Correlation Between Histological Assessment of Regenerated Articular Cartilage and Mid- to Long-Term Clinical Outcomes After Open-Wedge High Tibial Osteotomy

ISAKOS Congress 2025

Yasutoshi Ikeda, Kazushi Horita, Kodai Hamaoka, Kousuke Shiwaku, Shinichiro Okimura, Yohei Okada, Tomoaki Kamiya, Atsushi Teramoto

Department of Orthopedic Surgery,
Sapporo Medical School of Medicine ,
Sapporo, Hokkaido, JAPAN

札幌医科大学
SAPPORO MEDICAL UNIVERSITY

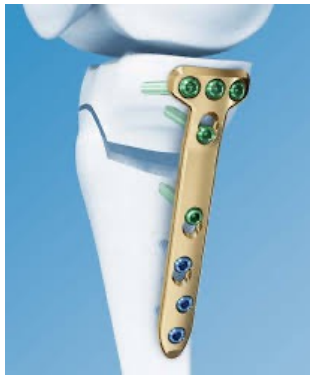
Conflict of Interest Disclosure

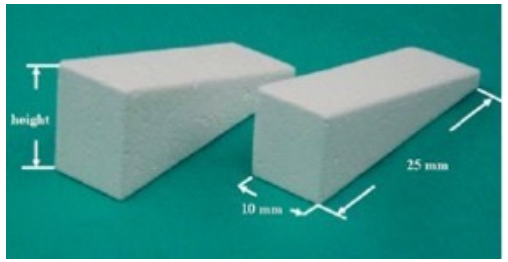
Yasutoshi Ikeda

ISAKOS congress 2025

The author declares no conflicts of interest related to this presentation.

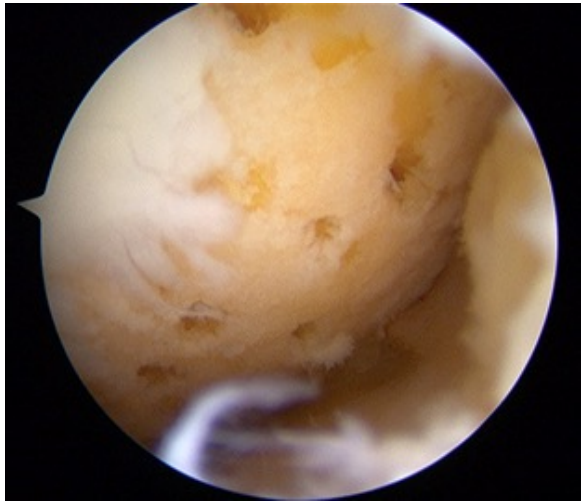
Open-Wedge High Tibial Osteotomy (OWHTO) for Knee Osteoarthritis





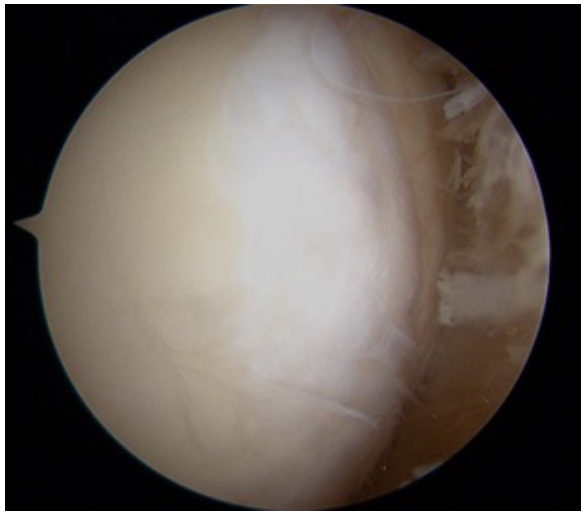
Excellent clinical outcomes

Staubli A et al. Injury. 2003
Takeuchi R et al. Arthroscopy. 2009



ICRS Ⅳ

p.o.1y



ICRS Ⅱ
Koshino stage C

Coverage by Repaired Cartilage

Post-OWHTO Repair Cartilage

Arthroscopic Finding : Partial/complete coverage in 82.6%

Sakakibara Y,Suzuki T et al. 2016

Histological finding : Relatively good staining of the ECM

Ikeda Y et al. 93th JOA 2020

S-O

Repaired cartilage - clinical outcomes (2Y): no correlation

Ikeda Y et al. JOSKAS 2021

Repaired cartilage:
its long-term clinical relevance is still unknown.

Purpose

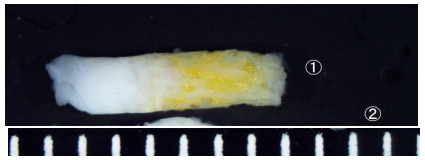
To clarify the association between repaired cartilage characteristics and mid- to long-term outcomes (≥5 years)

Subjects

Patients who consented to cartilage biopsy at the time of OWHTO plate removal and were available for follow-up ≥5 years postoperatively

Methods

- Biopsy from the MFC during implant removal
- Safranin-O & type II collagen (IHC)
- Evaluated using the ICRS-2　scoring system



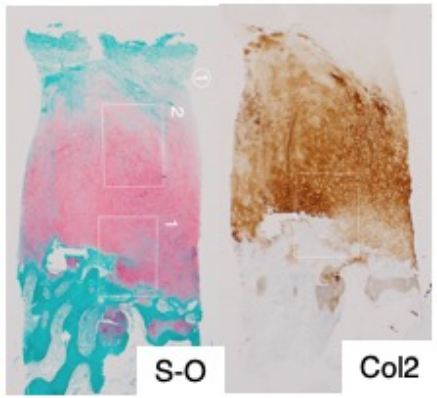
P Mainil-V et al. Am J Sports Med 2010

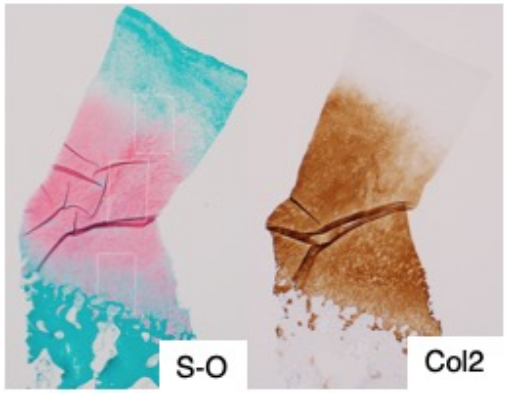
Grouped by total score

≧ 50

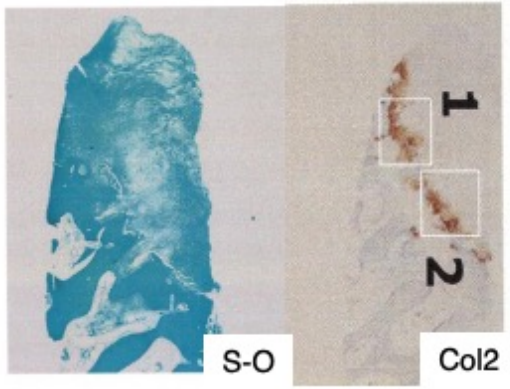
< 50

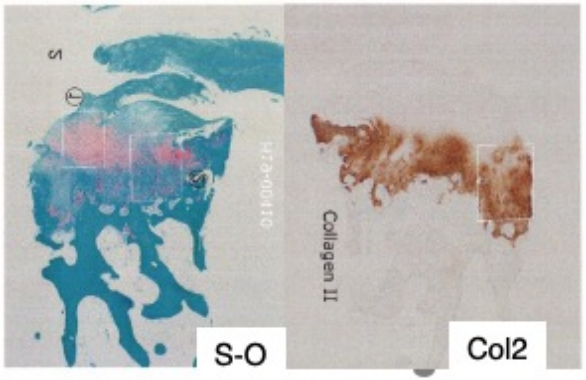
High score group





Low score group





S-O: Safranin-O; Col2: Type II collagen (IHC)

Evaluation Criteria

At final follow-up

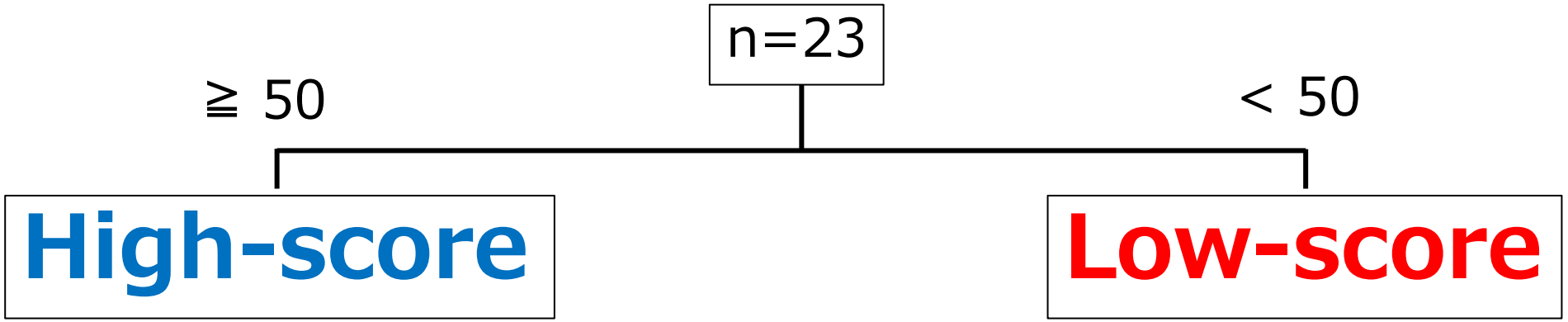
- X-ray(KL classification, %MA, FTA, PS)
- VAS
- PROMs (JKOM, JKOOS)

Statistical analysis: t-test, χ^2-test ($p<0.05$)

Results

Available for follow-up of 5 years or more **23 knee / 28 knee 82.1%**

ave **75.1** ± 5.1 month



n=11 **n=12**

At final follow-up～X-ray/pain～

	High	Low	*p value*
KL (n) (Ⅰ/Ⅱ/Ⅲ/Ⅳ)	0/2/7/3	0/0/9/2	*0.34*
%MA (%)	**61.5** ± 10.4	**60.4** ± 15.4	*0.84*
FTA (°)	**171.6** ± 2.6	**171.4** ± 3.2	*0.86*
PS (°)	**10.4** ± 2.6	**11.5** ± 3.7	*0.41*
VAS(mm)	**2.5** ± 2.7	**2.1** ± 2.5	*0.78*
ΔVAS	**6.4** ± 2.4	**5.0** ± 3.1	*0.18*

At final follow-up ～PROMs～

JKOM

	High	Low	*p value*
Pain/ swelling	**4.9** ± 2.7	**6.6** ± 4.2	0.37
ADL	**5.0** ± 4.2	**7.3** ± 6.9	0.45
Daily activity	**4.0** ± 2.3	**5.3** ± 4.2	0..46
General Health	**1.6** ± 1.3	**2.1** ± 1.4	0.43
Total	**15.4**± 7.8	**21.3** ± 14.9	0.36

KOOS

	High	Low	*p value*
Symptons	**86.2** ± 8.6	**73.0** ± 12.5	**0.025**
Pain	**85.1** ± 9.8	**74.4** ± 15.9	0.122
ADL	**85.7** ± 10.0	**79.4** ± 12.1	0.268
Sports/Rec	**56.9** ± 19.1	**44.4** ± 23.6	0.255
QOL	**71.0** ± 20.5	**52.8** ± 20.0	0.067
Total	**80.8** ± 9.6	**70.6** ± 12.9	0.087

Histological findings - Clinical Outcomes

No correction at 2 years post-op

Ikeda Y et al. 93th JOA 2020

This study

Mid- to long-term outcomes ≥5 years post-op : affected some KOOS subscales

High-score group: strong staining of the ECM

→ High biomechanical strength

Chung C et al. Adv Drug Deliv Rev 2008

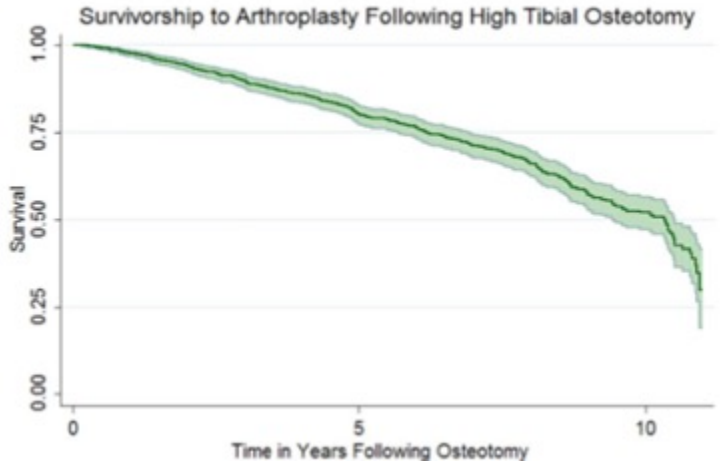
Favorable 10-year outcomes are expected

Current Issues in OWHTO

Survivorship of OWHTO
in Western countries

5y: **80–90%,** 10y: **50–70%**

Pannel WC et al. Orthop J Sports Med 2019
Hui C et al. Am J Sports Med 2011



Favorable Tissue Repair

- Positively correlated with pre-op %MA
- Negatively correlated with correction angle

Ikeda Y et al. JOSKAS 2022

Minor-correction
→ Favorable Tissue Repair
→ Possibility of good long-term results

Conclusion

- This study evaluated the mid- to long-term outcomes of 23 knees that underwent biopsy at the time of plate removal following OWHTO.

- Favorable tissue repair was associated with improvements in certain subscales of the JKOOS at mid- to long-term follow-up.

- OWHTO cases with favorable tissue regeneration may achieve sustained clinical benefits over an even longer follow-up period.