Functional midterm outcome of autologous chondrocyte implantation with spheroids combined with simultaneous autologous bone grafting for treating osteochondral defects of the knee joint

Stephan Oehme[1], Sophie Krafzick[1], Tobias Winkler[1,2,3], Philipp Damm[2], Tobias Jung[1]

[1]Center for Musculoskeletal Surgery (CMSC), Charité, Berlin, Germany.
[2]Julius Wolff Institute, Charité, Berlin, Germany.
[3]Berlin Institute of Health Center for Regenerative Therapies, Charité, Berlin, Germany.

Financial disclosures

The authors have no financial disclosure or conflicts of interest with the presented materials in this presentation

Introduction

- Several surgical procedures to treat osteochondral defects of the knee have been described.[1,2]
- The combination of autologous chondrocyte implantation with simultaneous autologous bone grafting is a relatively new procedure with promising results in published cohort studies.[3]
- Published cohort studies reported improvement of pain and knee function, but the analyzed number of patients remain small, and little is known about gait biomechanics after this procedure. However, abnormal gait patterns after surgical interventions of the knee joint, which could lead to joint degeneration are previously described. [4,5]

Aim of the study

Analysis of functional midterm outcome and gait biomechanics of patients with osteochondal defect of the knee treated with autologous chondrocyte implantation with spheroids combined with simultaneous autologous bone grafting.

Patient cohort

- 37 patients (22 male, 15 female, ø 31,4 y, 18 - 56 y)
- Follow-up: ⌀ 3,7 y ± 2,0 (1 - 7,3 y)
- Defect size: 4,5 cm^2 ± 2,8 (1,3 - 12,3 cm^2)
- Defect localization: 26 (70,3%) medial femur condyle
  5 (13,5%) lateral femur condyle
  4 (10,8) retropatellar
  2 (5,4%) multiple lesions

Control group

- 37 subjects (22 male, 15 female, ø 33,8 y, range: 19 – 57 y)

Surgical procedure

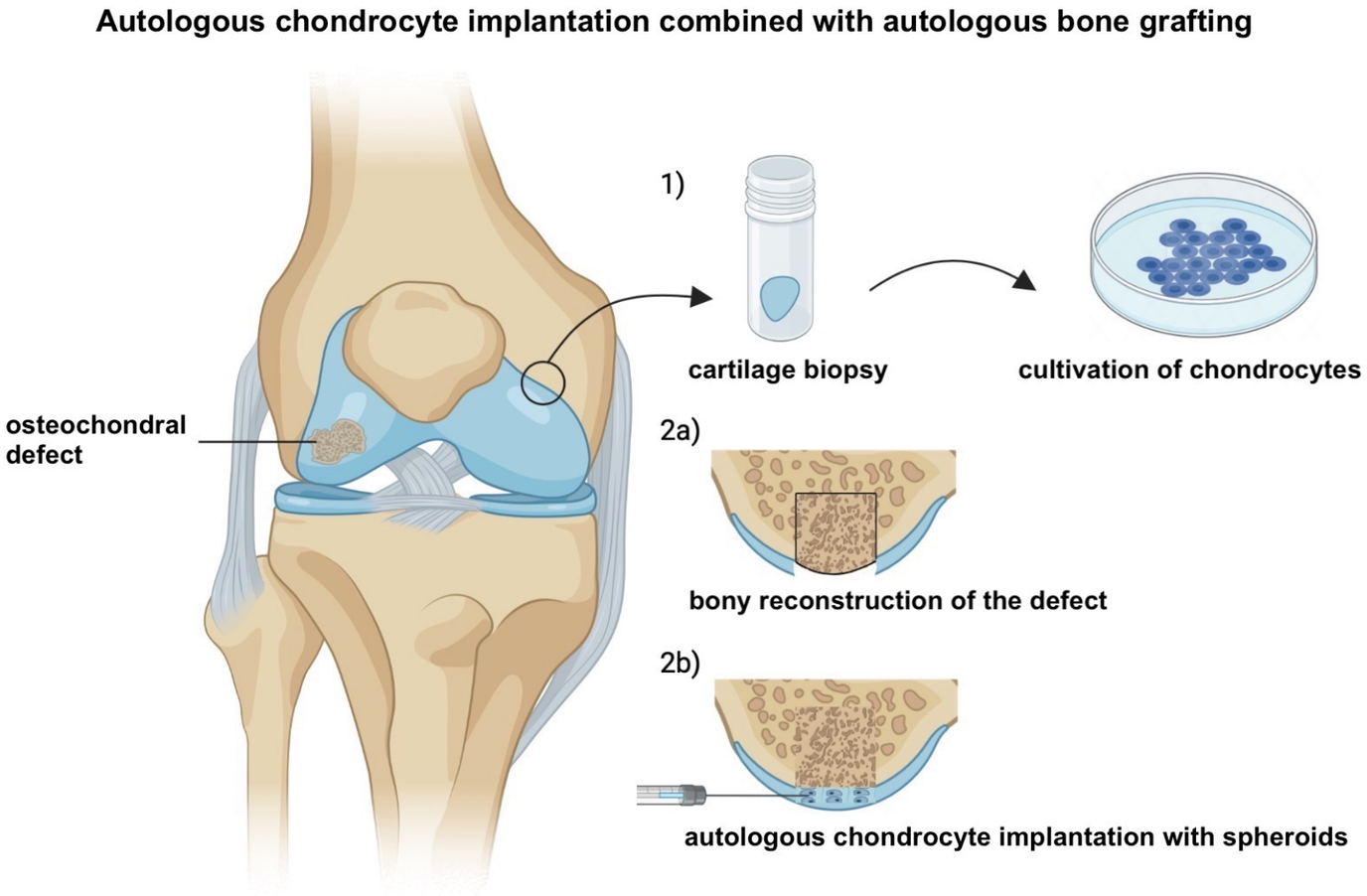

Figure 1: Surgical procedure *(created with BioRender.com)*

Methods

Analysis of functional outcome using:

- PROMs:
  - IKDC-Score
  - Lysholm-Score
  - PROMIS 29 Profile v2.0
- Patient satisfaction survey

Postoperative analysis of gait biomechanics:

- 3-D-instrumented gait analysis at self selected speed (Motion Capture System, Vicon Nexus)

Figure 2: Gait analysis

Results - PROMs

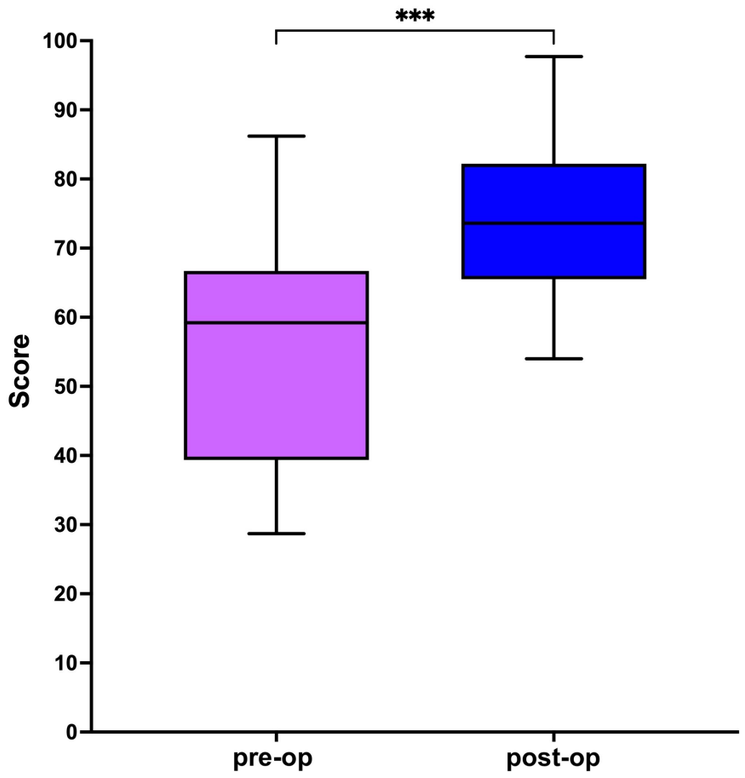

Figure 3: IKDC-Score pre-op vs. post-op
56.5 ± 17.0 vs. 73.6 ± 10.3; p<0.05

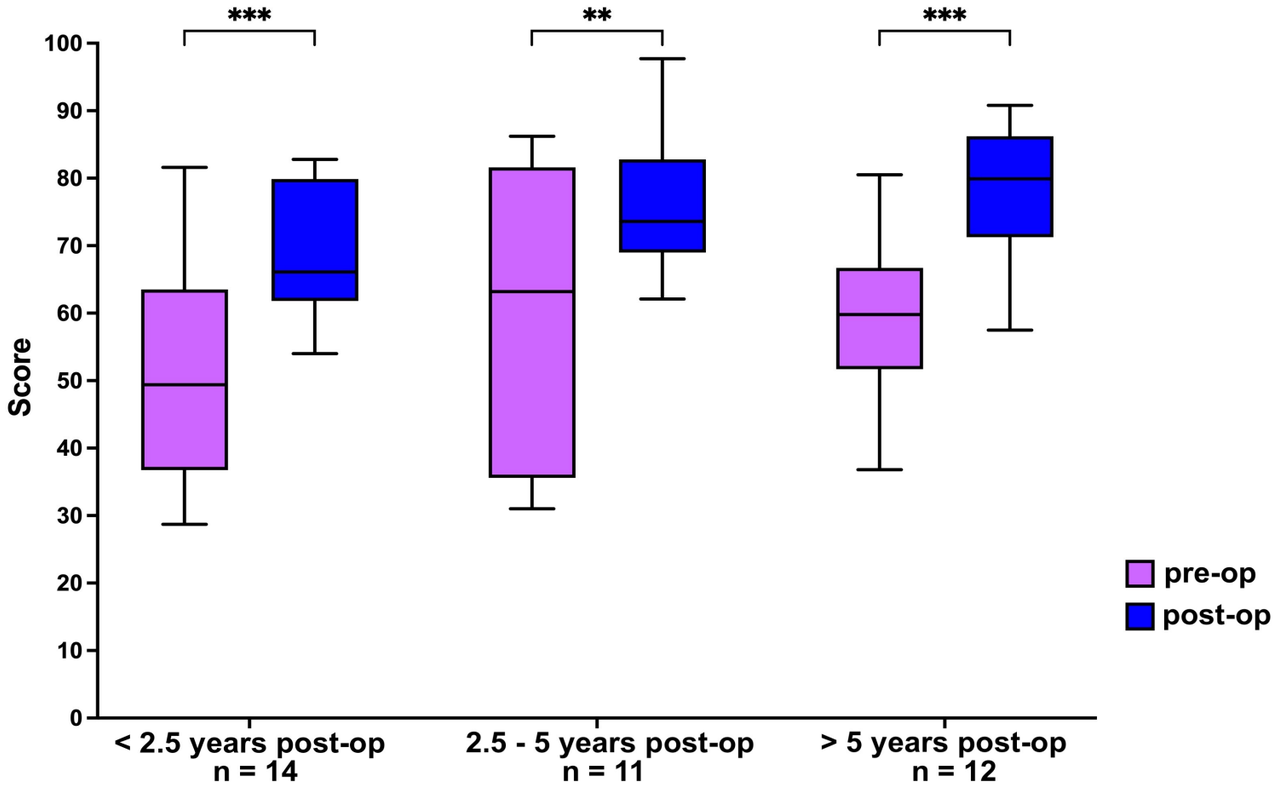

Figure 4: IKDC-Score subgroups
51.1 ± 15.9 vs. 68.4 ± 9.4; p<0.05
59.5 ± 21.2 vs. 76.3 ± 10.2; p<0.05
60.4 ± 12.4 vs. 77.6 ± 9.6; p<0.05

Results - PROMs

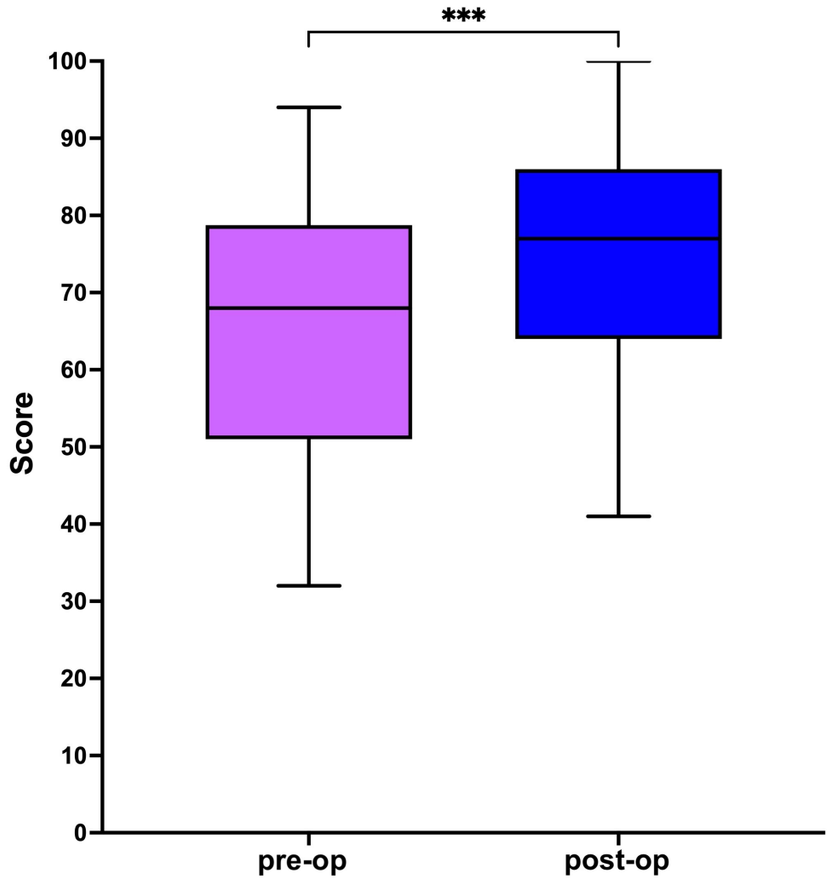

Figure 5: Lysholm-Score pre-op vs. post-op
64.6 ± 17.6 vs. 75 ± 14.5; p<0.05

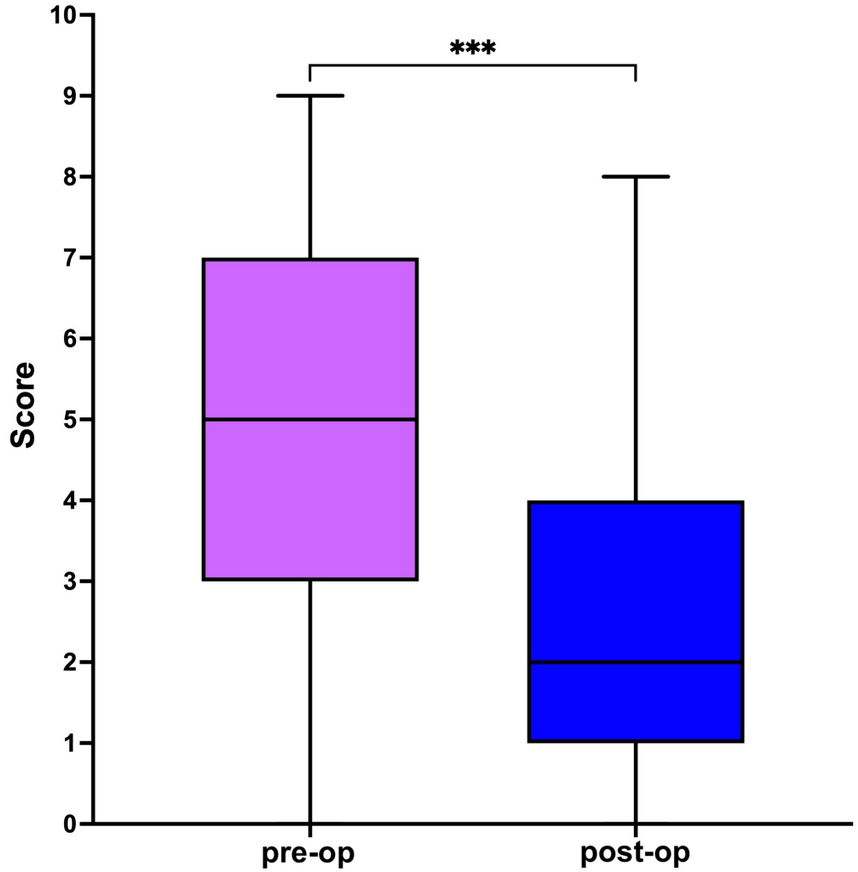

Figure 6: Pain intensity pre-op vs. post-op
4.9 ± 2.5 vs. 2.6 ± 2.0; p<0.05

Results - patient satisfaction survey

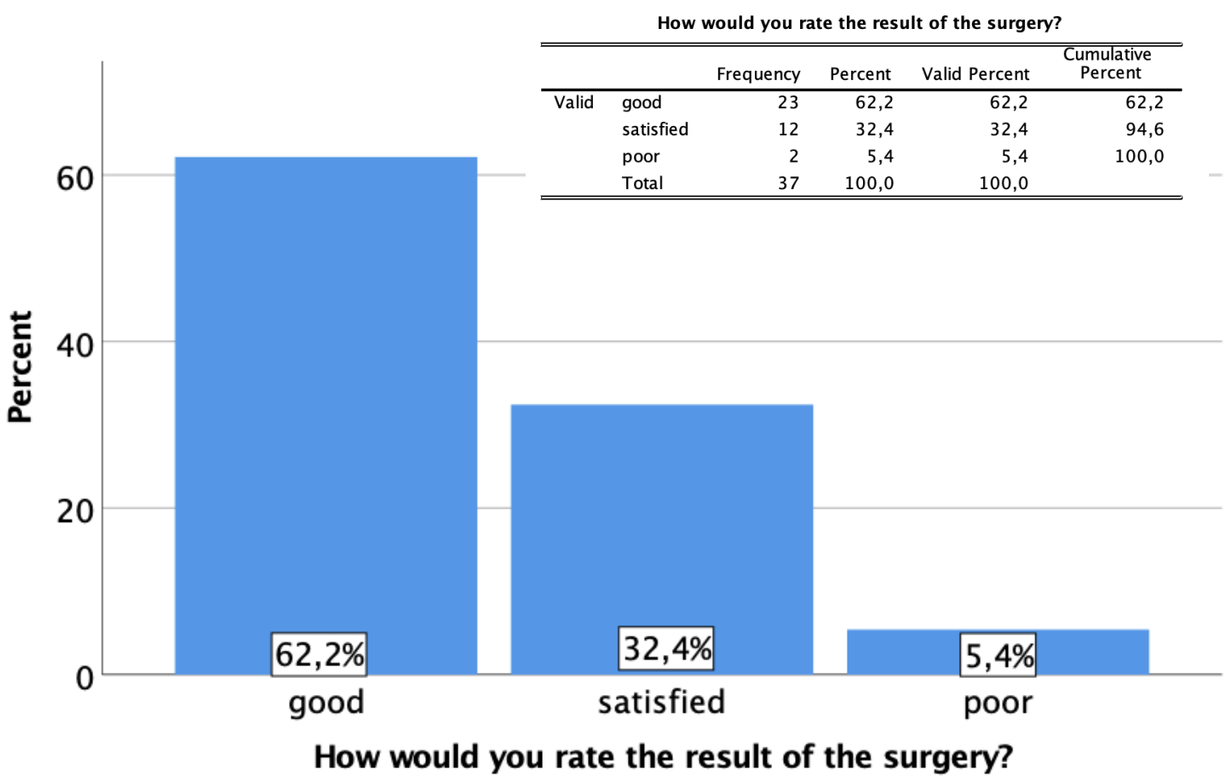

Figure 7: Patient satisfaction survey - result of the surgery

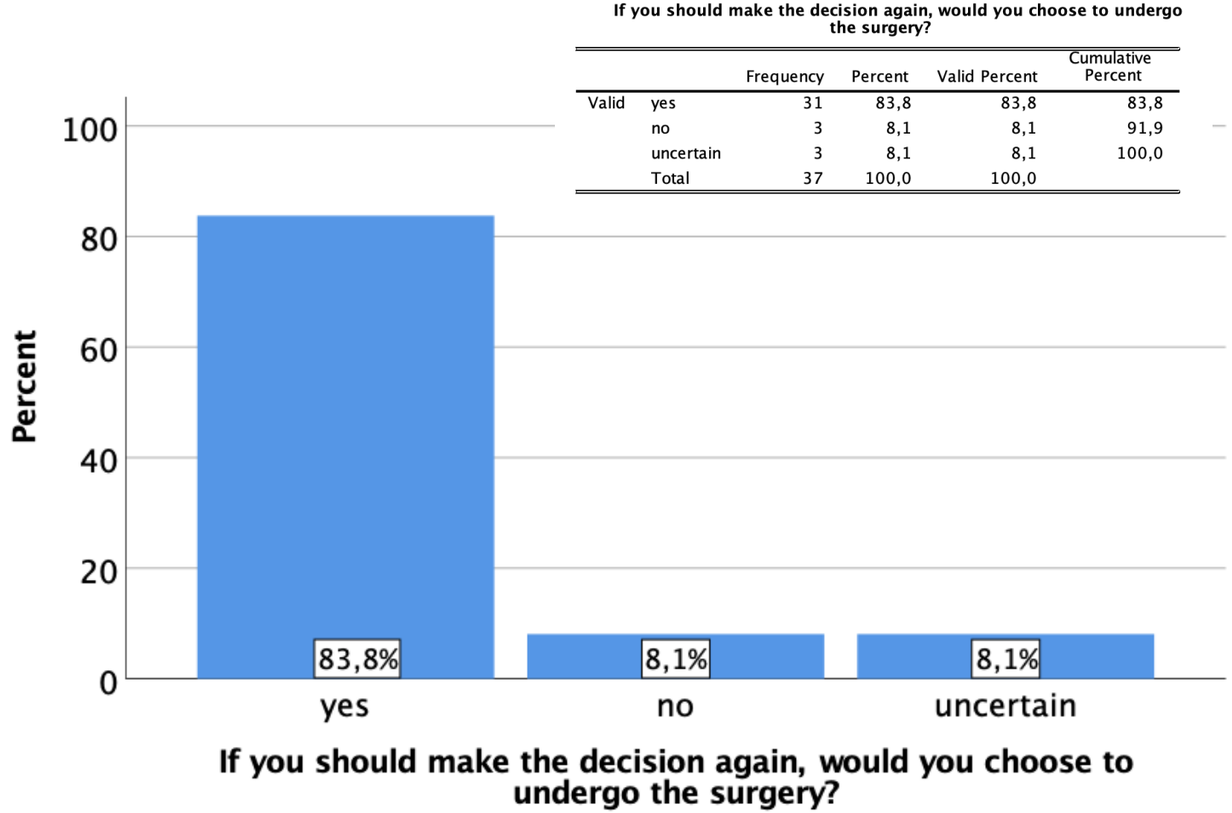

Figure 8: Patient satisfaction survey - decision for surgery

Results – gait biomechanics

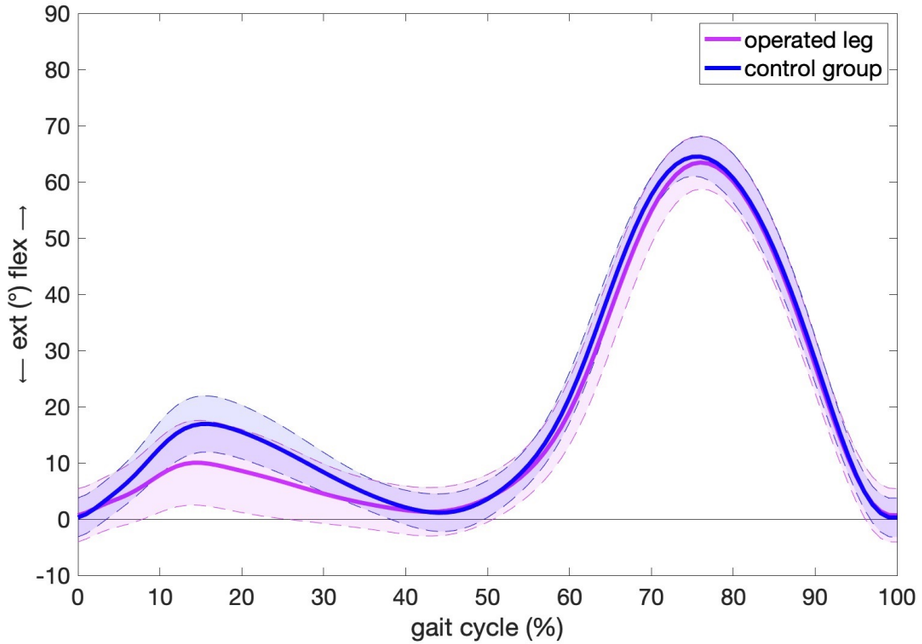

Figure 9: Knee flexion angle

Maximum knee flexion angle (stance phase):
10.2º ± 7.5 vs. 17.1º ± 5.0; p<0.05

ROM knee flexion/extension (stance phase):
18.6º ± 11.6 vs. 32.9º ± 8.8; p<0.05

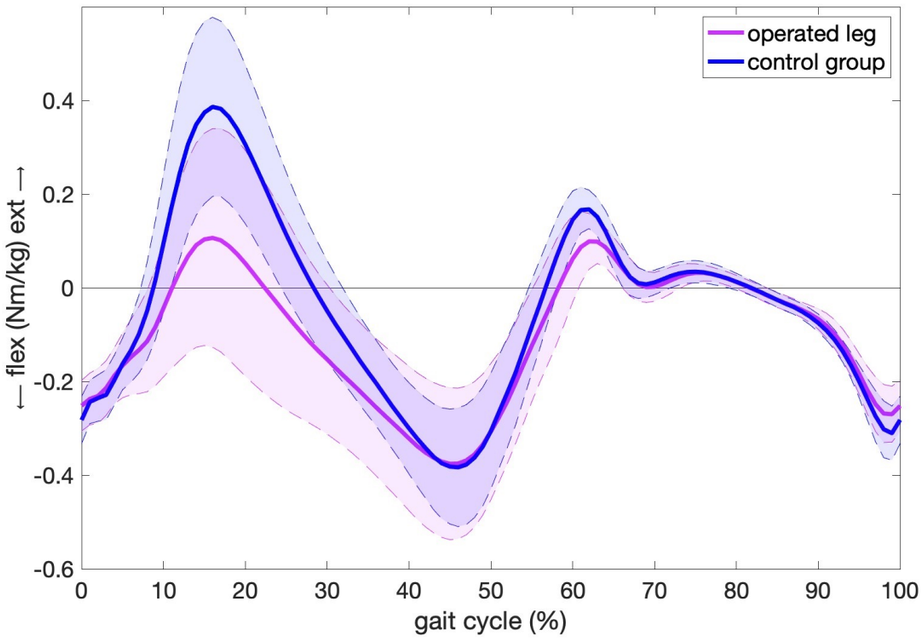

Figure 10: Knee extension moment

Maximum knee extension moment:
0.1 ± 0.2 vs. 0.4 ± 0.2; p<0.05

Results – gait biomechanics

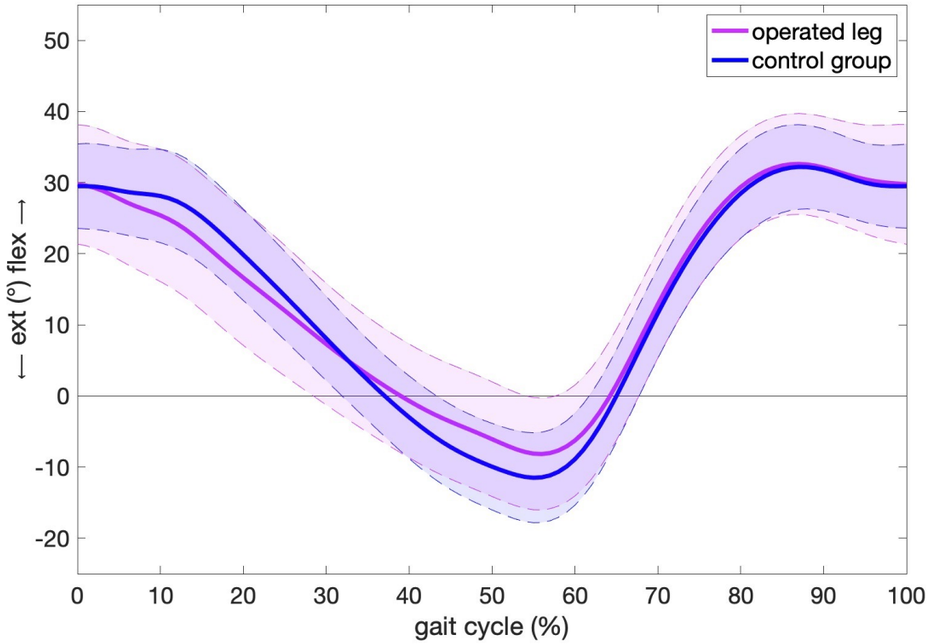

Figure 9: Hip extension angle

Minimum hip extension angle:
-8.3º ± 7.8 vs. -11.6º ± 6.3; p<0.05

Spatio-temporal parameters: patients vs. control group

- **Self-selected speed:** 3.6 ± 0.7 km/h vs. 4.2 ± 0.6 km/h; p<0.05
- **Stance time:** 0.82 s ± 0.1 vs. 0.75 s ± 0.1; p<0.05
- **Step length:** 0.6 m ± 0.08 vs. 0.66 m ± 0.06; p<0.05

Conclusion

- Autologous chondrocyte implantation with spheroids combined with simultaneous autologous bone grafting leads postoperatively to significant improvements in PROMs and to a high patient satisfaction rate.
- Postoperative gait biomechanics show an altered gait pattern with reduced knee flexion angle and a reduced knee extension moment during stance phase compared to a healthy control group.
- Based on these results postoperative rehabilitation protocols can be modified.
- Further research is needed to identify consequences of this altered gait pattern.

References

[1] Gorbachova T, Melenevsky Y, Cohen M, Cerniglia BW. Osteochondral Lesions of the Knee: Differentiating the Most Common Entities at MRI. Radiographics. 2018 Sep-Oct;38(5):1478-1495. doi: 10.1148/rg.2018180044. Epub 2018 Aug 17. PMID: 30118392.

[2] Filardo G, Andriolo L, Soler F, Berruto M, Ferrua P, Verdonk P, Rongieras F, Crawford DC. Treatment of unstable knee osteochondritis dissecans in the young adult: results and limitations of surgical strategies-The advantages of allografts to address an osteochondral challenge.

[3] Holwein C, Jungmann PM, Suchowierski J, Gersing AS, Wörtler K, Brucker PU, Angele P, Imhoff AB, Vogt S. Sandwich Technique for Large Osteochondral Lesions of the Knee. Cartilage. 2022 Jul-Sep;13(3):19476035221102571. doi: 10.1177/19476035221102571. PMID: 35906752; PMCID: PMC9340910.

[4]Knee Surg Sports Traumatol Arthrosc. 2019 Jun;27(6):1726-1738. doi: 10.1007/s00167-018-5316-5. Epub 2018 Dec 6. PMID: 30523367.
Ebert JR, Lloyd DG, Ackland T, Wood DJ. Knee biomechanics during walking gait following matrix-induced autologous chondrocyte implantation. Clin Biomech (Bristol, Avon). 2010 Dec;25(10):1011-7. doi: 10.1016/j.clinbiomech.2010.07.004. Epub 2010 Aug 7. PMID: 20692745.

[5] Slater LV, Hart JM, Kelly AR, Kuenze CM. Progressive Changes in Walking Kinematics and Kinetics After Anterior Cruciate Ligament Injury and Reconstruction: A Review and Meta-Analysis. J Athl Train. 2017 Sep;52(9):847-860. doi: 10.4085/1062-6050-52.6.06. PMID: 28985125; PMCID: PMC5634233.