

Clinical trial of ARtificial Protein (Silk-Elastin) for augmentation of arthroscopic meniscal repair (CARP-SE trial)

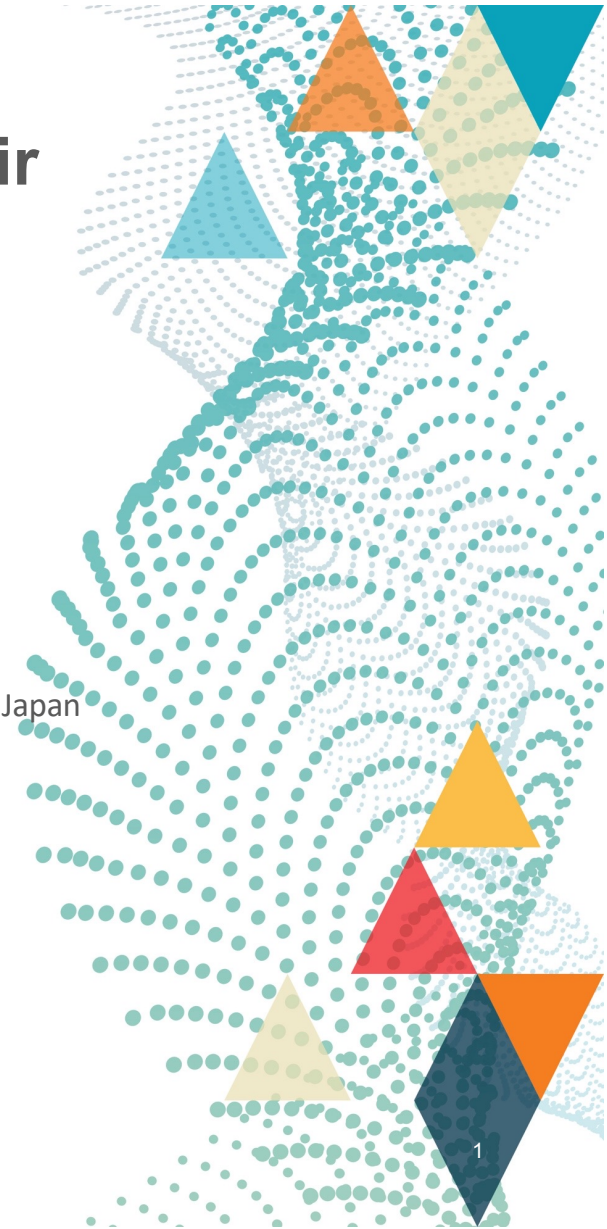
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Faculty Disclosure Information

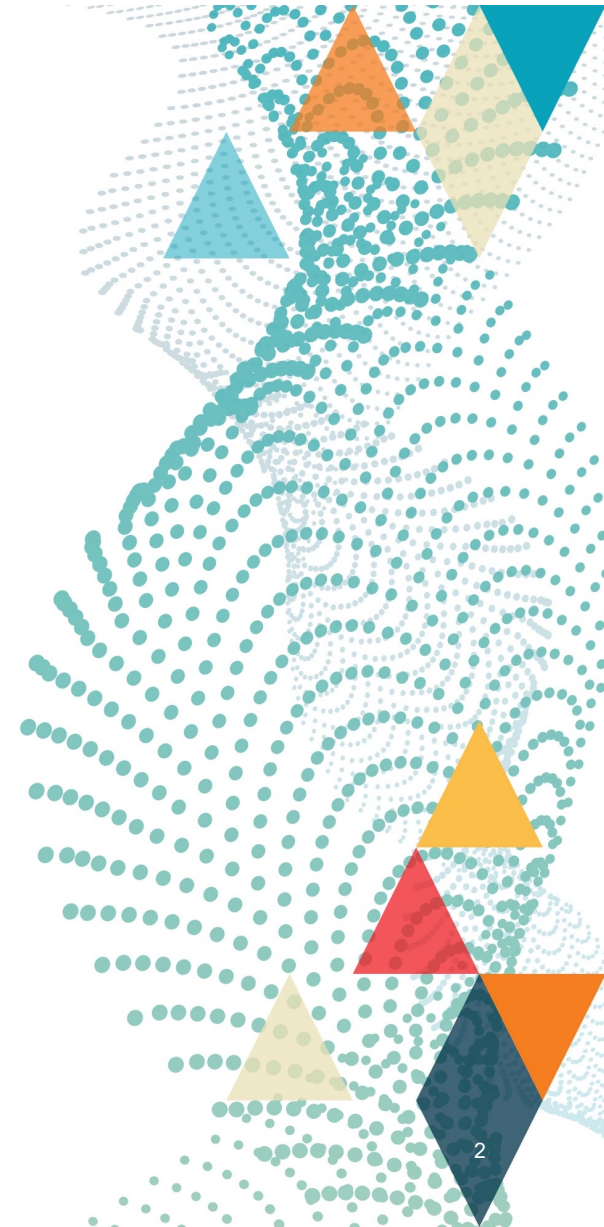
- Nothing to disclosure



ISAKOS
CONGRESS
2025



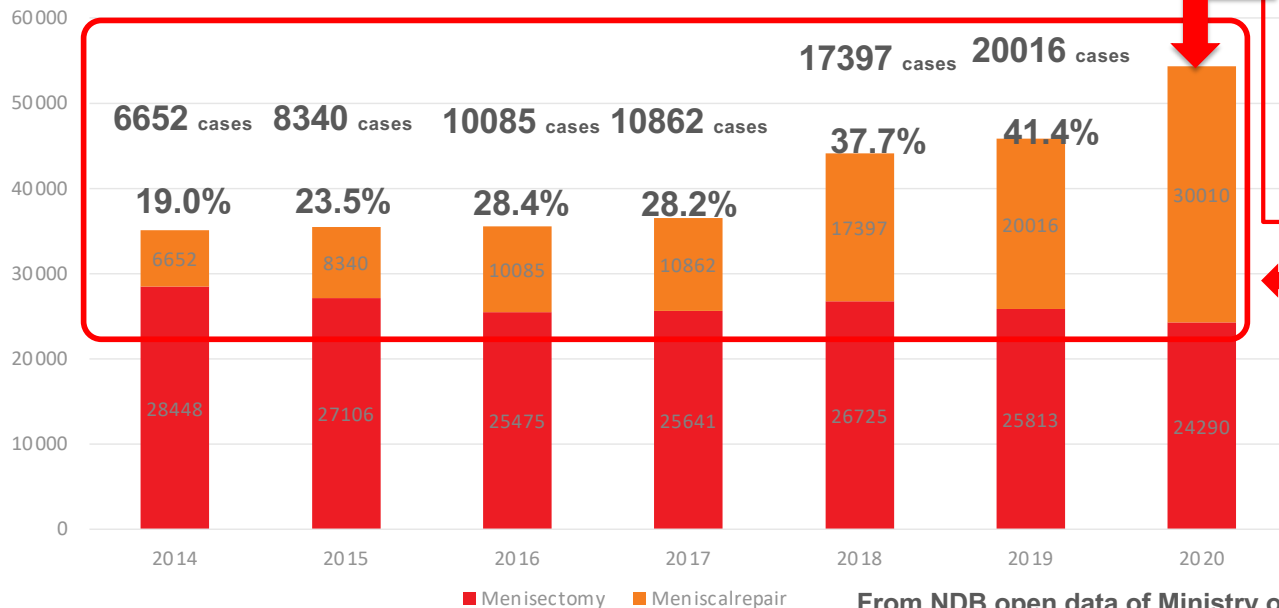
MUNICH
GERMANY
June 8–11



“Save the Meniscus”

Lubowitz JH & Poehling GG Arthroscopy 2011

Trend of arthroscopic meniscal surgery in Japan



From NDB open data of Ministry of Health, Labour and Welfare

Increase of arthroscopic meniscal repair in Japan as well

Silk-elastin (SE)

H₂N

COOH

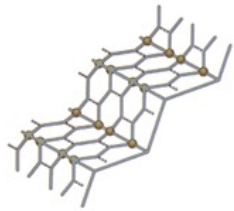


Silk fibroin sequence



Elastin sequence
(GVGVP)

(GAGAGS)

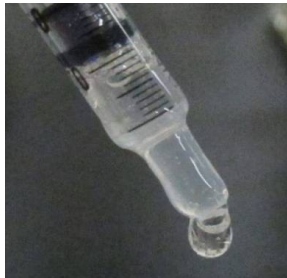


- β-sheet structure (high crystalline)
- Gelation capacity imparted (irreversible)
- Formability, mechanical strength
- Water insoluble

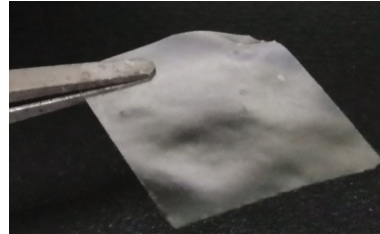


- Elasticity Coacervation capacity (Reversible)
- Water soluble

Gelling above 37°C



Aqueous solutions gel form

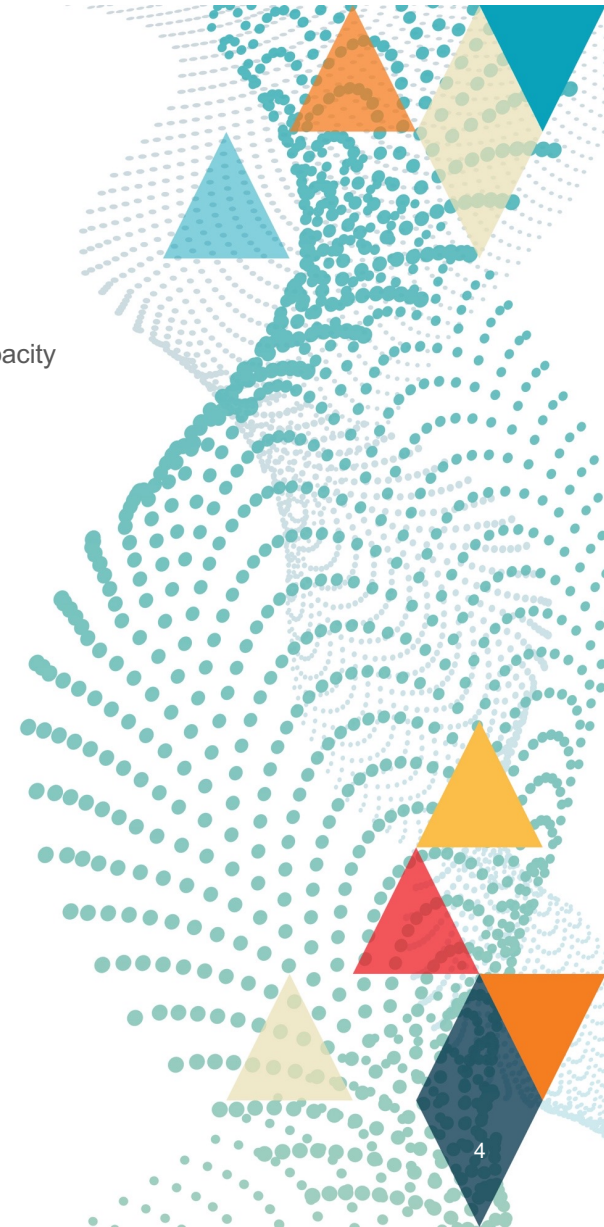


Sheet form



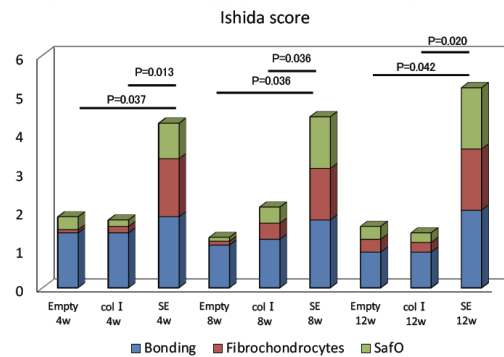
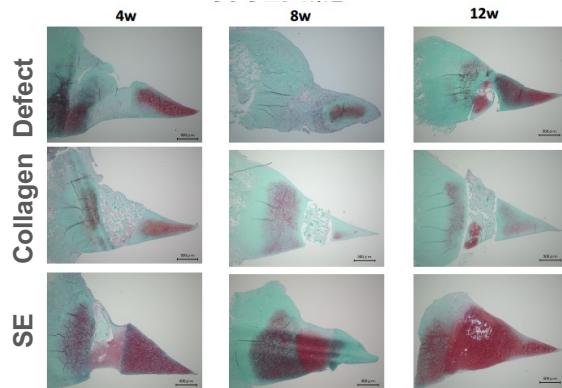
Sponge form

A variety of dosage forms



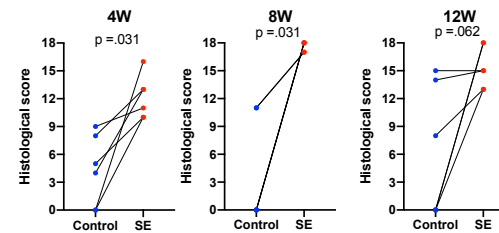
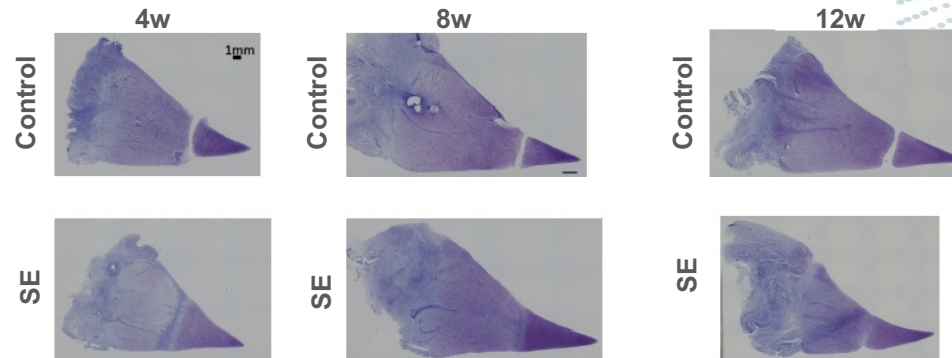
Therapeutic potential of SE in meniscus

Rabbit medial meniscus anterior horn defect model



Inoue, Nakasa, Ishikawa et al BMC Musculoskelet Disord. 2024

Pig model of longitudinal tear of the anterior segment of the medial meniscus



N = 6 in each group

Wilcoxon matched-pairs signed rank test

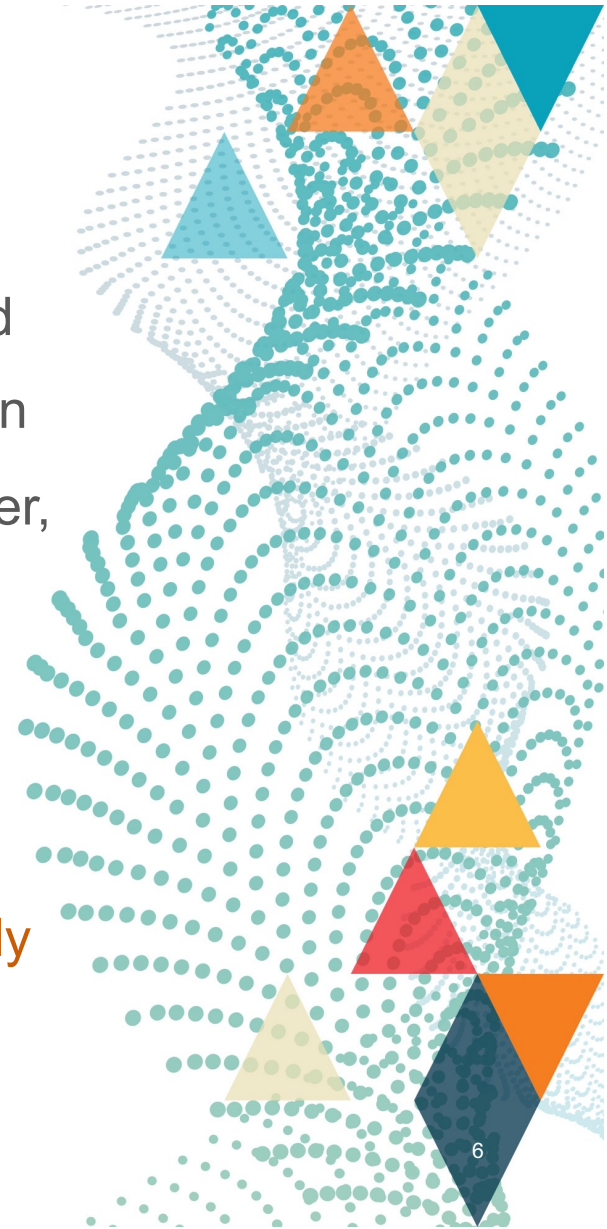
Therapeutic effect of SE in animal models was demonstrated

Purpose

This study aimed to assess the safety, technical feasibility, and efficacy of arthroscopic recombinant artificial protein, silk elastin (SE), application in patients with meniscal tears in a single-center, prospective, single-arm, exploratory clinical study.

Phase I/II

single-center, prospective, single-arm, exploratory clinical study



Study protocol

“Clinical Trial for Efficacy and Safety of ARtificial Protein (Silk-elastin, P47K-WAS-MR) in Patients with Meniscus Repair (CARP-SE trial)”

Principle investigator : Nobuo Adachi jRCT2062220056 (registered in 9/12/2022)

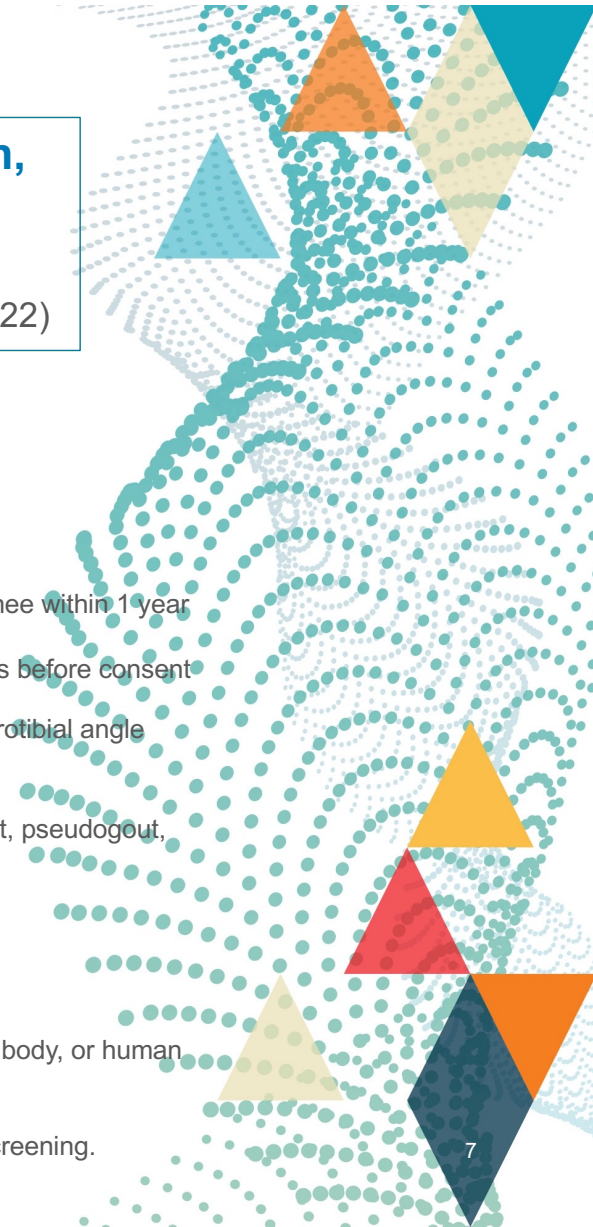
Inclusion criteria

- 1) age 8 to < 60 years at the time of consent (based on SE's intended use for discoid lateral meniscus treatment in younger patients)
- 2) MRI-confirmed meniscal injury involving the avascular white-white zone, either alone or with anterior cruciate ligament injury
- 3) persistent pain despite conservative treatment with physical therapy or analgesics.

Exclusion criteria

- 1) Body mass index (BMI) ≥ 50 kg/m²
- 2) History of total meniscectomy
- 3) Prior ligament reconstruction or osteotomy of the affected knee within 1 year
- 4) Intra-articular injection into the affected knee within 2 months before consent
- 5) Knee deformity $> 10^\circ$ valgus or varus from the normal femorotibial angle (FTA) (FTA 175°)
- 6) Autoimmune arthritis (e.g., rheumatoid arthritis), sepsis, gout, pseudogout, pyogenic arthritis, or secondary arthritis
- 7) Diabetes mellitus
- 8) Known allergies to silk, anesthetics, or antiseptics
- 9) Positive for hepatitis B surface antigen, hepatitis C virus antibody, or human immunodeficiency virus antigen/antibody
- 10) Participation in other clinical trials within 6 months before screening.

Planned number of cases: 8



Demographic and clinical characteristics of the

Patient #	Age	Gender	Side	BMI	Diagnosis	Time to surgery (months)	Lesion location	Type of tear	Surgical procedure	Operation time (min)
1	20	F	R	23.4	LM tear	10	Mid to posterior	Complex, horizontal oblique	AIS: FastFix 2 sutures Scorpion: 2 sutures	78
2	27	M	R	26.9	LM tear	4	Mid	Horizontal & radial	IOS 3 sutures	76
3	38	M	R	25.5	LM tear	5	Anterior	Longitudinal-vertical	IOS 3 sutures	65
4	17	M	L	22.7	LM tear, DLM	13	Mid to posterior	Mid flap tear and posterior horizontal	Partial meniscectomy AIS: Scorpion: 2 sutures	79
5	17	M	R	17.5	MM tear	3	Mid to posterior	Longitudinal-vertical, BHT	IOS 11 sutures	107
6	47	F	R	18.3	MM tear	11	Posterior	Horizontal	AIS: Scorpion: 2 sutures	4
7	52	M	R	29.3	MM tear	14	Posterior	Horizontal	AIS FastFix 2 sutures	55
8	21	M	R	26.6	MM tear	5	Anterior to posterior	Longitudinal-vertical, BHT	AIS: FastFix 2 sutures IOS: 10 sutures	117

Gender : Male 6 cases • Female 2 cases

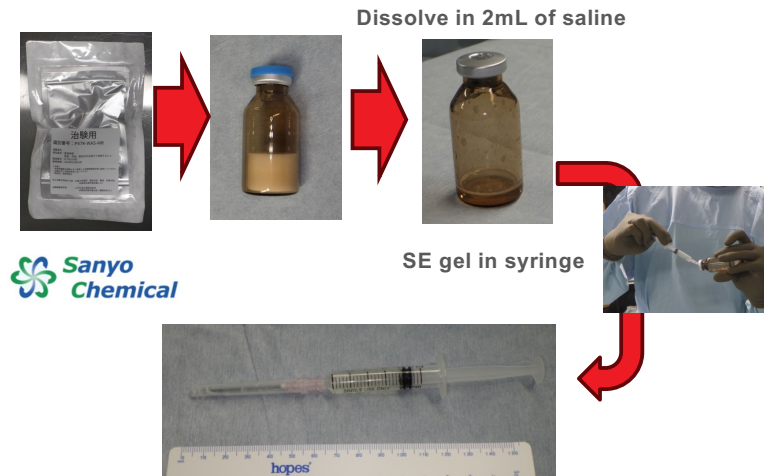
Mean age : 32 yo (17-52)

Lesions : lateral meniscus 4 cases

medial meniscus 4 cases

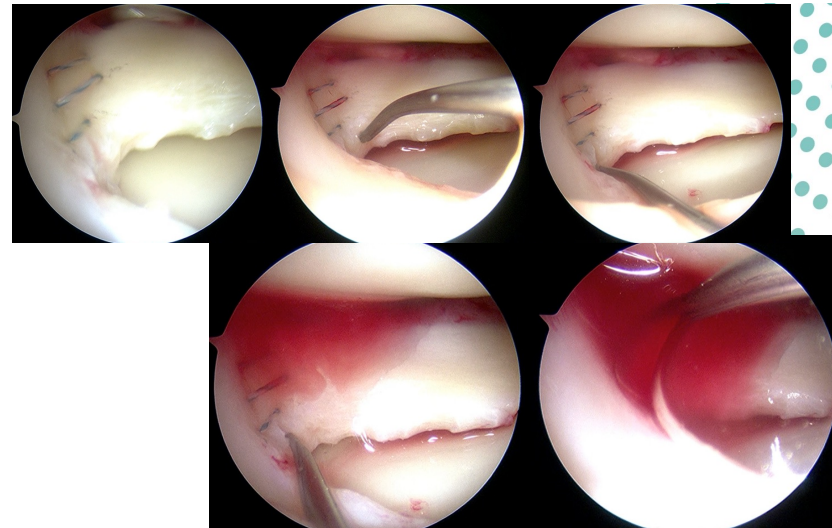
Preparation process of SE

Investigational device (P47K-WAS-MR)



Arthroscopic delivery

Delivery of SE gel into the repaired site



Safety

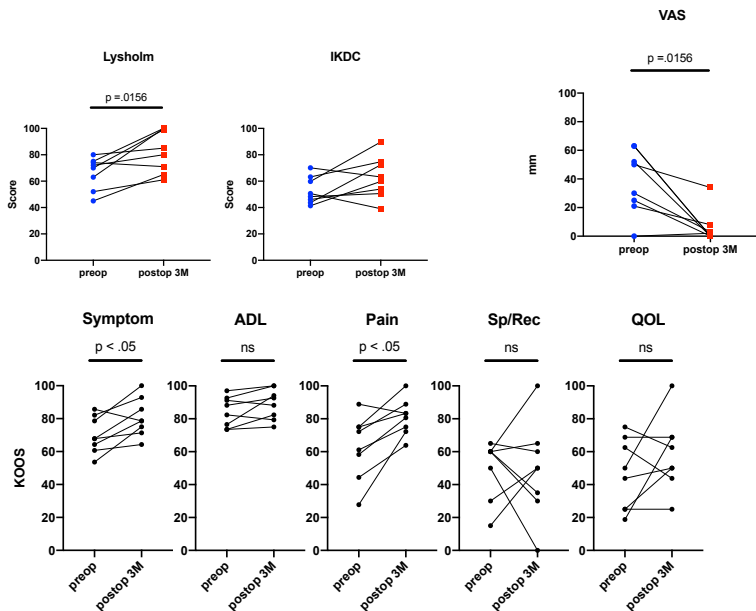
Adverse Events during follow up

Adverse event	Number of cases (%)	Level of severity	Degree of seriousness	Outcome	Relation to the application
Treatment-related pain	4 (50.0)	Moderate	Non-serious	Recovered	Not related
Fever	3 (37.5)	Moderate	Non-serious	Recovered	Might be related
Back pain	2 (25.0)	Moderate	Non-serious	Recovered	Not related
Nausea	2 (25.0)	Moderate	Non-serious	Recovered	Might be related
Insomnia	1 (12.5)	Moderate	Non-serious	Recovered	Not related
Itchiness	1 (12.5)	Moderate	Non-serious	Recovered	Not related
Joint pain	7 (87.5)	Mild	Non-serious	Recovered	Not related
CRP elevation	5 (62.5)	Mild	Non-serious	Recovered	Not related
Joint effusion	3 (37.5)	Mild	Non-serious	Recovered	Not related
Postoperative anemia	2 (25.0)	Mild	Non-serious	Recovered	Might be related
Amylase elevation	2 (25.0)	Mild	Non-serious	Recovered	Not related
CPK elevation	2 (25.0)	Mild	Non-serious	Recovered	Not related
ALP elevation	2 (25.0)	Mild	Non-serious	Recovered	Might be related
Swelling	1 (12.5)	Mild	Non-serious	Recovered	Not related
ALT elevation	1 (12.5)	Mild	Non-serious	Recovered	Not related
AST elevation	1 (12.5)	Mild	Non-serious	Recovered	Not related
Eosinophil elevation	1 (12.5)	Mild	Non-serious	Recovered	Not related
Hypersensitive	1 (12.5)	Mild	Non-serious	Recovered	Not related
Hypertension	1 (12.5)	Mild	Non-serious	Recovered	Not related

CRP: C-reactive protein; ALP: alkaline phosphatase; ALT: alanine transaminase; AST: aspartate transferase.

No serious adverse events

Efficacy

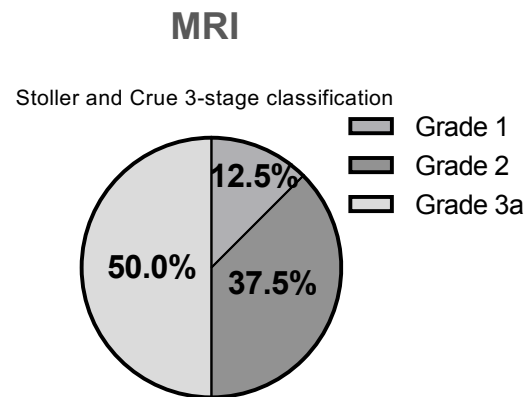


Wilcoxon matched-pairs signed rank test

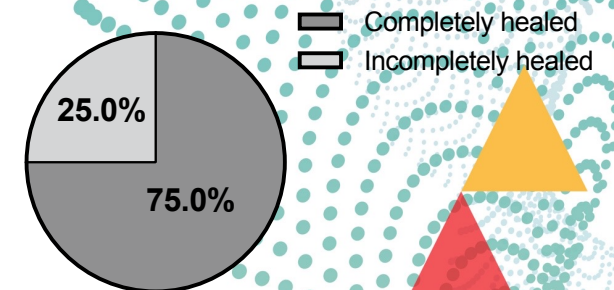
Significant improvements

- Lysholm scores
- VAS
- KOOS (symptom and pain)

Assessment of healing status at 3 months post-SE application



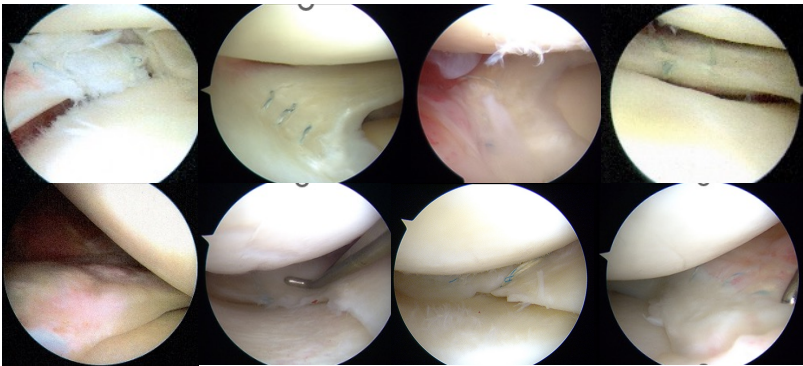
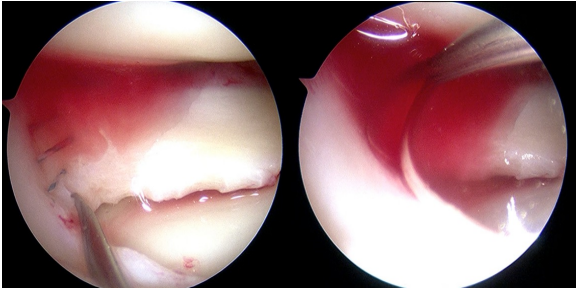
2nd-look arthroscopy



MRI < 2nd look arthroscopy

Safety and Feasibility

intra-articular application of SE



Discussion

“No serious adverse event”

Arthroscopic assessment
at 3 months post-operatively

“Confirmation healing of the repaired site”

**Intra-articular injection method (2 mL) using
gel SE is safe and feasible approach**

References

1. Lubowitz JH & Poehling GG Arthroscopy 2011
2. Inoue, Nakasa, Ishikawa et al BMC Musculoskelet Disord. 2024
3. Ishikawa M et al. First-in-human exploratory trial assessing safety, feasibility, and efficacy of artificial protein (silk-elastin) in promoting healing in patients with meniscus injuries. Sci Rep. 2025 Feb 7;15(1):4658.