Matrix-Induced Autologous Chondrocyte Implantation in Adolescents

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Long-Term Results from a Propensity Score Matched Cohort Study

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Research on long-term results after M-ACI

Adults

- Good clinical long-term results with low long-term M-ACI revision rates [1]

Adolescents

1st Generation ACI [2-4]
- Revision rates from 20% to 69%.

Matrix-associated ACI [5-6]
- Revision rates of 3-10%.
- Only 36 months of follow-up.
- Lack of control group comparability.

1. Evaluation of long-term survival and patient-reported outcome (PRO) of adolescents after matrix-induced ACI (M-ACI) at long-term follow-up

2. Compare clinical and radiographic outcomes after M-ACI in adolescents with a Propensity Score Matched (PSM) cohort of adults

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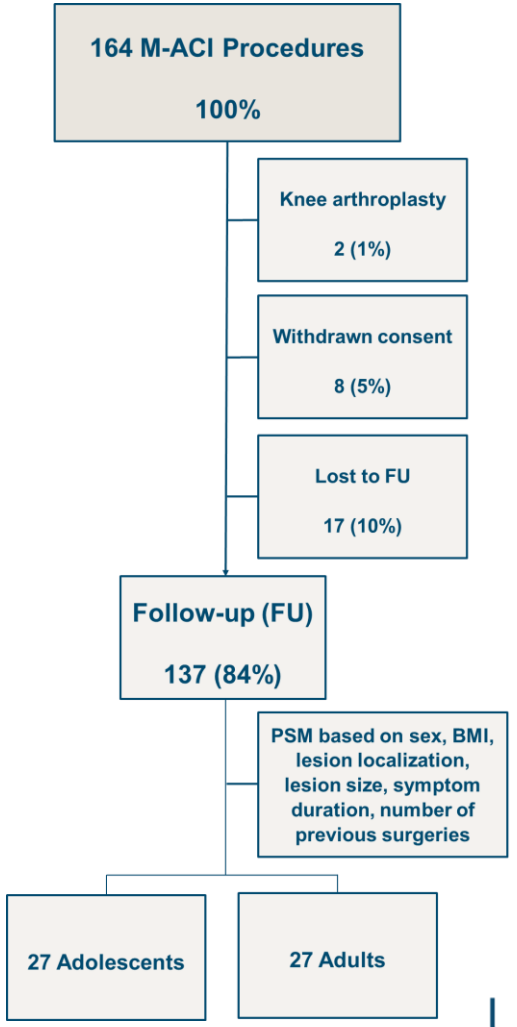
1. Weishorn et al. *The American journal of sports medicine* 2024
2. Macmull et al. *The American journal of sports medicine* 2011
3. Cvetanovich et al. *The American journal of sports medicine* 2017
4. Ogura et al. *The American journal of sports medicine* 2017
5. Niethammer et al. *International Orthopaedics* 2017
6. Hoburg et al. *The American journal of sports medicine* 2019

- Prospectively collected data of adolescents younger than 20 years at the time of surgery treated with M-ACI (Novocart 3D®, TETEC AG, Germany) for focal cartilage damage ICRS grade III and IV were included.
- A total of 27 adolescent patients could be identified and were matched to 27 adult patients with a minimum age of 18 years using 1:1 nearest neighbor propensity score matching (PSM) for baseline characteristics (Figure 1).
- The tolerance for matching was set at 0.01, resulting in similar baseline characteristics.
- Demographics, complications, revisions, and PROMs were assessed preoperatively and at 1, 2, and >5 years postoperatively.
- Clinical outcome was assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS) and its previously published Patient Acceptable Symptomatic State (PASS) and Minimal Clinically Important Difference (MCID).
- Area Measurement And Depth & Underlying Structures (AMADEUS) and Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) 2.0 Knee Score was used to evaluate MRI results by two blinded orthopedic surgeons.



Adolescents n=27		n=27 Adults
17.5 years (13.3-19.3)	*Age*	32.4 years (20.6-44.2)
25.2 kg/m² (SD 3.5)	*BMI*	25.1 kg/m² (SD 4.1)
16 ♂ 11 ♀	*Gender*	16 ♂ 11 ♀
4.6 cm² (SD 2.0)	*Defect size*	4.6 cm² (SD 1.8)
19 FT I 8 PF	*Defect localisation*	19 FT I 8 PF

Clinical evaluation

Measurement of clinical outcome by clinical examination and clinical score (KOOS score).

- Patient Acceptable Symptomatic State (PASS)
- Clinical Response Rate (CRR)
- Minimal Clinically Important Difference (MCID)

Radiologic evaluation

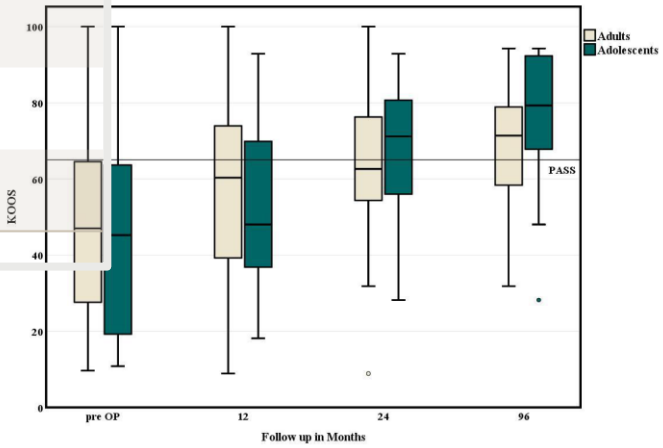
Radiologic evaluation by X-ray and MRI of the knee joint

- AMADEUS/MOCART 2.0 Knee Score
  - Intra-Observer Reliability = 0.96 (95%-KI; 0.91-0.99)
  - Inter-Observer Reliability = 0.89 (95%-KI; 0.65-0.96)

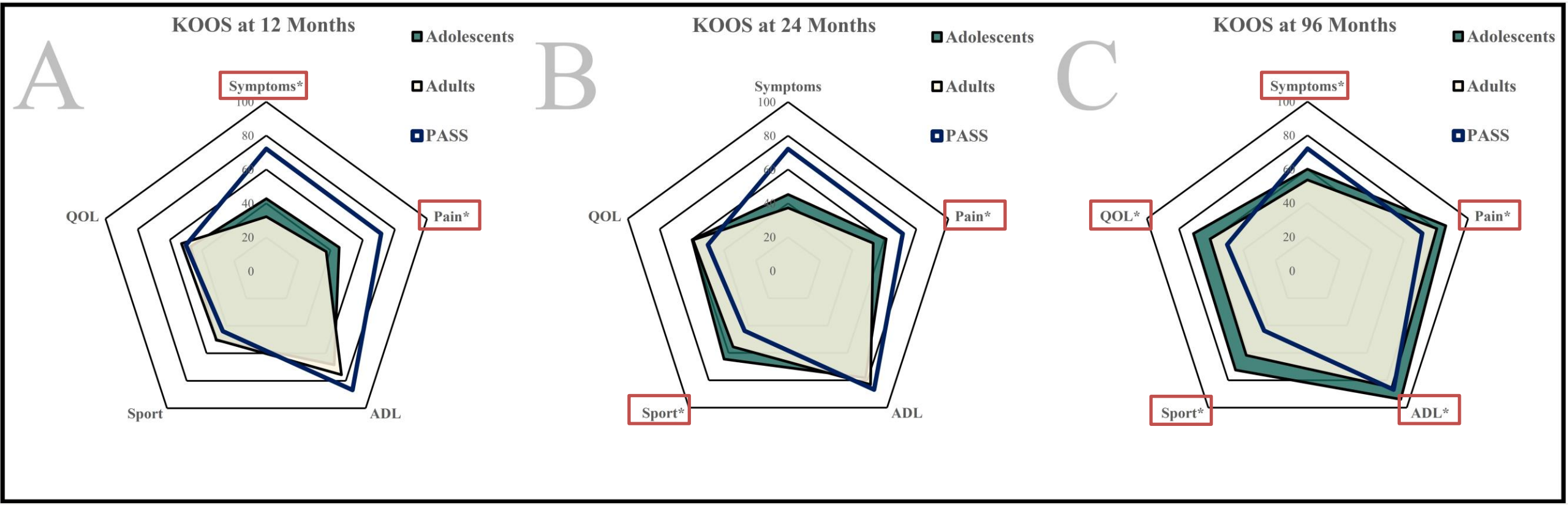
Complications and revision surgery

- ø Follow-up **8.2 years** (5.4-12.0 years).
- **0 revisions**.
- **93% of adolescents** and **70% of adults** would have the procedure done again.

	Adolescents	Adults	p-value
Baseline	48.4 (30.1)	52.0 (27.0)	(n.s.)
12 Months	54.3 (19.7)	57.4 (23.1)	(n.s.)
% reach PASS	29.6	33.3	(n.s.)
24 Months	68.9 (14.9)	63.0 (16.7)	(n.s.)
% reach PASS	51.9	44.4	(n.s.)
96 Months	76.9 (14.1)	66.1 (14.0)	0.03*
% reach PASS	74.1	55.6	0.02*



- Adolescents had a slightly worse preoperative clinical status compared to adults. This trend changed in favor of the adolescents, especially in the long term, with adolescents being significantly more likely to achieve PASS at 96 months compared to adults.



- KOOS subscale analysis showed that adolescents benefit from M-ACI compared to adults, particularly in symptom improvement (59.2±9.8 vs. 53.7±13.4), pain reduction (86.2±19.2 vs. 78.4±18.4), activities of daily living (93.4±13.5 vs. 86.2±16.2), and quality of life (70.1±27.6 vs. 55.9±16.0).

	Adolescents	Adults	p-Value
1 year postOP	5.9 (36.4)	5.4 (33.9)	(n.s.)
CRR in %	55.6	48.1	(n.s.)
2 years postOP	20.5 (34.5)	12.0 (31.1)	0.03
CRR in %	66.7	51.9	0.02
10 years postOP	28.4 (36.9)	16.3 (31.3)	0.02
CRR in %	70.4	66.7	(n.s.)

- Intraclass correlation coefficients showed excellent intraobserver (0.96 [0.91-0.99; 95% CI]) and good interobserver (0.89 [0.65-0.96; 95% CI]) reliability of the radiographic assessment.
- Notably, adolescent patients had persistently high MOCART scores at 24 and 96 months (83.2±11.5 and 80.3±16.3; p=(n.s.)).
- None of the patients in the adolescent group showed graft hypertrophy or required revision at the current follow-up.

	Adolescents	Adults	p-Value
AMADEUS	30.4 (15.7)	39.0 (14.6)	(n.s.)
MOCART			
1 Jahr postOP	76.1 (16.8)	84.2 (13.4)	(n.s.)
2 Jahre postOP	78.4 (18.3)	80.0 (18.2)	(n.s.)
10 Jahre postOP	80.6 (16.6)	76.2 (19.2)	(n.s.)

- Excellent **survival rate of 100%** for treatment failure after **10 years**.
- **Good long-term PRO** with increase over the follow-up period.
- **Good radiologic outcome** → Consistently high MOCART scores without progression to osteoarthritis.

- Revision rates in adolescents following M-ACI comparable to adults.
- Expansion of the indication for M-ACI in adolescents should be discussed.

- **Limitations:**
  - Small study population.
  - No comparison of different surgical techniques.

Thank you!

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Weishorn J, Wiegand J, Koch, KA, Trefzer R, Renkawitz T, Walker T, et al. (2024)
Favorable clinical outcomes and low revision rate after M-ACI in adolescents with immature cartilage compared to adult controls: results at 10 years.
Knee Surgery, Sports Traumatology