofemoral ligament repair or reconstruction. *Arthroscopy* 2014; 30(8): 1018–1025
41. Metcalfe AJ, Clark DA, Kemp MA, Eldridge JD: Trochleoplasty with a flexible osteochondral flap: results from an 11-year series of 214 cases. *Bone Joint J* 2017; 99: 344–350
42. Migliorini F, Marsilio E, Oliva F, Eschweiler J, Hildebrand F, Maffulli N: Chondral injuries in patients with recurrent patellar dislocation: a systematic review. *J Orthop Surg Res* 2022; 17(1): 63
43. Migliorini F, Trivellas A, Eschweiler J, Knobe M, Tingart M, Maffulli N: Comparable outcome for autografts and allografts in primary medial patellofemoral ligament reconstruction for patellofemoral instability: systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2022; 30(4): 1282–1291
44. Nelitz M, Dreyhaupt J, Lippacher S: Combined trochleoplasty and medial patellofemoral ligament reconstruction for recurrent patellar dislocations in severe trochlear dysplasia: a minimum 2-year follow-up study. *Am J Sports Med* 2013; 41(5): 1005–1012
45. Nelitz M, Dreyhaupt J, Williams SR, Dornacher D: Combined supracondylar femoral derotation osteotomy and patellofemoral ligament reconstruction for recurrent patellar dislocation and severe femoral anteversion syndrome: surgical technique and clinical outcome. *Int Orthop* 2015; 39(12): 2355–2362
46. Nelitz M, Williams RS, Lippacher S, Reichel H, Dornacher D: Analysis of failure and clinical outcome after unsuccessful medial patellofemoral ligament reconstruction in young patients. *Int Orthop* 2014; 38(11): 2265–2272
47. Ng J, Broomfield J, Barbosa F, Bhangoo N, Geutjens G: Low re-dislocation rate following Bereiter trochleoplasty for recurrent patellar instability with severe trochlear dysplasia. *Knee Surg Sports Traumatol Arthrosc* 2023; 31(6): 2494–2499
48. Nomura E, Horiuchi Y, Inoue M: Correlation of MR imaging findings and open exploration of medial patellofemoral ligament injuries in acute patellar dislocations. *Knee* 2002; 9: 139–143
49. Nomura E, Inoue M, Osada N: Anatomical analysis of the medial patellofemoral ligament of the knee, especially the femoral attachment. *Knee Surg Sports Traumatol Arthrosc* 2005; 13(7): 510–515
50. Ren B, Zhang X, Zhang L et al.: Isolated trochleoplasty for recurrent patellar dislocation has lower outcome and higher residual instability compared with combined MPFL and trochleoplasty: a systematic review. *Arch Orthop Trauma Surg* 2019; 139(11): 1617–1624
51. Sallay PI, Poggi J, Speer KP, Garrett WE: Acute Dislocation of the Patella: A Correlative Pathoanatomic Study. *The American Journal of Sports Medicine* 1996; 24(1): 52–60
52. Salonen EE, Magga T, Sillanpää PJ, Kiekara T, Mäenpää H, Mattila VM: Traumatic Patellar Dislocation and Cartilage Injury: A Follow-up Study of Long-Term Cartilage Deterioration. *Am J Sports Med* 2017; 45(6): 1376–1382
53. Sanchis-Alfonso V, Coloma-Saiz J, Herrero-Herrero M, Prades-Piñón J, Ramirez-Fuentes C: Evaluation of anterior knee pain patient: clinical and radiological assessment including psychological factors. *Annals of Joint* 2018; 3: 26
54. Sanders TL, Pareek A, Johnson NR, Stuart MJ, Dahm DL, Krych AJ: Patellofemoral Arthritis After Lateral Patellar Dislocation: A Matched Population-Based Analysis. *Am J Sports Med* 2017; 45(5): 1012–1017
55. Schöttle PB, Fucentese SF, Pfirrmann C, Bereiter H, Romero J: Trochleoplasty for patellar instability due to trochlear dysplasia: A minimum 2-year clinical and radiological follow-up of 19 knees. *Acta Orthop* 2005; 76: 693–698
56. Schöttle PB, Hensler D, Imhoff AB: Anatomical double bundle MPFL reconstruction with an aperture fixation. *Knee Surg Sports Traumatol Arthrosc* 2010; 18(2): 147–151

57. Schöttle PB, Schell H, Duda G, Weiler A: Cartilage viability after trochleoplasty. *Knee Surg Sports Traumatol Arthrosc* 2007; 15(2): 161–167
58. Schöttle PB, Schmeling A, Rosenstiel N, Weiler A: Radiographic landmarks for femoral tunnel placement in medial patellofemoral ligament reconstruction. *Am J Sports Med* 2007; 35(5): 801–804
59. Schuttler KF, Struwer J, Roessler PP et al.: Patellofemoral osteoarthritis after insall's proximal realignment for recurrent patellar dislocation. *Knee Surg Sports Traumatol Arthrosc* 2013; 22: 2623–2628
60. Servien E, Fritsch B, Lustig S et al.: In vivo positioning analysis of medial patellofemoral ligament reconstruction. *Am J Sports Med* 2011; 39(1): 134–139
61. Shah JN, Howard JS, Flanigan DC, Brophy RH, Carey JL, Lattermann C: A systematic review of complications and failures associated with medial patellofemoral ligament reconstruction for recurrent patellar dislocation. *Am J Sports Med* 2012; 40: 1916–1923
62. Sillanpää PJ, Peltola E, Mattila VM, Kiuru M, Visuri T, Pihlajamäki H: Femoral avulsion of the medial patellofemoral ligament after primary traumatic patellar dislocation predicts subsequent instability in men: a mean 7-year nonoperative follow-up study. *Am J Sports Med* 2009; 37(8): 1513–1521
63. Steiner T, Parker RD: Subluxation and Dislocation: Patellofemoral instability – Acute dislocation of the patella. In DeLee JC, Drez D Jr, Miller MD (eds): *Orthopaedic Sports Medicine: Principles and Practice*, 3rd Edition. Saunders, Elsevier, Philadelphia, PA, USA, 2010; 1534–1547
64. Stephen JM, Kaider D, Lumpaopong P, Deehan DJ, Amis AA: The effect of femoral tunnel position and graft tension on patellar contact mechanics and kinematics after medial patellofemoral ligament reconstruction. *Am J Sports Med* 2014; 42(2): 364–372
65. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R: Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. *Clin Orthop* 1991; 272: 208–212
66. Su P, Liu X, Jian N, Li J, Fu W: Clinical outcomes and predictive factors for failure with MPFL reconstruction combined with tibial tubercle osteotomy and lateral retinacular release for recurrent patellar instability. *BMC Musculoskelet Disord* 2021; 22(1): 632
67. Tanner SM, Garth WP Jr, Soileau R, Lemons JE: A modified test for patellar instability: the biomechanical basis. *Clin J Sport Med* 2003; 13(6): 327–338
68. Tarchala M, Kerslake S, Hiemstra LA: Sulcus-Deepening Trochleoplasty for High-Grade Trochlear Dysplasia: Demystifying the Procedure—a Review of the Current Literature. *Curr Rev Musculoskelet Med* 2023; 16(11): 538–549
69. Tian G, Yang G, Zuo L, Li F, Wang F: Conservative versus repair of medial patellofemoral ligament for the treatment of patients with acute primary patellar dislocations: A systematic review and meta-analysis. *Journal of Orthopaedic Surgery* 2020; 28(2):2309499020932375
70. Utting MR, Mulford JS, Eldridge JD: A prospective evaluation of trochleoplasty for the treatment of patellofemoral dislocation and instability. *J Bone Joint Surg Br* 2008; 90: 180–185
71. Vogel LA, Pace JL: Trochleoplasty, medial patellofemoral ligament reconstruction, and open lateral lengthening for patellar instability in the setting of high-grade trochlear dysplasia. *Arthrosc Tech* 2019; 8(9): 961–967
72. Vollnberg B, Koehlitz T, Jung T et al.: Prevalence of cartilage lesions and early osteoarthritis in patients with patellar dislocation. *Eur Radiol* 2012; 22: 2347–2356
73. von Engelhardt LV, Fuchs T, Weskamp P, Jerosch J: Effective patellofemoral joint stabilization and low complication rates using a hardware-free MPFL reconstruction technique with an intra-operative adjustment of the graft tension. *Knee Surg Sports Traumatol Arthrosc* 2018; 26(9): 2750–2757
74. von Engelhardt LV, Raddatz M, Bouillon B, Spahn G, Dávid A, Haage P, Lichtinger TK: How reliable is MRI in diagnosing cartilaginous lesions in patients with first and recurrent lateral patellar dislocations? *BMC Musculoskelet Disord* 2010; 11: 149
75. von Engelhardt LV, Weskamp P, Lahner M, Spahn G, Jerosch J: Deepening trochleoplasty combined with balanced medial patellofemoral ligament reconstruction for an adequate graft tensioning. *World J Orthop* 2017; 8(12): 935–945
76. von Knoch F, Bohm T, Burgi ML, von Knoch M, Bereiter H: Trochleoplasty for recurrent patellar dislocation in association with trochlear dysplasia. A 4– to 14-year follow-up study. *J Bone Joint Surg Br* 2006; 88(10): 1331–1335
77. Wagner D, Pfalzer F, Hingelbaum S, Huth J, Mauch F, Bauer G: The influence of risk factors on clinical outcomes following anatomical medial patellofemoral ligament (MPFL) reconstruction using the gracilis tendon. *Knee Surg Sports Traumatol Arthrosc*. 2013; 21(2): 318–324
78. Yamamoto RK: Arthroscopic repair of the medial retinaculum and capsule in acute patellar dislocations. *Arthroscopy* 1986 2(2): 125–131
79. Yoo JD, Huh MH, Lee CW, Roh YH, D’Lima DD, Shin YS: Medial patellofemoral ligament reconstruction appears to be a better treatment than repair, proximal realignment, or conservative management for primary patellar dislocation: A network meta-analysis. *Medicine* 2023; 102(39): 35251
80. Zaffagnini S, Previtali D, Tamborini S, Pagliuzzi G, Filardo G, Candrian C: Recurrent patellar dislocations: trochleoplasty improves the results of medial patellofemoral ligament surgery only in severe trochlear dysplasia. *Knee Surg Sports Traumatol Arthrosc* 2019; 27(11): 3599–3613
81. Zhang GY, Zheng L, Shi H, et al.: Correlation analysis between injury patterns of medial patellofemoral ligament and vastus medialis obliquus after acute first-time lateral patellar dislocation. *Knee Surg Sports Traumatol Arthrosc* 2018; 26(3): 719–726
82. Zimmermann F, Milinkovic DD, Balcarek P: Outcomes After Deepening Trochleoplasty and Concomitant Realignment in Patients With Severe Trochlear Dysplasia With Chronic Patellofemoral Pain: Results at 2-Year Follow-up. *Orthop J Sports Med* 2021; 9(6): 23259671211010404

Literatur zum Beitrag

Steffen Thier, Christoph Becher, Alexander Zimmerer:

Diagnostikstandards Knorpeltherapie Knie, OSG, Hüfte

1. AGA-Hüft-Komitee (Hrsg): Diagnostik des Hüftgelenkes, 2017
2. Becher C, Imhoff A: Leitfaden uni-kompartimenteller Gelenknorpel-schaden am Knie – Knorpelersatz, Osteotomie, Mini-Implantat oder Prothese? Orthopade 2021; 50: 88–95
3. Becher C, Plaaß C, Waizy H, Therman H, Stukenborg-Colsman C: Bildgebende Diagnostik und Klassifikation chondraler und osteochondraler Läsionen am Talus. Fuß & Sprunggelenk 2012; 10: 106–113
4. Bode G, Schmal H, Pestka JM, Ogon P, Südkamp NP, Niemeyer P: A Non-Randomized Controlled Clinical Trial on Autologous Chondrocyte Implantation (ACI) in Cartilage Defects of the Medial Femoral Condyle with or Without High Tibial Osteotomy in Patients with Varus Deformity of Less Than 5°. Arch Orthop Trauma Surg 2013; 133: 43–49
5. Brittberg M, Lindahl A, Nilsson A, Ohlsson C, Isaksson O, Peterson L: Treatment of Deep Cartilage Defects in the Knee with Autologous Chondrocyte Transplantation. N Engl J Med 1994; 331: 889–895
6. Buck FM, Hoffmann A, Hofer B, Pfirrmann CWA, Allgayer B: Chronic Medial Knee Pain Without History of Prior Trauma: Correlation of Pain at Rest and During Exercise Using Bone Scintigraphy and MR Imaging. Skeletal Radiol 2009; 38: 339–347
7. Buckwalter JA, Mankin HJ, Grodzinsky AJ: Articular Cartilage and Osteoarthritis. Instr Course Lect 2005; 54: 465–480
8. Cicuttini F, Ding C, Wluka A, Davis S, Ebeling PR, Jones G: Association of Cartilage Defects with Loss of Knee Cartilage in Healthy, Middle-Age Adults: a Prospective Study. Arthritis Rheum 2005; 52: 2033–2039
9. Ettinger S, Sonnow L, Plaass C, et al.: Arthroscopic Defect Size Measurement in Osteochondral Lesions of the Talus Underestimates the Exact Defect Size and Size Measurement with Arthro-MRI (MR-a) and High-Resolution Flat-Panel CT-Arthro Imaging (FPCT-a). Knee Surg Sports Traumatol Arthrosc 2023; 31: 716–723
10. Faber S, Angele P, Zellner J, Bode G, Hochrein A, Niemeyer P: Comparison of Clinical Outcome Following Cartilage Repair for Patients with Underlying Varus Deformity with or Without Additional High Tibial Osteotomy: a Propensity Score-Matched Study Based on the German Cartilage Registry (KnorpelRegister DGOU). Cartilage 2021; 13: 1206S-1216S
11. Faber S, Seifert N, Angele P, et al.: Factors Correlating with Patients' Satisfaction After Undergoing Cartilage Repair Surgery-Data from the German Cartilage Registry (Knorpel-Register DGOU). Int Orthop 2022; 46: 457–464
12. G. Matziolis et al.: S2k-Leitlinie Koxarthrose, 2019
13. Gebhardt S, Lerch S, Sobau C, Miehlke W, Wassilew GI, Zimmerer A: Prone Apprehension Relocation Test Significantly Correlates with Radiological Instability Scores of the Hip. J Hip Preserv Surg 2022; 9: 78–83
14. Griffin DR, Dickenson EJ, O'Donnell J, et al.: The Warwick Agreement on Femoroacetabular Impingement Syndrome (FAI Syndrome): an International Consensus Statement. Br J Sports Med 2016; 50: 1169–1176
15. Jacobsen S, Sonne-Holm S, Søballe K, Gebuhr P, Lund B: Hip Dysplasia and Osteoarthritis: a Survey of 4151 Subjects from the Osteoarthritis Substudy of the Copenhagen City Heart Study. Acta Orthop 2005; 76: 149–158
16. Kijowski R, Blankenbaker DG, Davis KW, Shinki K, Kaplan LD, Smet AA de: Comparison of 1.5- and 3.0-T MR Imaging for Evaluating the Articular Cartilage of the Knee Joint. Radiology 2009; 250: 839–848
17. Kuettner KE, Cole AA: Cartilage Degeneration in Different Human Joints. Osteoarthritis Cartilage 2005; 13: 93–103
18. Lerch TD, Antioco T, Meier MK, et al.: Combined Abnormalities of Femoral Version and Acetabular Version and McKibbin Index in FAI Patients Evaluated for Hip Preservation Surgery. J Hip Preserv Surg 2022; 9: 67–77
19. Leumann A, Valderrabano V, Plaass C, et al.: A Novel Imaging Method for Osteochondral Lesions of the Talus-Comparison of SPECT-CT with MRI. Am J Sports Med 2011; 39: 1095–1101
20. Linklater JM: Imaging of Talar Dome Chondral and Osteochondral Lesions. Top Magn Reson Imaging 2010; 21: 3–13
21. Mabey T, Honsawek S: Cytokines as Biochemical Markers for Knee Osteoarthritis. World J Orthop 2015; 6: 95–105
22. Marlovits S, Striessnig G, Resinger CT, et al.: Definition of Pertinent Parameters for the Evaluation of Articular Cartilage Repair Tissue with High-Resolution Magnetic Resonance Imaging. Eur J Radiol 2004; 52: 310–319
23. Mascarenhas VV, Castro MO, Rego PA, et al.: The Lisbon Agreement on Femoroacetabular Impingement Imaging-Part 1: Overview. Eur Radiol 2020; 30: 5281–5297
24. Niemeyer P, Albrecht D, Aurich M, et al.: Empfehlungen Der AG Klinische Geweberegeneration Zur Behandlung Von Knorpelschäden Am Kniegelenk. Z Orthop Unfall 2023; 161: 57–64
25. Niemeyer P, Angele P: Aktuelle Therapieempfehlungen zur operativen Knorpeltherapie am Kniegelenk. Arthroscopie 2022; 35: 365–370
26. Niemeyer P, Faber S, Bumberger A: Handlungsempfehlung: Knorpeltherapie am Kniegelenk. Knie J. 2022; 4: 72–75
27. Pazzinatto MF, Oliveira Silva D de, Faria NC, et al.: What Are the Clinical Implications of Knee Crepitus to Individuals with Knee Osteoarthritis? an Observational Study with Data from the Osteoarthritis Initiative. Braz J Phys Ther 2019; 23: 491–496
28. Plaaß C, Valderrabano V, Wiewiorski M, Leumann A: Ätiologie und Pathophysiologie der osteochondralen Läsion des Talus. Fuß & Sprunggelenk 2012; 10: 96–105
29. Schiphof D, Klerk BM de, Kerkhof HJM, et al.: Impact of Different Descriptions of the Kellgren and Lawrence Classification Criteria on the Diagnosis of Knee Osteoarthritis. Ann Rheum Dis 2011; 70: 1422–1427
30. Shah AJ, Patel D: Imaging Update on Cartilage. J Clin Orthop Trauma 2021; 22: 101610

31. Soellner ST, Goldmann A, Muelheims D, Welsch GH, Pachowsky ML: Intraoperative Validation of Quantitative T2 Mapping in Patients with Articular Cartilage Lesions of the Knee. *Osteoarthritis Cartilage* 2017; 25: 1841–1849
32. Solheim E, Hegna J, Inderhaug E: Early Determinants of Long-Term Clinical Outcome After Cartilage Repair Surgery in the Knee. *J Orthop* 2018; 15: 222–225
33. Trattnig S, Mlynárik V, Huber M, Bassalamah A, Puig S, Imhof H: Magnetic Resonance Imaging of Articular Cartilage and Evaluation of Cartilage Disease. *Invest Radiol* 2000; 35: 595–601
34. van Dijk CN, Reilingh ML, Zengerink M, van Bergen CJA: Osteochondral Defects in the Ankle: Why Painful? *Knee Surg Sports Traumatol Arthrosc* 2010; 18: 570–580
35. Widuchowski W, Widuchowski J, Trzaska T: Articular Cartilage Defects: Study of 25,124 Knee Arthroscopies. *Knee* 2007; 14: 177–182
36. Wyatt M, Weidner J, Pfluger D, Beck M: The Femoro-Epiphyseal Acetabular Roof (FEAR) Index: a New Measurement Associated with Instability in Borderline Hip Dysplasia? *Clin Orthop Relat Res* 2017; 475: 861–869
37. Wyles CC, Heidenreich MJ, Jeng J, Larson DR, Trousdale RT, Sierra RJ: The John Charnley Award: Redefining the Natural History of Osteoarthritis in Patients with Hip Dysplasia and Impingement. *Clin Orthop Relat Res* 2017; 475: 336–350
38. Zimmerer A, Löchel J, Schoon J, Janz V, Wassilew GI: Defining the Gothic Arch Angle (GAA) as a Radiographic Diagnostic Tool for Instability in Hip Dysplasia. *Sci Rep* 2021; 11: 19531

Literatur zum Beitrag

Arnd Hoburg, Christian Plaaß, Wolfram Steens:

Relevanz der Therapie von Begleitpathologien in der knorpelregenerativen Therapie an Hüft-, Knie- und Sprunggelenk

Praktisches Vorgehen

- Wenger DR. (2013) Is There a Role for Acetabular Dysplasia Correction in an Asymptomatic Patient? *Journal of Pediatric Orthopaedics* 33:S8–S12
- Steppacher SD, Tannast M, Werlen S, Siebenrock KA. (2008) Femoral Morphology Differs Between Deficient and Excessive Acetabular Coverage. *Clin Orthop Relat Res* 466:782–790
- Sanchez-Sotelo J, Berry DJ, Trousdale RT, Cabanela ME. (2002) Surgical Treatment of Developmental Dysplasia of the Hip in Adults: II. Arthroplasty Options. *Journal of the American Academy of Orthopaedic Surgeons* 10:334–344
- Sucato DJ. (2006) Treatment of Late Dysplasia with Ganz Osteotomy. *Orthopedic Clinics of North America* 37:161–171
- Clohisy JC, Dobson MA, Robison JF et al.. (2011) Radiographic Structural Abnormalities Associated with Premature, Natural Hip-Joint Failure. *Journal of Bone and Joint Surgery* 93:3–9
- Dwyer MK, Tumpowsky C, Boone A et al.. (2019) What Is the Association Between Articular Cartilage Damage and Subsequent THA 20 Years After Hip Arthroscopy for Labral Tears? *Clin Orthop Relat Res* 477:1211–1220
- McCarthy J, Mc Millan S. (2013) Arthroscopy of the Hip. *Orthopedic Clinics of North America* 44:489–498
- Ganz R, Klaue K, Vinh TS, Mast JW. (1988) A new periacetabular osteotomy for the treatment of hip dysplasia. Technique and preliminary results. *Clin Orthop Relat Res* 26–36
- Perry KI, Trousdale RT, Sierra RJ. (2013) Hip dysplasia in the young adult. *Bone Joint J* 95-B:21–25
- Matheney T, Kim Y-J, Zurakowski D et al.. (2009) Intermediate to Long-Term Results Following the Bernese Periacetabular Osteotomy and Predictors of Clinical Outcome. *The Journal of Bone and Joint Surgery-American Volume* 91:2113–2123
- Clohisy JC, Barrett SE, Gordon JE et al.. (2005) Periacetabular Osteotomy for the Treatment of Severe Acetabular Dysplasia. *J Bone Joint Surg* 87:254–259
- Cunningham T, Jessel R, Zurakowski D et al.. (2006) Delayed Gadolinium-Enhanced Magnetic Resonance Imaging of Cartilage to Predict Early Failure of Bernese Periacetabular Osteotomy for Hip Dysplasia. *J Bone Joint Surg* 88:1540–1548
- Peters CL. (2006) Early Results of the Bernese Periacetabular Osteotomy: The Learning Curve at an Academic Medical Center. *The Journal of Bone and Joint Surgery (American)* 88:1920
- Sucato DJ, Tulchin K, Shrader MW et al.. (2010) Gait, Hip Strength and Functional Outcomes After a Ganz Periacetabular Osteotomy for Adolescent Hip Dysplasia. *Journal of Pediatric Orthopaedics* 30:344–350
- Beaulé PE, Dowding C, Parker G, Ryu J-J. (2015) What Factors Predict Improvements in Outcomes Scores and Reoperations After the Bernese Periacetabular Osteotomy? *Clin Orthop Relat Res* 473:615–622
- Fickert S, Aurich M, Albrecht D et al.. (2017) Biologische Rekonstruktion lokalisiert vollschichtiger Knorpelschäden des Hüftgelenks: Empfehlungen der Arbeitsgemeinschaft „Klinische Geweberegeneration“ der DGOU und des Hüftkomitees der AGA. *Z Orthop Unfall* 155:670–682
- Tzaveas AP, Villar RN. (2010) Arthroscopic Repair of Acetabular Chondral Delamination with Fibrin Adhesive. *HIP International* 20:115–119
- Stafford GH, Bunn JR, Villar RN. (2011) Arthroscopic Repair of Delaminated Acetabular Articular Cartilage Using Fibrin Adhesive. Results at One to Three Years. *HIP International* 21:744–750
- Horisberger M, Brunner A, Herzog RF. (2010) Arthroscopic Treatment of Femoral Acetabular Impingement in Patients With Preoperative Generalized Degenerative Changes. *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 26:623–629
- Philippon MJ, Schenker ML, Briggs KK, Maxwell RB. (2008) Can Microfracture Produce Repair Tissue in Acetabular Chondral Defects? *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 24:46–50
- Karthikeyan S, Roberts S, Griffin D. (2012) Microfracture for Acetabular Chondral Defects in Patients With Femoroacetabular Impingement. *Am J Sports Med* 40:2725–2730
- Zaltz I, Leunig M. (2012) Parafoveal Chondral Defects Associated with Femoroacetabular Impingement. *Clin Orthop Relat Res* 470:3383–3389
- Fontana A, de Girolamo L. (2015) Sustained five-year benefit of autologous matrix-induced chondrogenesis for femoral acetabular impingement-induced chondral lesions compared with microfracture treatment. *Bone Joint J* 97-B:628–635
- Fontana A. (2016) Autologous Membrane Induced Chondrogenesis (AMIC) for the treatment of acetabular chondral defect. *Muscles Ligaments Tendons J*
- Körsmeier K, Claßen T, Kamminga M et al. (2016) Arthroscopic three-dimensional autologous chondrocyte transplantation using spheroids for the treatment of full-thickness cartilage defects of the hip joint. *Knee Surgery, Sports Traumatology, Arthroscopy* 24:2032–2037
- Mancini D, Fontana A. (2014) Five-year results of arthroscopic techniques for the treatment of acetabular chondral lesions in femoroacetabular impingement. *Int Orthop* 38:2057–2064
- Gebhardt S, Hofer A, Wassilew GI et al.. (2023) Minced Cartilage Implantation in Acetabular Cartilage Defects: Case Series with 2-Year Results. *Cartilage* 14:393–399
- Zellner J, Faber S, Spahn G et al. (2021) Current practice of concomitant surgeries in cartilage repair of

- the femorotibial compartment of the knee: baseline data of 4968 consecutive patients from the German cartilage registry (KnorpelRegister DGOU). *Arch Orthop Trauma Surg* 143:571–581
29. Bennell KL, Hunt MA, Wrigley TV et al.. (2007) The effects of hip muscle strengthening on knee load, pain, and function in people with knee osteoarthritis: a protocol for a randomized, single-blind controlled trial. *BMC Musculoskelet Disord* 8:121
 30. Huizinga MR, Brouwer RW, van Raaij TM. (2014) High tibial osteotomy: closed wedge versus combined wedge osteotomy. *BMC Musculoskelet Disord* 15:124
 31. Bode G, Schmal H, Pestka JM, et al.. (2013) A non-randomized controlled clinical trial on autologous chondrocyte implantation (ACI) in cartilage defects of the medial femoral condyle with or without high tibial osteotomy in patients with varus deformity of less than 5°. *Arch Orthop Trauma Surg* 133:43–49
 32. Dhillon J, Kraeutler MJ, Fasulo SM et al.. (2023) Cartilage Repair of the Tibiofemoral Joint With Versus Without Concomitant Osteotomy: A Systematic Review of Clinical Outcomes. *Orthop J Sports Med* 11:232596712311517
 33. Bode L, Eberbach H, Brenner A-S et al.. (2022) 10-Year Survival Rates After High Tibial Osteotomy Using Angular Stable Internal Plate Fixation: Case Series With Subgroup Analysis of Outcomes After Combined Autologous Chondrocyte Implantation and High Tibial Osteotomy. *Orthop J Sports Med* 10:232596712210780
 34. Sanders TL, Maradit Kremers H, Bryan AJ et al.. (2016) Incidence of Anterior Cruciate Ligament Tears and Reconstruction. *Am J Sports Med* 44:1502–1507
 35. Heijink A, Gomoll AH, Madry H et al.. (2012) Biomechanical considerations in the pathogenesis of osteoarthritis of the knee. *Knee Surgery, Sports Traumatology, Arthroscopy* 20:423–435
 36. Mehl J, Feucht M, Achtnich A et al.. (2022) Autologous chondrocyte implantation combined with anterior cruciate ligament reconstruction: similar short-term results in comparison with isolated cartilage repair in ligament intact joints. *Knee Surgery, Sports Traumatology, Arthroscopy* 30:3249–3257
 37. Ulstein S, Årøen A, Engebretsen L et al.. (2018) A Controlled Comparison of Microfracture, Debridement, and No Treatment of Concomitant Full-Thickness Cartilage Lesions in Anterior Cruciate Ligament-Reconstructed Knees: A Nationwide Prospective Cohort Study From Norway and Sweden of 368 Patients With 5-Year Follow-up. *Orthop J Sports Med* 6:232596711878776
 38. Gudas R, Gudaitė A, Mickevičius T et al.. (2013) Comparison of Osteochondral Autologous Transplantation, Microfracture, or Debridement Techniques in Articular Cartilage Lesions Associated With Anterior Cruciate Ligament Injury: A Prospective Study With a 3-Year Follow-up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery* 29:89–97
 39. Bąkowski P, Mieloch AA, Porzucek F et al.. (2023) Meniscus repair via collagen matrix wrapping and bone marrow injection: clinical and biomolecular study. *Int Orthop* 47:2409–2417
 40. Gaissmaier C, Angele P, Spiro RC et al.. (2024) Hydrogel-Based Matrix-Associated Autologous Chondrocyte Implantation Shows Greater Substantial Clinical Benefit at 24 Months Follow-Up than Microfracture: A Propensity Score Matched-Pair Analysis. *Cartilage*.
 41. Hoburg A, Niemeyer P, Laute V et al.. (2022) Safety and Efficacy of Matrix-Associated Autologous Chondrocyte Implantation With Spheroids for Patellofemoral or Tibiofemoral Defects: A 5-Year Follow-up of a Phase 2, Dose-Confirmation Trial. *Orthop J Sports Med* 10:232596712110533
 42. Burger D, Feucht M, Muench LN et al.. (2022) Good clinical outcomes after patellar cartilage repair with no evidence for inferior results in complex cases with the need for additional patellofemoral realignment procedures: a systematic review. *Knee Surgery, Sports Traumatology, Arthroscopy* 30:1752–1768
 43. Körner D, Ateschrang A, Schröter S et al.. (2020) Concomitant ankle instability has a negative impact on the quality of life in patients with osteochondral lesions of the talus: data from the German Cartilage Registry (KnorpelRegister DGOU). *Knee Surgery, Sports Traumatology, Arthroscopy* 28:3339–3346
 44. Saltzman CL, El-Khoury GY. (1995) The Hindfoot Alignment View. *Foot Ankle Int* 16:572–576
 45. Joshy S, Abdulkadir U, Chaganti S et al.. (2010) Accuracy of MRI scan in the diagnosis of ligamentous and chondral pathology in the ankle. *Foot and Ankle Surgery* 16:78–80
 46. Elkaim M, Thès A, Lopes R et al.. (2018) Agreement between arthroscopic and imaging study findings in chronic anterior talo-fibular ligament injuries. *Orthopaedics & Traumatology: Surgery & Research* 104:S213–S218
 47. Nakasa T, Ikuta Y, Sumii J et al.. (2022) MRI appearance of the lateral fibulotalocalcaneal ligament complex injury in the patients with chronic lateral ankle instability. *Foot and Ankle Surgery* 28:968–974
 48. Saltzman CL, El-Khoury GY. (1995) The Hindfoot Alignment View. *Foot Ankle Int* 16:572–576
 49. Nekomoto A, Nakasa T, Ikuta Y et al.. (2023) Quantitative evaluation of calcaneofibular ligament injury on the oblique coronal view of magnetic resonance imaging in chronic lateral ankle instability. *Journal of Orthopaedic Science*.
 50. Vega J, Dalmau-Pastor M. (2023) Ankle Joint Microinstability. *Foot Ankle Clin* 28:333–344
 51. Vega J, Allmendinger J, Malagelada F et al.. (2020) Combined arthroscopic all-inside repair of lateral and medial ankle ligaments is an effective treatment for rotational ankle instability. *Knee Surgery, Sports Traumatology, Arthroscopy* 28:132–140
 52. Ackermann J, Casari FA, Germann C et al.. (2021) Autologous Matrix-Induced Chondrogenesis With Lateral Ligament Stabilization for Osteochondral Lesions of the Talus in Patients With Ankle Instability. *Orthop J Sports Med* 9:232596712110074
 53. Ahrend M-D, Aurich M, Becher C et al.. (2022) Preexisting and treated concomitant ankle instability does not compromise patient-reported outcomes of solitary osteochondral lesions of the talus treated with matrix-induced bone marrow stimulation in the first postoperative year: data from the German Cartilage Registry (KnorpelRegister DGOU). *Knee Surgery, Sports Traumatology, Arthroscopy* 30:1187–1196
 54. Guelfi M, Nunes GA, Malagelada F et al.. (2020) Arthroscopic-Assisted Versus All-Arthroscopic Ankle Stabilization Technique. *Foot Ankle Int* 41:1360–1367
 55. Guelfi M, Baalbaki R, Malagelada F et al.. (2023) Arthroscopic all inside ligament repair has similar or superior clinical outcomes compared to open repair for chronic ankle instability without concomitant intra articular pathology at 5 years follow up. *Knee Surgery, Sports Traumatology, Arthroscopy* 31:6052–6058
 56. Plaass C, Becher C, Gottschalk O et al.. (2021) Actual all-arthroscopic techniques for the treatment of os-

- teochondral defects of the ankle joint. *Fuß & Sprunggelenk* 19:66–75
57. Gottschalk O, Baumbach SF, Altenberger S et al.. (2021) Influence of the Medial Malleolus Osteotomy on the Clinical Outcome of M-BMS + I/III Collagen Scaffold in Medial Talar Osteochondral Lesion (German Cartilage Register/Knorpelregister DGOU). *Cartilage* 13:1373S-1379S
58. Brown ML, McCauley JC, Gracitelli GC, Bugbee WD (2020) Osteochondritis Dissecans Lesion Location Is Highly Concordant With Mechanical Axis Deviation. *Am J Sports Med* 48:871–875
59. Paul J, Hinterwimmer S, Vavken P et al.. (2014) Zusammenhang der Rückfußachse mit der Lokalisation von osteochondralen Läsionen am Talus. *Z Orthop Unfall* 152:389–392
60. Krause F, Windolf M, Schwieger K, Weber M (2007) Ankle joint pressure in pes cavovarus. *J Bone Joint Surg Br* 89-B:1660–1665
61. Li X, Zhu Y, Xu Y et al.. (2017) Osteochondral autograft transplantation with biplanar distal tibial osteotomy for patients with concomitant large osteochondral lesion of the talus and varus ankle malalignment. *BMC Musculoskelet Disord* 18:23
62. Valderrabano V, Miska M, Leumann A, Wiewiorski M (2013) Reconstruction of Osteochondral Lesions of the Talus With Autologous Spongiosa Grafts and Autologous Matrix-Induced Chondrogenesis. *Am J Sports Med* 41:519–527
63. Kim J, Rajan L, Gagne O et al.. (2023) Realignment Surgery for Failed Osteochondral Autologous Transplantation in Osteochondral Lesions of the Talus Associated With Malalignment.

Literatur zum Beitrag

Wolfram Steens, Philip P. Roessler:

**Konservative medikamentöse Knorpeltherapie
und supportive Therapie nach Knorpelchirurgie
Aktueller Stand**

1. Mithoefer K, McAdams T, Williams RJ, Kreuz PC, Mandelbaum BR. Clinical efficacy of the microfracture technique for articular cartilage repair in the knee: an evidence-based systematic analysis. *The American journal of sports medicine*. 2009;37(10):2053–63
2. Volz M, Schaumburger J, Frick H, Grifka J, Anders S. A randomized controlled trial demonstrating sustained benefit of Autologous Matrix-Induced Chondrogenesis over microfracture at five years. *Int Orthop*. 2017;41(4):797–804
3. Stafford GH, Bunn JR, Villar RN. Arthroscopic repair of delaminated acetabular articular cartilage using fibrin adhesive. Results at one to three years. *Hip international : the journal of clinical and experimental research on hip pathology and therapy*. 2011;21(6):744–50
4. Tzaveas AP, Villar RN. Arthroscopic repair of acetabular chondral delamination with fibrin adhesive. *Hip international : the journal of clinical and experimental research on hip pathology and therapy*. 2010;20(1):115–119
5. Fontana A, Bistolfi A, Crova M, Rosso F, Massazza G. Arthroscopic treatment of hip chondral defects: autologous chondrocyte transplantation versus simple debridement—a pilot study. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2012;28(3):322–329
6. Fontana A. A novel technique for treating cartilage defects in the hip: a fully arthroscopic approach to using autologous matrix-induced chondrogenesis. *Arthroscopy techniques*. 2012;1(1):e63–68
7. Hangody L, Dobos J, Baló E, Pánics G, Hangody LR, Berkes I. Clinical experiences with autologous osteochondral mosaicplasty in an athletic population: a 17-year prospective multicenter study. *The American journal of sports medicine*. 2010;38(6):1125–1133
8. Krych AJ, Lorich DG, Kelly BT. Treatment of focal osteochondral defects of the acetabulum with osteochondral allograft transplantation. *Orthopedics*. 2011;34(7):e307–11
9. Martin DR, Cox NR, Hathcock TL, Niemeyer GP, Baker HJ. Isolation and characterization of multipotential mesenchymal stem cells from feline bone marrow. *Exp Hematol*. 2002;30(8):879–886
10. Indrawattana N, Chen G, Tadokoro M, Shann LH, Ohgushi H, Tateishi T et al. Growth factor combination for chondrogenic induction for human mesenchymal stem cell. *Biochem Biophys Res Commun*. 2004;320(3):914–919
11. Jo CH, Lee YG, Shin WH, Kim H, Chai JW, Jeong EC et al. Intra-articular injection of mesenchymal stem cells for the treatment of osteoarthritis of the knee: a proof-of-concept clinical trial. *Stem Cells*. 2014;32(5):1254–1266
12. Wolfstätt JJ, Cole BJ, Ogilvie-Harris DJ, Viswanathan S, Chahal J. Current concepts: the role of mesenchymal stem cells in the management of knee osteoarthritis. *Sports Health*. 2015;7(1):38–44
13. Hsu WK, Mishra A, Rodeo SR, Fu F, Terry MA, Randelli P et al. Platelet-rich plasma in orthopaedic applications: evidence-based recommendations for treatment. *J Am Acad Orthop Surg*. 2013;21(12):739–748
14. Mifune Y, Matsumoto T, Takayama K, Ota S, Li H, Meszaros LB et al. The effect of platelet-rich plasma on the regenerative therapy of muscle derived stem cells for articular cartilage repair. *Osteoarthritis and cartilage*. 2013;21(1):175–185
15. Abrams GD, Frank RM, Fortier LA, Cole BJ. Platelet-rich plasma for articular cartilage repair. *Sports Med Arthrosc Rev*. 2013;21(4):213–219
16. Sánchez M, Guadilla J, Fiz N, Andia I. Ultrasound-guided platelet-rich plasma injections for the treatment of osteoarthritis of the hip. *Rheumatology (Oxford)*. 2012;51(1):144–150
17. Heijnen HF, Schiel AE, Fijnheer R, Geuze HJ, Sixma JJ. Activated platelets release two types of membrane vesicles: microvesicles by surface shedding and exosomes derived from exocytosis of multivesicular bodies and alpha-granules. *Blood*. 1999;94(11):3791–3799
18. Civinini R, Nistri L, Martini C, Redl B, Ristori G, Innocenti M. Growth factors in the treatment of early osteoarthritis. Clinical cases in mineral and bone metabolism : the official journal of the Italian Society of Osteoporosis, Mineral Metabolism, and Skeletal Diseases. 2013;10(1):26–29
19. Bendinelli P, Matteucci E, Dogliotti G, Corsi MM, Banfi G, Maroni P et al. Molecular basis of anti-inflammatory action of platelet-rich plasma on human chondrocytes: mechanisms of NF-κB inhibition via HGF. *J Cell Physiol*. 2010;225(3):757–766
20. Stratz C, Nührenberg TG, Binder H, Valina CM, Trenk D, Hochholzer W et al. Micro-array profiling exhibits remarkable intra-individual stability of human platelet micro-RNA. *Thromb Haemost*. 2012;107(4):634–641
21. Nagalla S, Shaw C, Kong X, Kondkar AA, Edelstein LC, Ma L et al. Platelet microRNA-mRNA coexpression profiles correlate with platelet reactivity. *Blood*. 2011;117(19):5189–5197
22. Semple JW. Platelets deliver small packages of genetic function. *Blood*. 2013;122(2):155–156
23. Ham O, Song BW, Lee SY, Choi E, Cha MJ, Lee CY et al. The role of microRNA-23b in the differentiation of MSC into chondrocyte by targeting protein kinase A signaling. *Biomaterials*. 2012;33(18):4500–4507
24. Dohan Ehrenfest DM, Andia I, Zimstein MA, Zhang CQ, Pinto NR, Bielecki T. Classification of platelet concentrates (Platelet-Rich Plasma-PRP, Platelet-Rich Fibrin-PRF) for topical and infiltrative use in orthopedic and sports medicine: current consensus, clinical implications and perspectives. *Muscles Ligaments Tendons J*. 2014;4(1):3–9

25. Anitua E, Sánchez M, Orive G, Andia I. The potential impact of the preparation rich in growth factors (PRGF) in different medical fields. *Biomaterials*. 2007;28(31):4551–4560
26. Mazzucco L, Balbo V, Cattana E, Guaschino R, Borzini P. Not every PRP-gel is born equal. Evaluation of growth factor availability for tissues through four PRP-gel preparations: Fibrinet, RegenPRP-Kit, Plateltex and one manual procedure. *Vox Sang*. 2009;97(2):110–8
27. Lucarelli E, Beretta R, Dozza B, Tazzari PL, O’Connel SM, Ricci F et al. A recently developed bifacial platelet-rich fibrin matrix. *Eur Cell Mater*. 2010;20:13–23
28. Zumstein MA, Berger S, Schober M, Boileau P, Nyffeler RW, Horn M et al. Leukocyte- and platelet-rich fibrin (L-PRF) for long-term delivery of growth factor in rotator cuff repair: review, preliminary results and future directions. *Curr Pharm Biotechnol*. 2012;13(7):1196–1206
29. Lee GW, Son JH, Kim JD, Jung GH. Is platelet-rich plasma able to enhance the results of arthroscopic microfracture in early osteoarthritis and cartilage lesion over 40 years of age? *Eur J Orthop Surg Traumatol*. 2013;23(5):581–587
30. Dhollander AA, De Neve F, Almqvist KF, Verdonk R, Lambrecht S, Elewaut D et al. Autologous matrix-induced chondrogenesis combined with platelet-rich plasma gel: technical description and a five pilot patients report. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2011;19(4):536–542
31. Siclari A, Mascaro G, Gentili C, Cancedda R, Boux E. A cell-free scaffold-based cartilage repair provides improved function hyaline-like repair at one year. *Clin Orthop Relat Res*. 2012;470(3):910–919
32. Siclari A, Mascaro G, Gentili C, Kaps C, Cancedda R, Boux E. Cartilage repair in the knee with subchondral drilling augmented with a platelet-rich plasma-immersed polymer-based implant. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*. 2014;22(6):1225–1234
33. Turajane T, Thitiset T, Honsawek S, Chaveewanakorn U, Aojanepong J, Papadopoulos KI. Assessment of chondrogenic differentiation potential of autologous activated peripheral blood stem cells on human early osteoarthritic cancellous tibial bone scaffold. *Musculoskelet Surg*. 2014;98(1):35–43
34. Deng MW, Wei SJ, Yew TL, Lee PH, Yang TY, Chu HY et al. Cell Therapy With G-CSF-Mobilized Stem Cells in a Rat Osteoarthritis Model. *Cell Transplant*. 2015;24(6):1085–1096
35. Fu WL, Zhou CY, Yu JK. A new source of mesenchymal stem cells for articular cartilage repair: MSCs derived from mobilized peripheral blood share similar biological characteristics in vitro and chondrogenesis in vivo as MSCs from bone marrow in a rabbit model. *The American journal of sports medicine*. 2014;42(3):592–601
36. Saw KY, Anz A, Siew-Yoke Jee C, Merican S, Ching-Soong Ng R, Roohi SA et al. Articular cartilage regeneration with autologous peripheral blood stem cells versus hyaluronic acid: a randomized controlled trial. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2013;29(4):684–694
37. Giannini S, Buda R, Vannini F, Cavallo M, Grigolo B. One-step bone marrow-derived cell transplantation in talar osteochondral lesions. *Clin Orthop Relat Res*. 2009;467(12):3307–3320
38. Giannini S, Buda R, Battaglia M, Cavallo M, Ruffilli A, Ramponi L et al. One-step repair in talar osteochondral lesions: 4-year clinical results and t2-mapping capability in outcome prediction. *The American journal of sports medicine*. 2013;41(3):511–518
39. Sermer C, Devitt B, Chahal J, Kandel R, Theodoropoulos J. The Addition of Platelet-Rich Plasma to Scaffolds Used for Cartilage Repair: A Review of Human and Animal Studies. *Arthroscopy: the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2015;31(8):1607–1625
40. Belk JW, Kraeutler MJ, Houck DA, Goodrich JA, Dragoo JL, McCarty EC. Platelet-Rich Plasma Versus Hyaluronic Acid for Knee Osteoarthritis: A Systematic Review and Meta-analysis of Randomized Controlled Trials. *The American journal of sports medicine*. 2021;49(1):249–260
41. Filardo G, Previtali D, Napoli F, Candrian C, Zaffagnini S, Grassi A. PRP Injections for the Treatment of Knee Osteoarthritis: A Meta-Analysis of Randomized Controlled Trials. *Cartilage*. 2021;13(1_suppl):364s-375s
42. Hohmann E, Tetsworth K, Glatt V. Is platelet-rich plasma effective for the treatment of knee osteoarthritis? A systematic review and meta-analysis of level 1 and 2 randomized controlled trials. *Eur J Orthop Surg Traumatol*. 2020;30(6):955–967
43. Laudy AB, Bakker EW, Rekers M, Molen MH. Efficacy of platelet-rich plasma injections in osteoarthritis of the knee: a systematic review and meta-analysis. *Br J Sports Med*. 2015;49(10):657–672
44. Meheux CJ, McCulloch PC, Lintner DM, Varner KE, Harris JD. Efficacy of Intra-articular Platelet-Rich Plasma Injections in Knee Osteoarthritis: A Systematic Review. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2016;32(3):495–505
45. Burchard R, Huflage H, Soost C, Richter O, Bouillon B, Graw JA. Efficiency of platelet-rich plasma therapy in knee osteoarthritis does not depend on level of cartilage damage. *Journal of orthopaedic surgery and research*. 2019;14(1):153
46. Laver L, Marom N, Dnyanesh L, Meidan O, Espregueira-Mendes J, Gobbi A. PRP for Degenerative Cartilage Disease: A Systematic Review of Clinical Studies. *Cartilage*. 2017;8(4):341–364
47. Kon E, Buda R, Filardo G, Di Martino A, Timoncini A, Cenacchi A et al. Platelet-rich plasma: intra-articular knee injections produced favorable results on degenerative cartilage lesions. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*. 2010;18(4):472–479
48. Filardo G, Kon E, Buda R, Timoncini A, Di Martino A, Cenacchi A et al. Platelet-rich plasma intra-articular knee injections for the treatment of degenerative cartilage lesions and osteoarthritis. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2011;19(4):528–535
49. Chang KV, Hung CY, Aliwarga F, Wang TG, Han DS, Chen WS. Comparative effectiveness of platelet-rich plasma injections for treating knee joint cartilage degenerative pathology: a systematic review and meta-analysis. *Arch Phys Med Rehabil*. 2014;95(3):562–575
50. Krüger JP, Hondke S, Endres M, Pruss A, Siclari A, Kaps C. Human platelet-rich plasma stimulates migration and chondrogenic differentiation of human subchondral progenitor cells. *Journal of orthopaedic research : official*

- cial publication of the Orthopaedic Research Society. 2012;30(6):845–852
51. Wong CC, Ou KL, Lin YH, Lin MF, Yang TL, Chen CH et al. Platelet-Rich Fibrin Facilitates One-Stage Cartilage Repair by Promoting Chondrocytes Viability, Migration, and Matrix Synthesis. *Int J Mol Sci.* 2020;21(2)
 52. Wang K, Li J, Li Z, Wang B, Qin Y, Zhang N, et al. Chondrogenic Progenitor Cells Exhibit Superiority Over Mesenchymal Stem Cells and Chondrocytes in Platelet-Rich Plasma Scaffold-Based Cartilage Regeneration. *The American journal of sports medicine.* 2019;47(9):2200–2215
 53. Jeyakumar V, Niculescu-Morzsza E, Bauer C, Lacza Z, Nehrer S. Redifferentiation of Articular Chondrocytes by Hyperacute Serum and Platelet Rich Plasma in Collagen Type I Hydrogels. *Int J Mol Sci.* 2019;20(2)
 54. Tischer T, Bode G, Buhs M, Marquass B, Nehrer S, Vogt S, et al. Platelet-rich plasma (PRP) as therapy for cartilage, tendon and muscle damage – German working group position statement. *J Exp Orthop.* 2020;7(1):64
 55. Honvo G, Reginster JY, Rannou F, Rygaert X, Geerinck A, Rabenda V et al. Safety of Intra-articular Hyaluronic Acid Injections in Osteoarthritis: Outcomes of a Systematic Review and Meta-Analysis. *Drugs Aging.* 2019;36(Suppl 1):101–127
 56. Kaplan LD, Lu Y, Snitzer J, Nemke B, Hao Z, Biro S et al. The effect of early hyaluronic acid delivery on the development of an acute articular cartilage lesion in a sheep model. *The American journal of sports medicine.* 2009;37(12):2323–2327
 57. Altman RD, Devji T, Bhandari M, Fierlinger A, Niazi F, Christensen R. Clinical benefit of intra-articular saline as a comparator in clinical trials of knee osteoarthritis treatments: A systematic review and meta-analysis of randomized trials. *Semin Arthritis Rheum.* 2016;46(2):151–159
 58. Leighton R, Fitzpatrick J, Smith H, Crandall D, Flannery CR, Conrozier T. Systematic clinical evidence review of NASHA (Durolane hyaluronic acid) for the treatment of knee osteoarthritis. *Open Access Rheumatol.* 2018;10:43–54
 59. Cooper C, Rannou F, Richette P, Bruyère O, Al-Daghri N, Altman RD et al. Use of Intraarticular Hyaluronic Acid in the Management of Knee Osteoarthritis in Clinical Practice. *Arthritis Care Res (Hoboken).* 2017;69(9):1287–1296
 60. Newberry SJ, Fitzgerald JD, Maglione MA, O’Hanlon CE, Booth M, Motala A et al. AHRQ Technology Assessments. Systematic Review for Effectiveness of Hyaluronic Acid in the Treatment of Severe Degenerative Joint Disease (DJD) of the Knee. *Rockville (MD): Agency for Healthcare Research and Quality (US);* 2015
 61. Bellamy N, Campbell J, Robinson V, Gee T, Bourne R, Wells G. Viscosupplementation for the treatment of osteoarthritis of the knee. *Cochrane Database Syst Rev.* 2006;2006(2):Cd005321
 62. Adams ME, Atkinson MH, Lussier AJ, Schulz JI, Siminovitch KA, Wade JP et al. The role of viscosupplementation with hylan G-F 20 (Synvisc) in the treatment of osteoarthritis of the knee: a Canadian multicenter trial comparing hylan G-F 20 alone, hylan G-F 20 with non-steroidal anti-inflammatory drugs (NSAIDs) and NSAIDs alone. *Osteoarthritis and cartilage.* 1995;3(4):213–225
 63. Bannuru RR, Schmid CH, Kent DM, Vaysbrot EE, Wong JB, McAlindon TE. Comparative effectiveness of pharmacologic interventions for knee osteoarthritis: a systematic review and network meta-analysis. *Ann Intern Med.* 2015;162(1):46–54
 64. Shang XL, Tao HY, Chen SY, Li YX, Hua YH. Clinical and MRI outcomes of HA injection following arthroscopic microfracture for osteochondral lesions of the talus. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA.* 2016;24(4):1243–1249
 65. Moser LB, Bauer C, Jeyakumar V, Niculescu-Morzsza EP, Nehrer S. Hyaluronic Acid as a Carrier Supports the Effects of Glucocorticoids and Diminishes the Cytotoxic Effects of Local Anesthetics in Human Articular Chondrocytes In Vitro. *Int J Mol Sci.* 2021;22(21)
 66. Tan J, Chen H, Zhao L, Huang W. Platelet-Rich Plasma Versus Hyaluronic Acid in the Treatment of Knee Osteoarthritis: A Meta-analysis of 26 Randomized Controlled Trials. *Arthroscopy : the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association.* 2021;37(1):309–325
 67. Tang JZ, Nie MJ, Zhao JZ, Zhang GC, Zhang Q, Wang B. Platelet-rich plasma versus hyaluronic acid in the treatment of knee osteoarthritis: a meta-analysis. *Journal of orthopaedic surgery and research.* 2020;15(1):403
 68. Belk JW, Houck DA, Littlefield CP, Kraeutler MJ, Potyk AG, Mei-Dan O et al. Platelet-Rich Plasma Versus Hyaluronic Acid for Hip Osteoarthritis Yields Similarly Beneficial Short-Term Clinical Outcomes: A Systematic Review and Meta-Analysis of Level I and II Randomized Controlled Trials. *Arthroscopy: the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association.* 2021
 69. Shen L, Yuan T, Chen S, Xie X, Zhang C. The temporal effect of platelet-rich plasma on pain and physical function in the treatment of knee osteoarthritis: systematic review and meta-analysis of randomized controlled trials. *Journal of orthopaedic surgery and research.* 2017;12(1):16

Literatur zum Beitrag

Frank Diemer, Julia Benitz, Wolfgang Schoch:

Moderne prä- und postoperative Rehabilitation vor und nach Knorpeltherapie und Patientenprofiling

Ein Leitfaden für eine progressive Belastungssteigerung

- Ebert JR, Smith A, Janes GC et al.: Association between isokinetic knee strength and perceived function and patient satisfaction with sports and recreational ability after matrix-induced autologous chondrocyte implantation. *Orthopaedic Journal of Sports Medicine*. 2019; 7: 2325967119885873
- Buford TW, Rossi SJ, Smith DB et al.: A comparison of periodization models during nine weeks with equated volume and intensity for strength. *J Strength Cond Res*. 2007; 4: 1245–1250
- Hambly K, Bobic V, Wondrasch B et al.: Autologous chondrocyte implantation postoperative care and rehabilitation: science and practice. *The American journal of sports medicine*. 2006; 34: 1020–1038
- Arhos EK, Thoma LM, Grindem H et al.: The association of quadriceps strength symmetry and surgical status with clinical osteoarthritis 5 years after anterior cruciate ligament rupture. *Arthritis Care Research*. 2022; 74: 386
- Ackermann J, Ogura T, Duerr RA et al.: Preoperative Mental Health Has a Stronger Association with Baseline Self-Assessed Knee Scores than Defect Morphology in Patients Undergoing Cartilage Repair. *Cartilage*. 2020; 11: 309–315
- Frey-Law LA, Bohr NL, Sluka KA et al.: Pain sensitivity profiles in patients with advanced knee osteoarthritis. *Pain*. 2016; 157:1988
- Alattas SA, Smith T, Bhatti M et al.: Greater pre-operative anxiety, pain and poorer function predict a worse outcome of a total knee arthroplasty. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2017; 25: 3403–3410
- Hassett AL, Marshall E, Bailey AM et al.: Changes in Anxiety and Depression are Mediated by Changes in Pain Severity in Patients Undergoing Lower Extremity Total Joint Arthroplasty. *Reg Anesth Pain Med*. 2018; 43: 14–18
- Hirschmüller A, Baur H, Braun S et al.: Rehabilitation after autologous chondrocyte implantation for isolated cartilage defects of the knee. *American Journal of Sports Medicine*. 2011; 39: 2686
- Hirschmüller A, Schoch W, Baur H et al.: Rehabilitation before regenerative cartilage knee surgery. A new prehabilitation guideline based on the best available evidence. *Archives of orthopaedic and trauma surgery*. 2018; 139: 217–230
- Edwards PK, Ackland T, Ebert JR: Clinical rehabilitation guidelines for matrix-induced autologous chondrocyte implantation on the tibiofemoral joint. *J Orthop Sports Phys Ther*. 2014 Feb;44(2):102–19. doi: 10.2519/jospt.2014.5055. Epub 2013 Oct 30. PMID: 24175609
- Li M, Yin H, Yan Z et al.: The immune microenvironment in cartilage injury and repair. *Acta Biomaterialia*. 2022; 140: 23
- Tousignant-Laflamme Y: Rehabilitation management of low back pain – it's time to pull it all together! *Journal of Pain Research*. 2017; 10: 2373
- Schmitt LC, Quatman CE, Paterno MV et al.: Functional outcomes after surgical management of articular cartilage lesions in the knee: a systematic literature review to guide postoperative rehabilitation. *Journal of Orthopaedic Sports Physical Therapy*. 2014; 44: 565
- Frey-Law LA, Bohr NL, Sluka KA et al.: Pain sensitivity profiles in patients with advanced knee osteoarthritis. *Pain*. 2016; 157: 1988
- Cook CE, Zhou L, Bolognesi M et al.: Does surgery for concomitant cruciate and meniscus injuries increase or decrease subsequent comorbidities at 2 years? *Journal of Knee Surgery*. 2022; 35: 1063
- Truong LK, Mosewich AD, Holt CJ et al.: Psychological, social and contextual factors across recovery stages following a sportrelated knee injury: a scoping review. *British Journal of Sports Medicine*. 2020; 54: 114
- Migliorini F, Maffulli N, Eschweiler J, Götze C, Hildebrand F, Betsch M (2023): Prognostic factors for the management of chondral defects of the knee and ankle joint: a systematic review. In *European Journal of Trauma and Emergency Surgery* (Vol. 49, Issue 2, pp. 723–745). Springer Science and Business Media Deutschland GmbH
- Levett DZH, Grimmett C (2019): Psychological factors, prehabilitation and surgical outcomes: evidence and future directions. In *Anaesthesia* (Vol. 74, pp. 36–42). Blackwell Publishing Ltd
- Pedersen BK (2018): The Physiology of Optimizing Health with a Focus on Exercise as Medicine. 1. <https://doi.org/10.1146/annurev-physiol-020518>
- Ackermann J, Ogura T, Duerr RA, Barbieri Mestriner A, Gomoll A H (2020): Preoperative Mental Health Has a Stronger Association with Baseline Self-Assessed Knee Scores than Defect Morphology in Patients Undergoing Cartilage Repair. *Cartilage*, 11(3), 309–315
- Alattas SA, Smith T, Bhatti M, Wilson-Nunn D, Donell S (2017): Greater pre-operative anxiety, pain and poorer function predict a worse outcome of a total knee arthroplasty. In *Knee Surgery, Sports Traumatology, Arthroscopy* (Vol. 25, Issue 11, pp. 3403–3410). Springer Verlag
- Baron JE, Westermann RW, Bedard NA, Willey MC, Lynch TS, Duchman KR: Is the Actual Failure Rate of Hip Arthroscopy Higher Than Most Published Series? An Analysis of a Private Insurance Database. *Iowa Orthop J*. 2020;40(1):135–142
- Burgess LC, Arundel J, Wainwright TW (2019): The effect of preoperative education on psychological, clinical and economic outcomes in elective spinal surgery: A systematic review. In *Healthcare (Switzerland)* (Vol. 7, Issue 1). MDPI

25. Hampton SN, Nakonezny PA, Richard HM, Wells JE: Pain catastrophizing, anxiety, and depression in hip pathology. *Bone Joint J.* 2019 Jul;101-B(7):800–807
26. Clapp IM, Nwachukwu BU, Beck EC, Rasio JP, Alter T, Allison B, Nho SJ (2020): What is the Role of Kinesiophobia and Pain Catastrophizing in Outcomes After Hip Arthroscopy for Femoroacetabular Impingement Syndrome? *Arthroscopy, Sports Medicine, and Rehabilitation*, 2(2), e97–e104
27. Fischer M, Nonnenmacher L, Möller A, Hofer A, Reichert J, Matziolis G, Zimmerer A, Wassilew G (2023): Psychological Factors as Risk Contributors for Poor Hip Function after Periacetabular Osteotomy. *Journal of Clinical Medicine*, 12(12)
28. Niemeyer P, Porichis S, Salzmann G, Südkamp N P (2012): What Patients Expect About Autologous Chondrocyte Implantation (ACI) for Treatment of Cartilage Defects at the Knee Joint. *Cartilage*, 3(1), 13–19
29. Toonstra JL, Howell D, English RA, Lattermann C, Mattacola CG (2016): Patient experiences of recovery after autologous chondrocyte implantation: A qualitative study. *Journal of Athletic Training*, 51(12), 1028–1036
30. Ranjit N, Diez-Roux AV, Shea S, Cushman M, Seeman T, Jackson SA, Ni H. (n.d.): Psychosocial Factors and Inflammation in the Multi-Ethnic Study of Atherosclerosis. <http://archinte.jamanetwork.com/>
31. Al Sayah F, Lahtinen M, Bonsel GJ, Ohinmaa A, Johnson JA (2021): A multi-level approach for the use of routinely collected patient-reported outcome measures (PROMs) data in healthcare systems. *Journal of Patient-Reported Outcomes*, 5. <https://doi.org/10.1186/s41687-021-00375-1>
32. Van der Kraan PM: The interaction between joint inflammation and cartilage repair. *Tissue Engineering Regenerative Medicine*. 2019; 16: 327
33. Diemer F: Training und Entzündung – Teil 1. *Zeitschrift für Physiotherapeuten*. 2018; 70: 43
34. Diemer F: Training und Entzündung – Teil 2. *Zeitschrift für Physiotherapeuten*. 2018; 70: 41
35. Diemer F: Update Temperaturmessung. *Sportphysio*. Thieme. Stuttgart. 2021; 9: 92
36. Niethammer TR, Aurich M, Brucker PU et al.: Follow-up treatment after cartilage therapy of the knee joint – a recommendation of the DGOU clinical tissue regeneration working group. *Zeitschrift für Orthopädie und Unfallchirurgie*. 2024; doi: 10.1055/a-2206–7242
37. Buck TMF, Dahmen J, Tak IJR et al.: Large variation in postoperative rehabilitation protocols following operative treatment of osteochondral lesions of the talus: a systematic review and meta-analysis. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2024; 32: 334
38. Zimmerer A, Gebhardt S, Kinkel S et al.: Das Minced -Cartilage-Verfahren zur Therapie azetabulärer Knorpelschäden am Hüftgelenk. *Oper. Orthop. Traumatol.* 2023; 35: 100
39. Song M, Li S, Yang S et al.: Is early or delayed weightbearing the better choice after microfracture for osteochondral lesions of the talus? A meta-analysis and systematic review. *The Journal of Foot and Ankle Surgery*. 2021; 60: 1232
40. Seow D, Ubillus HA, Azam MT et al.: Limited evidence of adjuvant biologics with bone marrow treatment of osteochondral lesion of the talus: a systematic review. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2022; 30: 4238
41. Mullins K, Filan D, Carton P: PRP is not associated with improved outcomes following hip femoroacetabular impingement surgery: very low-quality evidence suggests hyaluronic acid and cell-based therapies may be beneficial—a systematic review of biological treatments. *Arthroscopic Sports Medicine Rehabilitation*. 2022; 4: e1557
42. Altman R, Bedi A, Manjoo A et al.: anti-inflammatory effects of intra-articular hyaluronic acid: a systematic review. *Cartilage*. 2019; 10: 43
43. Grässel S, Aszodi A: Osteoarthritis and cartilage regeneration: focus on pathophysiology and molecular mechanisms. *International Journal of Molecular Science*. 2019; 20: 6156
44. Wang HC, Lin TH, Chang NJ et al.: Continuous passive motion promotes and maintains chondrogenesis in autologous endothelial progenitor cell-loaded porous PLGA scaffolds during osteochondral defect repair in a rabbit model. *International Journal of Molecular Science*. 2019; 20: 259
45. Howard JS, Mattacola CG, Romine SE et al.: Continuous passive motion, early weight bearing, and active motion following knee articular cartilage repair: evidence for clinical practice. *Cartilage*. 2010; 1: 276
46. Hanish S, Muhammed M, Kelly S et al.: Postoperative rehabilitation for arthroscopic management of femoroacetabular impingement syndrome: a contemporary review. *Current Reviews in Musculoskeletal Medicine*. 2023; 16: 381
47. Dhillon J, Fasulo SM, Kraeutler MJ et al.: The most common rehabilitation protocol after matrix assisted autologous chondrocyte implantation is immediate partial weight-bearing and continuous passive motion. *Arthroscopy, Sports Medicine, and Rehabilitation*. 2020; 4: e2115
48. D`Hooghe P, Murawski CD, Boakye T et al.: Rehabilitation and return to sports: proceedings of the international consensus meeting on cartilage repair of the ankle. *Foot and Ankle International*. 2018; 39: 615
49. Rogan S, Taeymans J, Hirschi Müller A et al.: Effect of continuous passive motion for cartilage regenerative surgery – a systematic review. *Zeitschrift für Orthopädie und Unfallchirurgie*. 2013; 151: 468
50. Karnes JM, Harris JD, Griesser MJ et al.: Continuous passive motion following cartilage surgery: does a common protocol exist? *Phys Sportsmed*. 2013; 41: 53
51. Walther M, Martin K: Scaffold Based Reconstruction of Focal Full Thickness Talar Cartilage Defects *Clinical Research on Foot & Ankle*. 2013; 1: 2
52. Hirschi Müller A, Andres T, Schoch W et al.: Quadriceps strength in patients with isolated cartilage defects of the knee. *Orthopaedic Journal of Sports Medicine*. 2017; 26: 2325967117703726
53. Schmitt LC, Quatman CE, Paterno MV et al.: Functional outcomes after surgical management of articular cartilage lesions in the knee: a systematic literature review to guide postoperative rehabilitation. *Journal of Orthopaedic Sports Physical Therapy*. 2014; 44: 565
54. Ebert JR, Smith A, Edwards PK et al.: The progression of isokinetic knee strength after matrix-induced autologous chondrocyte implantation: implications for rehabilitation and return to activity. *Journal of Sport Rehabilitation*. 2014; 23: 244
55. Hallberg S, Sansone M, Augustsson J et al.: Full recovery of hip muscle strength is not achieved at return to sports in patients with femoroacetabular impingement surgery. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2020; 28: 1276
56. Kierkegaard S, Mechlenburg I, Lund B et al.: Is hip muscle strength normalised in patients with femoroacetabular impingement syndrome one year after surgery. *Journal of Science in Medicine and Sport*. 2019; 22: 413

57. Diamond LE, Dobson FL, Bennell KL et al.: Physical impairments and activity limitations in people with femoroacetabular impingement: a systematic review. *British Journal of Sports Medicine*. 2015; 49: 230
58. Freke MD, Kemp J, Svege I et al.: Physical impairments in symptomatic femoroacetabular impingement: a systematic review of the evidence. *British Journal of Sports Medicine*. 2016; 50: 1180
59. Aurich M, Albrecht D, Angele P et al.: Behandlung osteochondraler Läsionen des Sprunggelenks: Empfehlungen der Arbeitsgemeinschaft klinische Geweberegeneration der DGOU. *Zeitschrift für Orthopädie und Unfallchirurgie*. 2017; 155: 92
60. Hara S, Kitano M, Kudo S: The effects of short foot exercises to treat flat foot deformity: a systematic review. *Journal of Back and Musculoskeletal Rehabilitation*. 2023; 36: 21
61. Willegger M, Seydova N, Schuh R et al.: The tibialis posterior tendon footprint: an anatomical dissection study. *Journal of Foot and Ankle Research*. 2020; 13: 25
62. McKeon PO, Hertel J, Bramble et al.: The foot core system: a new paradigm for understanding intrinsic foot muscle function. *British Journal of Sports Medicine*. 2015; 49: 290
63. Kamiya T, Uchiyama E, Watanabe K et al.: Dynamic effect of the tibialis posterior muscle on the arch of the foot during cyclic axial loading. *Clinical Biomechanics*. 2012; 27: 962
64. Lepley AS, Lepley LK: Mechanisms of arthrogenic muscle inhibition. *Journal of Sport Rehabilitation*. 2021; 31: 707
65. An YW, Lobacz ADT, Lehmann T et al.: Neuroplastic Changes in ACLR Patients from Neuromechanical Decoupling. *Scandinavian Journal of Medicine and Science in Sports*. 2019; 19: 251
66. Buckthorpe M, Gokeler A, Herrington L et al.: Optimising the early-stage rehabilitation process post-acl reconstruction. *Sports Medicine*. 2024; 54: 49
67. Norte G, Rush J, Sherman D: Arthrogenic muscle inhibition: best evidence, mechanisms, and theory for treating the unseen in clinical rehabilitation. *Journal of Sport Rehabilitation*. 2021; 31: 717
68. Samaan MA, Zhang AL, Popovic T et al.: Hip joint muscle forces during gait in patients with femoroacetabular impingement syndrome are associated with patient reported outcomes and cartilage composition. *Journal of Biomechanics*. 2019; 84: 138
69. Slater LV, Hart JM, Kelly AR et al.: Progressive changes in walking kinematics and kinetics after anterior cruciate ligament injury and reconstruction: a review and meta-analysis. *Journal of Athletic Training*. 2017; 52: 847
70. Labanca L, Mosca M, Ghislieri M et al.: Muscle activations during functional tasks in individuals with chronic ankle instability: a systematic review of electromyographical studies. *Gait and Posture*. 2021; 90: 340
71. Erhart-Hledik JC, Chu CR, Asay JL et al.: Longitudinal changes in knee gait mechanics between 2 and 8 years after anterior cruciate ligament reconstruction. *Journal of Orthopaedic Research*. 2018; 36: 1478
72. Dolan P, Kenny I, Glyn L et al.: Risk factors for acute ankle sprains in field-based, team contact sports: a systematic review of prospective etiological studies. *The Physician and Sportsmedicine*. 2023; 51: 517
73. Paterno MV, Schmitt LC, Ford KR et al.: Biomechanical measures during landing and postural stability predict second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. *American Journal of Sports Medicine*. 2010; 38: 1968
74. Gokeler A, Nijmeijer EM, Heuvelmans P et al.: Motor learning principles during rehabilitation after anterior cruciate ligament injury. *Arthroscopie*. 2023; doi.org/10.1007/s00142-023-00606-1
75. VBG – Return-to-Competition Testmanual zur Beurteilung der Spielfähigkeit nach Ruptur des vorderen Kreuzbands. Return-to-Competition – Testmanual zur Beurteilung der Spielfähigkeit nach Ruptur des vorderen Kreuzbands (vbg.de)
76. VBG – Return-to-Competition Testmanual zur Beurteilung der Spielfähigkeit nach akuter lateraler Bandverletzung am Sprunggelenk. Return-to-Competition Sprunggelenk (vbg.de)
77. Holling MJ, Miller ST, Geeslin AG: Rehabilitation and return to sport after arthroscopic treatment of femoroacetabular impingement: a review of the recent literature and discussion of advanced rehabilitation techniques for athletes. *Arthroscopy, Sports Medicine and Rehabilitation*. 2022; 4: e125
78. Minoonejad H, Ardakani MK, Rejabi R et al.: Hop stabilization training improves neuromuscular control in collegiate basketball players with chronic ankle instability: A randomized controlled trial. *Journal of Sport Rehabilitation*. 2019; 28: 576
79. Buckthorpe M, Della Villa F: Optimising the “mid-stage” training and testing process after acl reconstruction. *Sports Medicine*. 2020; 50: 657
80. Buckthorpe M: Optimising the late-stage rehabilitation and return-to-sport training and testing process after acl reconstruction. *Sports Medicine*. 2019; 49: 1043
81. Turk R, Shah S, Chilton M et al.: Critical criteria recommendations: return to sport after acl reconstruction requires evaluation of time after surgery of 8 months, >2 functional tests, psychological readiness, and quadriceps/hamstring strength. *Arthroscopy and Related Surgery*. 2023; 39: 790
82. Ishoi L, Thorborg K, Kemp JL et al.: Maximal hip muscle strength and rate of torque development 6–30 months after hip arthroscopy for femoroacetabular impingement syndrome: a cross-sectional study. *Journal of Science and Medicine in Sport*. 2021; 24: 1110
83. Thorborg K et al.: Clinical assessment of hip strength using a hand-held dynamometer is reliable. *Scand. J. Med. Sci. Sports*. 2010; 20: 493
84. Picot B, Lopes R, Rauline G et al.: Development and validation of the ankle-go score for discriminating and predicting return-to-sport outcomes after lateral ankle sprain. *Sports Health*. 2024; 16: 47
85. Carroll M, Joyce W, Brenton-Rule A et al.: Assessment of foot and ankle muscle strength using hand held dynamometry in patients with established rheumatoid arthritis. *Journal of Foot and Ankle Research*. 2013; 6: 10
86. Wörner T, Thorborg K, Webster KE et al.: Psychological readiness is related to return to sport following hip arthroscopy and can be assessed by the hip-return to sport after injury scale (Hip-RSI). *Knee Surgery, Sports Traumatology, Arthroscopy*. 2021; 29: 1353
87. Aguilaniu A, Schwartz C, Abran G et al.: Ankle strength assessed by one repetition maximum: a new approach to detect weakness in chronic ankle lateral instability. *Foot and Ankle Surgery*. 2024; doi.org/10.1016/j.fas.2024.02.005

Literatur zum Beitrag

Christoph Werry:

Matrixaugmentierte Knochenmarkstimulation (mBMS) am Schultergelenk

1. Bouaicha S: Knorpelreparative Eingriffe am Schultergelenk. *Orthopäde* 2017; 46: 914–918
2. Scheibel M, Bartl C, Magosch P, Lichtenberg S, Habermeyer P: Osteochondral autologous transplantation for the treatment of full-thickness articular cartilage defects of the shoulder. *J Bone Joint Surg Br* (2004); 86: 991–997
3. Boehm E, Minkus M, Scheibel M: Autologous chondrocyte implantation for treatment of focal articular cartilage defects of the humeral head. *J Shoulder Elbow Surg.* 2020; 29: 2–11
4. Millet PJ, Horan MP, Pennock AT, Rios D: Comprehensive Arthroscopic Management (CAM) Procedure: Clinical Results of a Joint-Preserving Arthroscopic Treatment for Young, Active Patients with Advanced Shoulder Osteoarthritis. *Arthroscopy* 2013; 29: 440–448
5. Kreuz PC, Gille J, Mehl J, Mumme M: Zellfreie Biomaterialien zur Knorpelregeneration. *Arthroskopie* 2022; 35: 328–334

Literatur zum Beitrag

Sebastian Leutheuser, Johannes Zellner, Matthias Buhs, Klaus Ruhнау:

Indikation und Langzeitergebnisse verschiedener Knorpeltherapien am Knie

1. Mundi R, Bedi A, Chow L, Crouch S et al.: Cartilage restoration of the knee: A systematic review and meta-analysis of level 1 studies. *Am J Sports Med.* 2016;44(7):1888–1895
2. Niemeyer P, Farber S, Bumberger A: Handlungsempfehlung: Knorpeltherapie am Kniegelenk. *Knie Journal.* 2022;1:72–74
3. Bode G, Schmal H, Pestka JM, Ogon P, Sudkamp NP, Niemeyer P: A non-randomized controlled clinical trial on autologous chondrocyte implantation (ACI) in cartilage defects of the medial femoral condyle with or without high tibial osteotomy in patients with varus deformity of less than 5 degrees. *Archives of orthopaedic and trauma surgery.* 2013;133(1): 43
4. Roffi A, Andriolo L, Di Martino A et al.: Long-term Results of Matrix-assisted Autologous chondrocyte transplantation combined with autologous bone grafting for the treatment of juvenile osteochondritis dissecans; *J Pediatr Orthop.* 2020;40(2):115–121
5. Bildt C, Alfredsson L, Punnett L, Theobald H, Torgén M, Wikman A: Effects of drop out in a longitudinal study of musculoskeletal disorders *Occup Environ Med.* 2001;58(3):194–199
6. Solheim E, Hegna J, Inderhaug E: Long-Term Survival after Microfracture and Mosaicplasty for Knee Articular Cartilage Repair: A Comparative Study Between Two Treatments Cohorts, *Cartilage.* 2020;11(1):71–76
7. Ebert JR, Fallon M, Wood DJ et al.: Long-term prospective clinical and magnetic resonance imaging-based evaluation of matrix-induced autologous chondrocyte implantation. *The American Journal of Sports Medicine.* 2021;49(3):579–587
8. Kreuz PC, Kalkreuth RH, Niemeyer P, Uhl M, Erggelet C: Long-Term Clinical and MRI Results of Matrix-Assisted Autologous Chondrocyte Implantation for Articular Cartilage Defects of the Knee; *Cartilage.* 2019; 10(3): 305–313
9. Pellegrino M, Trinchese E, Bisaccia M et al.: Long-term outcome of grade III and IV chondral injuries of the knee treated with Steadman microfracture technique. *Clinical Cases in Mineral and Bone Metabolism.* 2016;13(3):237–240
10. Gudas R, Gudaite A, Pocius A et al.: Ten-Year Follow-up of a Prospective, Randomized Clinical Study of Mosaic Osteochondral Autologous Transplantation Versus Microfracture for the Treatment of Osteochondral Defects in the Knee Joint of Athletes. *The American Journal of Sports Medicine.* 2012;40(11): 2499–2507
11. Ulstein S, Arøen A, Røtterud JH, Løken S, Engebretsen L, Heir S: Microfracture technique versus osteochondral autologous transplantation mosaicplasty in patients with articular chondral lesions of the knee: a prospective randomized trial with long-term follow-up; *Knee Surg Sports Traumatol Arthrosc.* 2014;22:1207–1215
12. Gobbi A, Karnatzikos G, Kumar A: Long-term results after microfracture treatment for full-thickness knee chondral lesions in athletes; *Knee Surg Sports Traumatol Arthrosc.* 2014;22:1986–1996
13. Steadman JR, Briggs KK, Rodrigo JJ et al.: *The Journal of Arthroscopic and Related Surgery.* 2003;19(5):477–484
14. Ossendorf R, Franke K, Erdle B, Uhl M, Südkamp NP, Salzmann GM: Clinical and radiographical ten years long-term outcome of microfracture vs. autologous chondrocyte implantation: a matched-pair analysis; *Int Orthop.* 2019;43(3):553–559
15. Knutsen G, Drogset JO, Engebretsen L et al.: A randomized multicenter trial comparing autologous chondrocyte implantation with microfracture. Long-term follow-up at 14 to 15 years; *J Bone Joint Surg Am.* 2016;98:1332–1339
16. Goyal D, Keyhani S, Lee EH, Hui JH: Evidence-based status of microfracture technique: a systematic review of level I and II studies. *Arthroscopy.* 2013;29(9):1579–1588.
17. de Girolamo L, Schönhuber H, Viganò M et al.: Autologous Matrix-Induced Chondrogenesis (AMIC) and AMIC Enhanced by Autologous Concentrated Bone Marrow Aspirate (BMAC) Allow for Stable Clinical and Functional Improvements at up to 9 Years Follow-Up: Results from a Randomized Controlled Study. *J Clin Med.* 2019. 21;8(3):392
18. Kaiser N, Jakob RP, Pagenstert G, Tannast M, Petek D: Stable clinical long term results after AMIC in the aligned knee. *Arch Orthop Trauma Surg.* 2021;141(11):1845–1854
19. Gobbi A, Whyte GP: Long-term Clinical Outcomes of One-Stage Cartilage Repair in the Knee With Hyaluronic Acid-Based Scaffold Embedded With Mesenchymal Stem Cells Sourced From Bone Marrow Aspirate Concentrate. *The American Journal of Sports Medicine.* 2019;47(7):1621–1628
20. Brittberg M, Lindahl A, Nilsson A, Ohlsson C, Isaksson O, Peterson L: Treatment of deep cartilage defects in the knee with autologous chondrocyte transplantation. *The New England journal of medicine.* 1994;331(14):889–895
21. Niemeyer P, Pestka JM, Kreuz PC, Erggelet C, Schmal H, Südkamp NP et al.: Characteristic complications after autologous chondrocyte implantation for cartilage defects of the knee joint. *The American journal of sports medicine.* 2008;36(11):2091–2099
22. DiBartola AC, Everhart JS, Magnusson RA, Carey JL, Brophy RH, Schmitt LC et al.: Correlation between histological outcome and surgical cartilage repair technique in the knee: A meta-analysis. *The Knee.* 2016;23(3):344–349
23. Grevenstein D, Mamilos A, Schmitt VH, Niedermaier T, Wagner W, Kirkpatrick CJ et al.: Excellent histological results in terms of articular cartilage regeneration after spheroid-based autologous chondrocyte implantation (ACI). *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA.* 2021;29(2):417–421
24. Niemeyer P, Albrecht D, Aurich M et al.: Empfehlungen der AG Klinische Geweberegeneration zur Behandlung von Knorpelschäden am Knie-

- gelenk. *Z Orthop Unfall*. 2023; 161(1):57–64
25. Aldrian S, Zak L, Wondrasch B, Albrecht C, Stelzener B, Binder H et al.: Clinical and radiological long-term outcomes after matrix-induced autologous chondrocyte transplantation: a prospective follow-up at a minimum of 10 years. *The American journal of sports medicine*. 2014;42(11):2680–2688
 26. Gille J, Behrens P, Schulz AP, Oheim R, Kienast B: Matrix-Associated Autologous Chondrocyte Implantation: A Clinical Follow-Up at 15 Years. *Cartilage*. 2016;7(4):309–315
 27. Kon E, Filardo G, Gobbi A, Berruto M, Andriolo L, Ferrua P et al.: Long-term Results After Hyaluronan-based MACT for the Treatment of Cartilage Lesions of the Patellofemoral Joint. *The American journal of sports medicine*. 2016;44(3):602–608
 28. Berruto M, Ferrua P, Pasqualotto S, Uboldi F, Maione A, Tradati D et al.: Long-term follow-up evaluation of autologous chondrocyte implantation for symptomatic cartilage lesions of the knee: A single-centre prospective study. *Injury*. 2017;48(10):2230–2234
 29. Filardo G, Andriolo L, Sessa A, Vannini F, Ferruzzi A, Marcacci M et al.: Age Is Not a Contraindication for Cartilage Surgery: A Critical Analysis of Standardized Outcomes at Long-term Follow-up. *The American journal of sports medicine*. 2017;45(8):1822–1828
 30. Zaffagnini S, Vannini F, Di Martino A, Andriolo L, Sessa A, Perdida F et al.: Low rate of return to pre-injury sport level in athletes after cartilage surgery: a 10-year follow-up study. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2019;27(8):2502–2510
 31. Andriolo L, Reale D, Di Martino A, De Filippis R, Sessa A, Zaffagnini S et al.: Long-term Results of Arthroscopic Matrix-Assisted Autologous Chondrocyte Transplantation: A Prospective Follow-up at 15 Years. *The American journal of sports medicine*. 2020;48(12):2994–3001
 32. Niethammer TR, Altmann D, Holzgruber M, Gulecyuz MF, Notohamiprodjo S, Baur-Melnyk A et al.: Patient-Reported and Magnetic Resonance Imaging Outcomes of Third-Generation Autologous Chondrocyte Implantation After 10 Years. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2020;36(7):1928–1938
 33. Andriolo L, Di Martino A, Altamura SA, Boffa A, Poggi A, Busacca M et al.: Matrix-assisted chondrocyte transplantation with bone grafting for knee osteochondritis dissecans: stable results at 12 years. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2021;29(6):1830–1840
 34. Niemeyer P, Porichis S, Steinwachs M, Erggelet C, Kreuz PC, Schmal H et al.: Long-term outcomes after first-generation autologous chondrocyte implantation for cartilage defects of the knee. *The American journal of sports medicine*. 2014;42(1):150–157
 35. Ebert JR, Fallon M, Ackland TR, Janes GC, Wood DJ: Minimum 10-Year Clinical and Radiological Outcomes of a Randomized Controlled Trial Evaluating 2 Different Approaches to Full Weightbearing After Matrix-Induced Autologous Chondrocyte Implantation. *The American journal of sports medicine*. 2020;48(1):133–142
 36. Ogura T, Mosier BA, Bryant T, Minas T: A 20-Year Follow-up After First-Generation Autologous Chondrocyte Implantation. *The American journal of sports medicine*. 2017;45(12):2751–2761
 37. Ogura T, Bryant T, Mosier BA, Minas T: Autologous Chondrocyte Implantation for Bipolar Chondral Lesions in the Tibiofemoral Compartment. *The American journal of sports medicine*. 2018;46(6):1371–1381
 38. Pareek A, Carey JL, Reardon PJ, Peterson L, Stuart MJ, Krych AJ: Long-Term Outcomes after Autologous Chondrocyte Implantation: A Systematic Review at Mean Follow-Up of 11.4 Years. *Cartilage*. 2016;7(4):298–308
 39. Mehl J, Huck J, Bode G, Hohloch L, Schmitt A, Sudkamp NP et al.: Clinical mid- to long-term outcome after autologous chondrocyte implantation for patellar cartilage lesions and its correlation with the geometry of the femoral trochlea. *The Knee*. 2019;26(2):364–373
 40. Beck JJ, Sugimoto D, Micheli L: Sustained Results in Long-Term Follow-Up of Autologous Chondrocyte Implantation (ACI) for Distal Femur Juvenile Osteochondritis Dissecans (J OCD). *Advances in orthopedics*. 2018;2018:7912975
 41. Carey JL, Shea KG, Lindahl A, Vasiliadis HS, Lindahl C, Peterson L: Autologous Chondrocyte Implantation as Treatment for Unsalvageable Osteochondritis Dissecans: 10- to 25-Year Follow-up. *The American journal of sports medicine*. 2020;48(5):1134–1140
 42. Angele P, Niemeyer P, Steinwachs M, Filardo G, Gomoll AH, Kon E et al.: Chondral and osteochondral operative treatment in early osteoarthritis. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2016;24(6):1743–1752
 43. Ogura T, Bryant T, Minas T: Long-term Outcomes of Autologous Chondrocyte Implantation in Adolescent Patients. *The American journal of sports medicine*. 2017;45(5):1066–1074
 44. Lynch TS, Patel RM, Benedick A, Amin NH, Jones MH, Miniaci A: Systematic review of autogenous osteochondral transplant outcomes. *Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2015;31(4):746–754
 45. Devitt BM, Bell SW, Webster KE, Feller JA, Whitehead TS: Surgical treatments of cartilage defects of the knee: Systematic review of randomized controlled trials. *The Knee*. 2017;24(3):508–517
 46. Zamborsky R, Danisovic L: Surgical Techniques for Knee Cartilage Repair: An Updated Large-Scale Systematic Review and Network Meta-analysis of Randomized Controlled Trials. *Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 2020;36(3):845–858
 47. Angele P, Zellner J, Schroter S, Flechtenmacher J, Fritz J, Niemeyer P: Biological Reconstruction of Localized Full-Thickness Cartilage Defects of the Knee: A Systematic Review of Level 1 Studies with a Minimum Follow-Up of 5 Years. *Cartilage*. 2022;19476035221129571
 48. Jones KJ, Kelley BV, Arshi A, McAllister DR, Fabricant PD: Comparative Effectiveness of Cartilage Repair With Respect to the Minimal Clinically Important Difference. *The American journal of sports medicine*. 2019;47(13):3284–3293
 49. Mistry H, Connock M, Pink J, Shyngandan D, Clar C, Royle P et al.: Autologous chondrocyte implantation in the knee: systematic review and economic evaluation. *Health Technol Assess*. 2017;21(6):1–294
 50. Vogelmann T, Roessler PP, Buhs M, Ostermeier S, Gille J, Hoburg A et al.: Long-term cost-effectiveness of matrix-associated chondrocyte implantation in the German health care sys-

- tem: a discrete event simulation. Archives of orthopaedic and trauma surgery. 2023;143(3):1417–1427
51. Albrecht F, Roessner A, Zimmermann E: Closure of osteochondral lesions using chondral fragments and fibrin adhesive. Arch Orthop Trauma Surg. 1983;101(3):213–217
52. Grechenig S, Worlicek M, Penzkofer R et al.: Bone block augmentation from the iliac crest for treatment of deep osteochondral defects of the knee resembles biomechanical properties of the subchondral bone. Knee Surg Sports Traumatol Arthrosc. 2019; 27(8):2488–2493
53. Ekman E, Mäkelä K, Kohonen I, Hiltunen A, Itälä A: Favourable long-term functional and radiographical outcome after osteoautograft transplantation on surgery of the knee: a minimum 10-year follow-up. Knee Surg Sports Traumatol Arthrosc. 2018;26(12):3560–3565
54. Filardo G, Kon E, Di Matteo B, Di Martino A, Marcacci M: Single-plug autologous osteochondral transplantation: results at minimum 16 years' follow-up. Orthopedics. 2014;37(9):e761–767
55. Nishitani K, Nakagawa Y, Kobayashi M et al.: Long-Term Survivorship and Clinical Outcomes of Osteochondral Autologous Transplantation for Steroid-Induced Osteonecrosis of the Knee. Cartilage. 2021;13(1_suppl):1156S-1164S
56. Tetta C, Busacca M, Moio A et al.: Knee osteochondral autologous transplantation: long-term MR findings and clinical correlations. Eur J Radiol. 2010;76(1):117–123
57. Cognault J, Seurat O, Chaussard C, Ionescu S, Saragaglia D. Return to sports after autogenous osteochondral mosaicplasty of the femoral condyles: 25 cases at a mean follow-up of 9 years. Orthop Traumatol Surg Res. 2015; 101(3):313–317
58. Chahal J, Gross AE, Gross C et al.: Outcomes of osteochondral allograft transplantation in the knee. Arthroscopy. 2013;29(3):575–588