

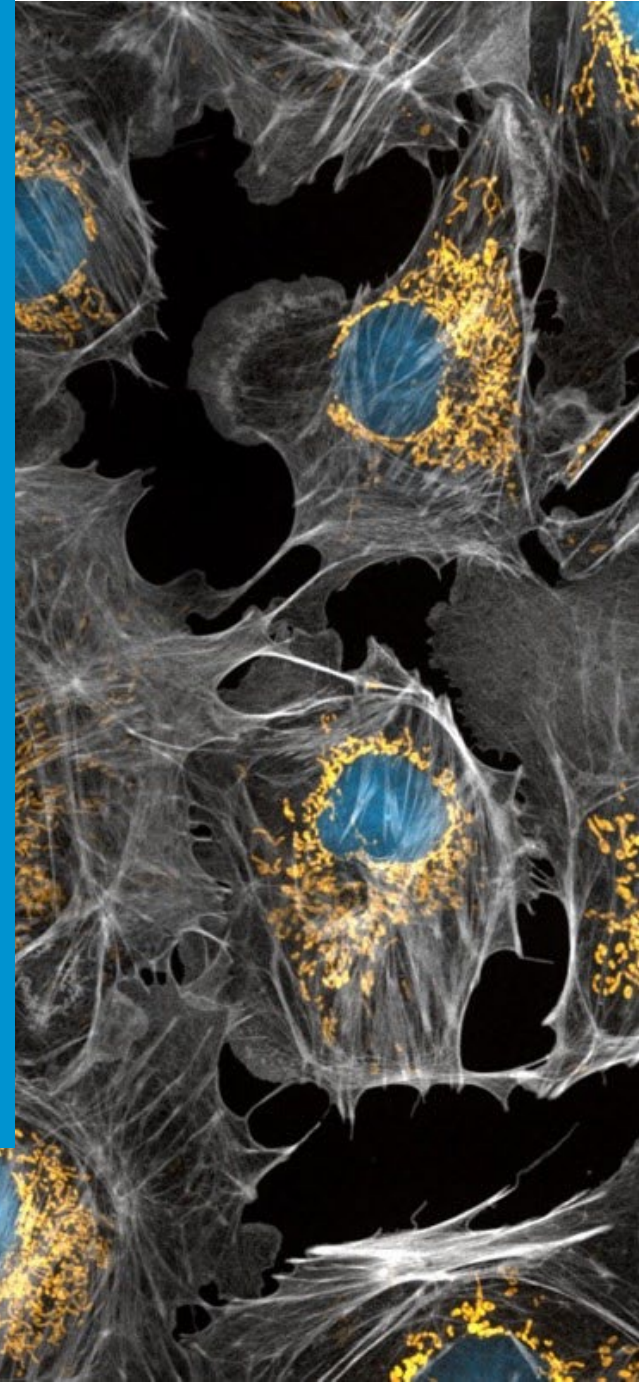


University of California
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Arthrofibrosis

The Total Knee Albatross

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Disclosures

- Consulting, Royalties – Johnson & Johnson
- Stock – Visie

Outline

- Epidemiology/Pathology of Arthrofibrosis
- Treatments
- To Hinge or not to Hinge



Definition of arthrofibrosis

Subjective and individualized

- **Functionally Limiting Stiffness that is significantly worse than prior to surgery**
- ROM needs for flexion
 - Level walking – 65 degrees
 - Reciprocal Stair climbing – 83 degrees
 - Reciprocal stair descent – 100 degrees
 - Sit in a chair without hands – 93 degrees
 - Tie shoes while seated – 106 degrees
- Lack of extension - variable problem depending on patient but flexion contracture >5 degrees associated with gait changes and pain/functional limitations
- Incidence 1.3-6.9%

*Dependent
on height!!!!*

Risk Factors/Epidemiology

Pathology

- Genetic predisposition related to the tendency to create extracellular matrix proteins
- Abnormal response to tissue trauma of surgery
 - Fibroblast cascade, imbalance of matrix synthesis and degradation and reduced MMPs, increased TGF – β 1 changes in IL-6 and TNF – α

Patient

- Preop stiffness, Patella Baja, Prior surgery, Post-traumatic OA, history of MUA/stiffness in contralateral knee, opioid dependence, pain syndromes, catastrophizing/low resilience

Surgery

- Malrotation of components, oversized components, improper tibial slope, imbalance, paradoxical instability, patellofemoral over-stuffing

Reducing Incidence in Primary TKA

Chalmers, et al, A Comprehensive Approach to Stiffness in Total Knee Arthroplasty, JOA 2025

- Optimization – BMI, smoking, Diabetes, Expectations, Preop exercise and strengthening, Preop counseling
- Surgery/Early Postop
 - Multimodal pain control
 - Appropriate PT –aggressive?
 - NSAIDs, Steroids – strong support
 - Extended TXA – RCT for ROM, underpowered for MUA?
- Postop early motion
 - Home stationary bike?
 - CPM? →



→ -No difference in Pain and Function and ultimate motion
-RR 0.34 for MUA

Table 1

Prescription Medications That Have Been Studied for the Prevention of Postoperative Stiffness After Total Knee Arthroplasty.

Corticosteroids
Nonsteroidal anti-inflammatory drugs
Ketotifen (anti-histamine)
Colchicine
Metformin
Atorvastatin
Angiotensin-converting enzyme inhibitors (losartan)
Angiotensin II receptor blockers
Leukotriene receptor antagonist
Colchicine
Glucagon-like peptide-1 receptor agonists

Table 2

Postoperative "Quiet Knee" Protocol Aimed to Minimize Knee Swelling and Early Knee Trauma.

For 7 to 10 day after primary total knee arthroplasty, patients should:

1. Self-directed GENTLE active range of motion (ROM) exercises
 - a. Avoid aggressive passive ROM exercises
2. Focus on terminal extension exercises
3. Ambulate <1,000 feet per day
4. Limit standing to <20 minute at a time
5. Ice and elevate for 20 to 30 minute every 2 to 3 hour

Managing Expectations

Cannot Emphasize This Enough!

My wife and I have a couple follow up questions.

- What are the additional risks of having bilateral knee surgeries? Example: infections etc.
- How many days prior to surgery should I stop alcohol use?
- I know we talked about the implant and you said there was one kind you used. Here is a quote from a doctor on one the jiu jitsu forums. I don't completely remember your response on this. Should I worry (more than I already am) about this? "Your ability to return to jiu jitsu definitely depends on what implant you have. If you have a cruciate retaining implant or a medial pivot implant then your implant will both bend and pivot, so movements like guards, triangles, and sprawling are possible. If you have a posterior stabilized implant, then only bending in the sagittal plane is possible. This type of implant (which many surgeons routinely use) is much more problematic for BJJ. Anyone who wants to do this after TKA should ask for a cruciate-retaining or medial pivot implant."

thanks

57 M, Active Tech Exec
-ROM 5-130



Medications

Perioperative Use of Antifibrotic Medications Associated With Lower Rate of Manipulation After Primary TKA: An Analysis of 101,366 Patients

Ajay Premkumar, MD, MPH ^{a,*}, Alex Anatone, MD ^a, Alex Illescas, MPH ^b, Stavros Memtsoudis, MD, PhD ^c, Michael B. Cross, MD ^a, Peter K. Sculco, MD ^a, Alejandro Gonzalez Della Valle, MD ^a

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■ Truven database study of 101,366 patients

Table 1

Medications With Demonstrated Antifibrotic Properties.

Medication	Class	Mechanism of Adhesion Prevention
Losartan [14,19]	Angiotensin II receptor blocker	Inhibits TGF-B signaling
Benazepril, captopril, enalapril, fosinopril, lisinopril, moexipril, quinapril, Ramipril [20,21]	ACE inhibitors	Inhibits production of AT2 and inhibits TGF-B signaling downstream
Simvastatin, atorvastatin, rosuvastatin, pravastatin, pitavastatin, fluvastatin, lovastatin [16,19]	HMG CoA reductase inhibitors	Increase tissue tPA and blocks TGF-B stimulation of collagen synthesis
Rosiglitazone [19]	PPAR-γ agonist	Disrupts TGF-B and SMAD signaling
Celecoxib, rofecoxib [14,15]	COX 2 inhibitors	Reduces inflammation
Vitamin D [22]	Supplement	Activation of the Vit D receptor antagonizes TGF-B/SMAD dependent transcriptional responses
Sildenafil, tadalafil [14,23]	Phosphodiesterase 5 inhibitors	Increases cGMP leading to increased fibroblast apoptosis
Octreotide [14,24]	Decreases growth stimulating hormones	Decreases EGF receptor, increases tPA levels, reduces TGF-B1
Mexdroxyprogesterone [14,16]	Increases progesterone to estrogen ratio	Unclear
Leuprolide Acetate [14,15]	GnRH agonist	Unclear
Tamoxifen [14,25]	ER blocker	Downregulates TGF-B, inhibits fibroblast proliferation
Anastrozole [14,25]	Aromatase inhibitor	Decreases inflammation

TGF-B, transforming growth factor-beta; ACE, angiotensin-converting enzyme; AT2, angiotensin II; HMG CoA, 3-hydroxy-3-methylglutaryl coenzyme A; tPA, tissue plasminogen activator; PPAR-γ, peroxisome proliferator-activated receptor gamma; SMAD, protein transducers involved with TGF-B superfamily; COX 2, cyclooxygenase 2; cGMP, cyclic guanosine monophosphate; EGF, endothelial growth factor; TGF-B1, transforming growth factor-beta 1; GnRH, gonadotropin-releasing hormone. ER, estrogen receptor.

Medications

Table 3

Multivariable Regression Evaluating Likelihood of Undergoing Manipulation Under Anesthesia After Primary TKA.

Variable	Knee Manipulation	
	OR (95% CI)	<i>P</i> -Value
ACE Inhibitors	0.91 (0.84-1.00)	.0417
Angiotensin II receptor blocker	0.80 (0.70-0.91)	.0007
COX 2 inhibitors	0.88 (0.81-0.96)	.0022
HMG CoA reductase Inhibitors	1.01 (0.94-1.08)	.8734

Treatments - MUA

- Incidence as high as 10% in registry studies
- Gold standard
 - ROM less than 90 at 6-8 weeks depending on preop motion
 - Within 3 months >> outcomes than late MUA
 - Repeat MUA –limited evidence
- Adjunct medications/injections
 - Limited evidence, most practitioners use

Table 1. Gains in knee ROM, timing of procedure, and final followup

Study	Number of knees (number of patients)	Final increase in ROM (mean)	Final increase in flexion (mean)
MUA group			
Daluga et al. [6]	94 (60)	—	42°
Esler et al. [9]	47 (42)	—	35°
Fox and Poss [10]	76 (—)	—	30°
Keating et al. [14]	113 (90)	—	35°
Maloney [16]	24 (—)	47°*	—
Pariente et al. [20]	65 (60)	32°	—
Scranton [24]	19 (19)	42°	—
Yercan et al. [33]	46 (46)	47°	—

2024 Knee Society Award

The Chitranjan S. Ranawat Award: Manipulation Under Anesthesia to Treat Postoperative Stiffness After Total Knee Arthroplasty: A Multicenter Randomized Clinical Trial

Matthew P. Abdel, MD ^{a,*}, Harold I. Salmons, MD ^a, Dirk R. Larson, MS ^a, Matthew S. Austin, MD ^b, C. Lowry Barnes, MD ^c, Michael P. Bolognesi, MD ^d, Craig J. Della Valle, MD ^e, Douglas A. Dennis, MD ^f, Kevin L. Garvin, MD ^g, Jeffrey A. Geller, MD ^h, Stephen J. Incavo, MD ⁱ, Adolph V. Lombardi Jr., MD ^j, Christopher L. Peters, MD ^k, Ran Schwarzkopf, MD ^l, Peter K. Sculco, MD ^m, Bryan D. Springer, MD ⁿ, Mark W. Pagnano, MD ^a, Daniel J. Berry, MD ^a

The Journal of Arthroplasty 39 (2024) S9–S14

Treatments – Arthroscopic LOA

A Decade of Experience With Arthroscopic Lysis of Adhesions for Arthrofibrosis After Total Knee Arthroplasty

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The Journal of Arthroplasty 40 (2025) 2525–2530

- Retrospective, 103 patients
- Flexion improved 51,
Extension improved 8.9

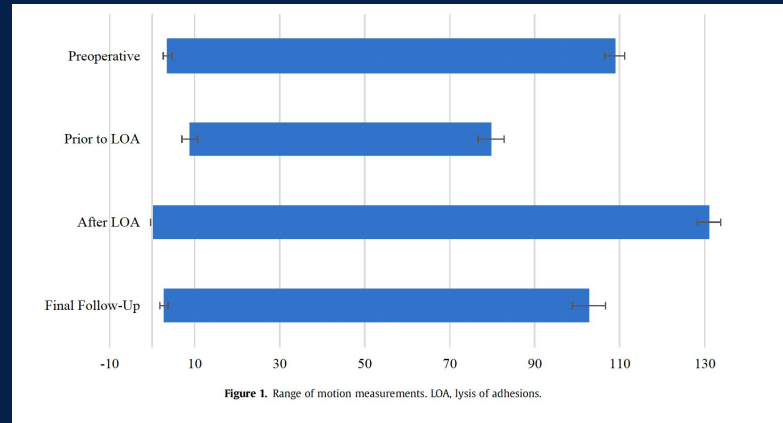


Table 1. Gains in knee ROM, timing of procedure, and final followup

Study	Number of knees (number of patients)	Final increase in ROM (mean)	Final increase in flexion (mean)	Final increase in extension (mean)	Timing of procedure (mean in months)	Followup (mean in months)
Arthroscopy group						
Bae et al. [2]	13 (11)	42°	45°	−3°	20	12
Campbell [4]	7 (7)	18.5°	—	—	11.6	≥ 12
Diduch et al. [8]	8 (8)	26.3°	—	—	7.4	—
Jerosch and Aldawoudy [11]	32 (32)	—	34°	23°†	8.5	28
Johnson et al. [13]	2 (2)	—	30°	—	—	—
Parisien [21]	1 (1)	50°	45°	5°	3	10
Scranton [24]	7 (7)	31°	—	—	—	≥ 12
Sprague et al. [26]	1 (1)	23°	5°	18°	12	3
Teng et al. [28]	11 (11)	30.8°	29°	1.8°	13	3
Wasilewski and Frankl [29]	6 (6)	34°	26°	8°	30	30
Williams et al. [30]	10 (9)	33°	30.5°	2.5°	29	20
Yercan et al. [33]	3 (3)	60°	58.4°	1.6°	—	—

Treatments – Open LOA/Liner change

- Indications

- Well positioned/sized components
- Patient had reasonable motion prior to surgery
- Limited Gains in Severe AF

Table 1. Gains in knee ROM, timing of procedure, and final followup

Study	Number of knees (number of patients)	Final increase in ROM (mean)	Final increase in flexion (mean)	Final increase in extension (mean)	Timing of procedure (mean in months)	Followup (mean in months)
Open group						
Babis et al. [1]	5 (5)	19°	—	—	—	—
Mont et al. [19]	18 (17)	31°	—	—	31	30
Yercan et al. [33]	3 (3)	21°	—	—	—	—

Treatments – LOA/Liner Change

Revision Arthroplasty

Outcomes of Liner Exchange Versus Component Revision for the Treatment of Stiffness Following Primary Total Knee Arthroplasty

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The Journal of Arthroplasty 40 (2025) 1014–1020

- Retrospective, 129 patients, 91 Liner change, 38 revision
- Revision performed if components determined to be mal-positioned, No hinges

Table 3

Results.

Outcome	Component Revision	Liner Exchange	P-Value
Achievement of successful post-revision total knee arthroplasty (rTKA) range of movement (ROM) – All patients (%)	23/37 (62)	59/82 (72)	0.29
Achievement of successful post rTKA ROM – Patients with pre-existing extension deficit > 10 ⁰ (%)	15/22 (68)	12/20 (60)	0.58
Achievement of successful post rTKA ROM – Patients without pre-existing extension deficit ≤ 10 ⁰ (%)	9/16	45/61 (74)	0.17
Mean improvement in arc of motion (AOM) – All patients	25.4 ⁰ (–40 to 70 ⁰)	24.9 (–65 to 70 ⁰)	0.45
Mean improvement in AOM – Patients with pre-existing extension deficit > 10 ⁰	22.4 ⁰	30 ⁰	0.17
Mean improvement in AOM – Patients without pre-existing extension deficit ≤ 10 ⁰	27.4 ⁰	23.4 ⁰	0.55
Mean length of stay	3.7 days	2.9 days	0.01
Mean Hemoglobin Drop	31.2g/dL	18.1g/dL	<0.00001
Mean tourniquet time (minutes)	77	33.2	<0.0001

Treatments - Revision

Review

Efficacy of Revision Surgery for the Treatment of Stiffness After Total Knee Arthroplasty: A Systematic Review

Jordan S. Cohen ^{a,*}, Alex Gu ^{a,b}, Nicole S. Lopez ^c, Mindy S. Park ^a, Keith A. Fehring, MD ^d, Peter K. Sculco, MD ^b

■ Improvements but with cautious expectations

Table 3

Results of Revision Surgery.

Study	Patient Count	Number of Knees	Gender	Age	BMI	ROM Pre-Revision	ROM at Final Follow-Up	Gain in Motion	Extension Pre-Revision	Extension at Final Follow-Up	Significant Improvement in Final ROM, Flexion, or Extension?
Kim et al (2004) [1]	52	56	14 M and 38 F	69	—	54.55 ± 20.50	82.18 ± 21.32	27.63 ± 23.32	11.3 ± 11.9	3.2 ± 5.4	ROM $P < .001$, Extension $P < .001$
Keeney et al [10] (limited approach)	12	12	—	63	32.8	70.6	96.3	25.7	7.45 ± 8.02	0.82 ± 3.25	ROM $P < .0001$, Extension $P = .002$
Keeney et al [10] (component revision)	11	11	—	59	35.7	49.4	67.3	17.9	21.6 ± 16.3	8.90 ± 10.0	ROM $P = .03$, Extension $P = .006$
Donaldson et al [15]	47	48	13 M and 35 F	65.5	—	42.4	87.4	45	12.0 ± 10.6	3.5 ± 5.5	Flexion $P < .001$, ROM not calc., Extension $P < .001$
Heesterbeek et al [14]	40	40	9 M and 31 F	64	—	60	85	25	—	—	ROM $P < .001$
Kasmire et al [13]	175	175	65 M and 110 F	66	32.1	—	—	—	—	—	—
Hartman et al [11]	35	35	20 M and 15 F	62	—	53.6	98.1	44.5	13.5	2.7	ROM $P < .0001$, Extension $P < .001$
Christensen et al [8]	11	13	1 M and 10 F	62.1	—	39.7 ± 19.9	83.2 ± 23.5	43.5	11.8 ± 11.7	2.5 ± 4.6	ROM $P < .01$, Extension $P < .02$
Kim et al (2012) [12]	36	37	14 M and 22 F	60.8	30.7	67	85	18	14	5	ROM $P = .001$, Extension $P < .0001$
Moya et al [16]	39	42	14 M and 28 F	61	33	72	92	20	9.7	2.3	ROM $P < .001$, Extension $P < .001$
Haidukewych et al [9]	15	16	6 M and 9 F	67	—	40	73	33	22.5 ± 16.53	8.06 ± 9.05	Not calc.

BMI, body mass index; ROM, range of motion; —, results not available; M, male; F, female.

Treatments - Revision

- Revision to Semi-Constrained

- Pros

- Preserve collaterals
- Lower rate of loosening
- Bone Preserving

- Cons

- TTO in severe AF, limits postop motion
- Need to balance gaps

- Revision to Hinge

- Pros

- Exposure – avoid TTO
- Extensive scar tissue debridement
- Avoid collateral flexion-extension mismatch contributions to stiffness

- Cons

- Loss of Bone Stock
- Loosening
- DFR is salvage?

Treatments - Hinge

Rotating Hinge Revision Total Knee Arthroplasty Provides Greater Arc of Motion Gains for Patients Who Have Severe Arthrofibrosis

Ming Han Lincoln Liow, MD, FRCS ^{a, b, c}, Dimitrios A. Flevas, MD, PhD ^b,
Sebastian Braun, MD ^b, Allina Nocon, PhD, MPH ^b, Gwo-Chin Lee, MD ^{b, c},
Peter K. Sculco, MD ^{b, c, d, *}, TKAF Consortium

- Retrospective, Severe (<70 degrees flexion) versus non-severe AF
- 52 patients, 32 severe (avg motion 50), 20 non-severe (avg motion 84)

Table 2
Outcomes of Severe (Group A) Versus Non-severe (Group B).

	Group A: Severe (ROM ≤70)	Group B: Non-severe (ROM >70)	P-Value
	N = 36	N = 20	
Postoperative ROM and PROMs (1 y)			
Average ROM	83.2 (25.7)	95.9 (22.5)	0.090
KOOS JR	59.5 (18.9)	60.3 (21.0)	0.684
LEAS	9.5 (3.8)	10.5 (4.0)	0.312
Pain score	3.5 (2.8)	3.2 (2.9)	0.698
Delta change of ROM and PROMs (1 year)			
Average ROM	31.1 (20.9)	11.4 (25.0)	0.005
KOOS JR	21.3 (17.7)	16.7 (18.2)	0.607
LEAS	2.1 (3.6)	2.1 (3.0)	0.440
Pain score	-1.4 (3.1)	-2 (3.6)	0.812
Proportion achieving MCID (1 year)			
KOOS JR	27 (75.0%)	15 (75.0%)	0.768

All continuous variables are reported as mean (standard deviation).

Table 3
Subgroup Analysis of Severe Arthrofibrosis Group - Rotating Hinge (RH) Versus Non-rotating Hinge (NRH) Groups.

	Group RH: N = 20	Group NRH: N = 16	P-Value
Postoperative ROM and PROMs (1 year)			
Average ROM	89.5 (23.9)	75.3 (26.4)	0.119
KOOS JR	60.5 (14.9)	58.3 (23.4)	0.702
LEAS	10.2 (3.8)	8.7 (3.7)	0.173
Pain score	3.8 (2.9)	3.0 (2.8)	0.410
Delta change of ROM and PROMs (1 year)			
Average ROM	41.4 (19.4)	18.3 (15.1)	<0.001
KOOS JR	23.8 (18.2)	18.3 (17.2)	0.356
LEAS	2.8 (3.5)	1.2 (3.5)	0.085
Pain score	-1.3 (3.5)	-1.5 (2.6)	0.661
Proportion achieving MCID (1 year)			
KOOS JR	15 (75.0%)	12 (75%)	0.706

Table 4

MCID Threshold and PASS Threshold (KOOS JR.).

	Group A: Severe (ROM ≤ 70)	Group B: Non-severe (ROM > 70)	P-Value
	N = 36	N = 20	
MCID (%)	27 (75.0)	15 (75.0)	0.788
PASS (%)	14 (38.9)	11 (55.0)	0.322
	Group RH: N = 20	Group NRH: N = 16	P-Value
MCID (%)	15 (75.0)	12 (75.0)	0.706
PASS (%)	8 (40.0)	6 (37.5)	0.675

MCID, minimal clinically important difference; KOOS JR, Knee Injury and Osteoarthritis Outcomes Score for Joint Replacement; PASS, patient acceptable symptom state.

Table 5

ROM in degrees by Time Point for Severe and Non-Severe Groups.

	Severe				Non-Severe			
	Flexion (mean)	Flexion (std)	Extension (mean)	Extension (std)	Flexion (mean)	Flexion (std)	Extension (mean)	Extension (std)
Preop	65.2	17.0	14.9	9.4	101.4	11.2	17.3	12.9
6 weeks	86.5	15.8	5.8	6.6	93.7	19.4	7.0	5.5
6 months	88.2	18.7	8.1	7.8	99.2	13.7	6.8	4.7
1 year	68.1	45.0	3.7	5.4	84.5	46.9	4.8	6.3

ROM, range of motion.

Treatments - Hinge

Low-Dose Irradiation and Rotating-Hinge Revision for the Treatment of Severe Idiopathic Arthrofibrosis Following Total Knee Arthroplasty: A Review of 60 Patients With a Mean 6-Year Follow-Up

Andrew M. Schneider, MD ^{a,*}, Steven J. Rice, DO ^b, Neil Lancaster, DO ^c, Michael McGraw, DO ^c, Yasser Farid, MD, PhD ^d, Henry A. Finn, MD ^b

- Retrospective, 60 consecutive patients (Median flexion contracture 20, median flexion 70, median arc 50)
- 800 centigray of radiation immediately prior to surgery
- Average gain in arc of 60 degrees
- Mean extension 0, mean flexion 110

Table 2
Types of Reoperations.

Procedure Type	Number of Knees (% of Total N)
Minor reoperation	
Manipulation under anesthesia	16 (26.6)
Irrigation and debridement (superficial infection)	2 (3.3)
Irrigation and debridement, modular component exchange (deep infection)	2 (3.3)
Irrigation and debridement (hemarthrosis)	2 (3.3)
Wear-related insert and bushing exchanges	0 (0.0)
Major reoperation	
Resection arthroplasty with insertion of antibiotic spacer	1 (1.7)
Femoral component revision (aseptic)	1 (1.7)
Extensor mechanism repair	1 (1.7)

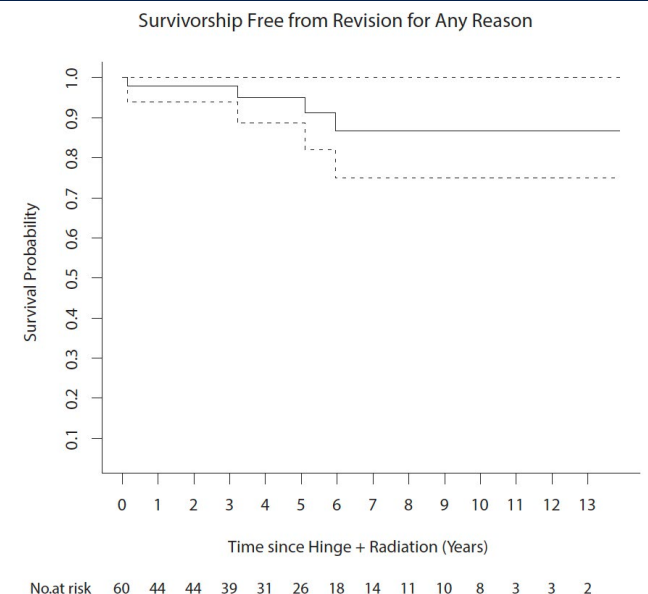


Fig. 3. Kaplan-Meier survival graph showing the cumulative survival free from revision for any reason, which was 87% at 10 years. Dashed lines indicate 95% confidence interval.

Treatment - Hinge

Reliable Outcomes Provided by a Rotating Hinge Knee Arthroplasty for Patients Who Have Moderate-To-Severe Arthrofibrosis

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- Retrospective, 41 patients, avg FU 3.6 years
- Average flexion improvement of 25 and Extension of 10
- 4 Reoperations, all for stiffness

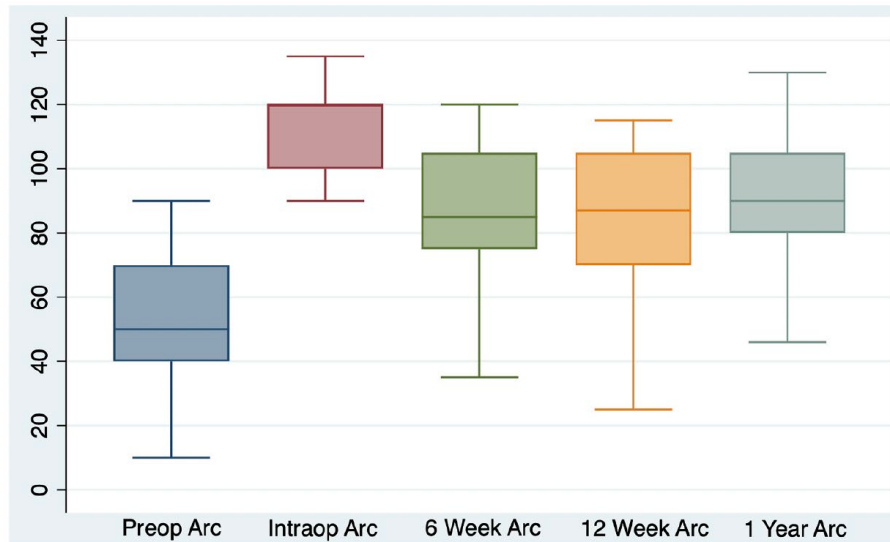


Figure 1. Box plot showing arc of motion as measured preoperatively, intraoperatively, and postoperatively at 6 weeks, 12 weeks, and 1 year.

Treatment - Hinge

Table 3
Review of Literature Reporting Range of Motion and Implant Survivorship in the Treatment of Arthrofibrosis After Total Knee Arthroplasty With Rotating-Hinge Prostheses.

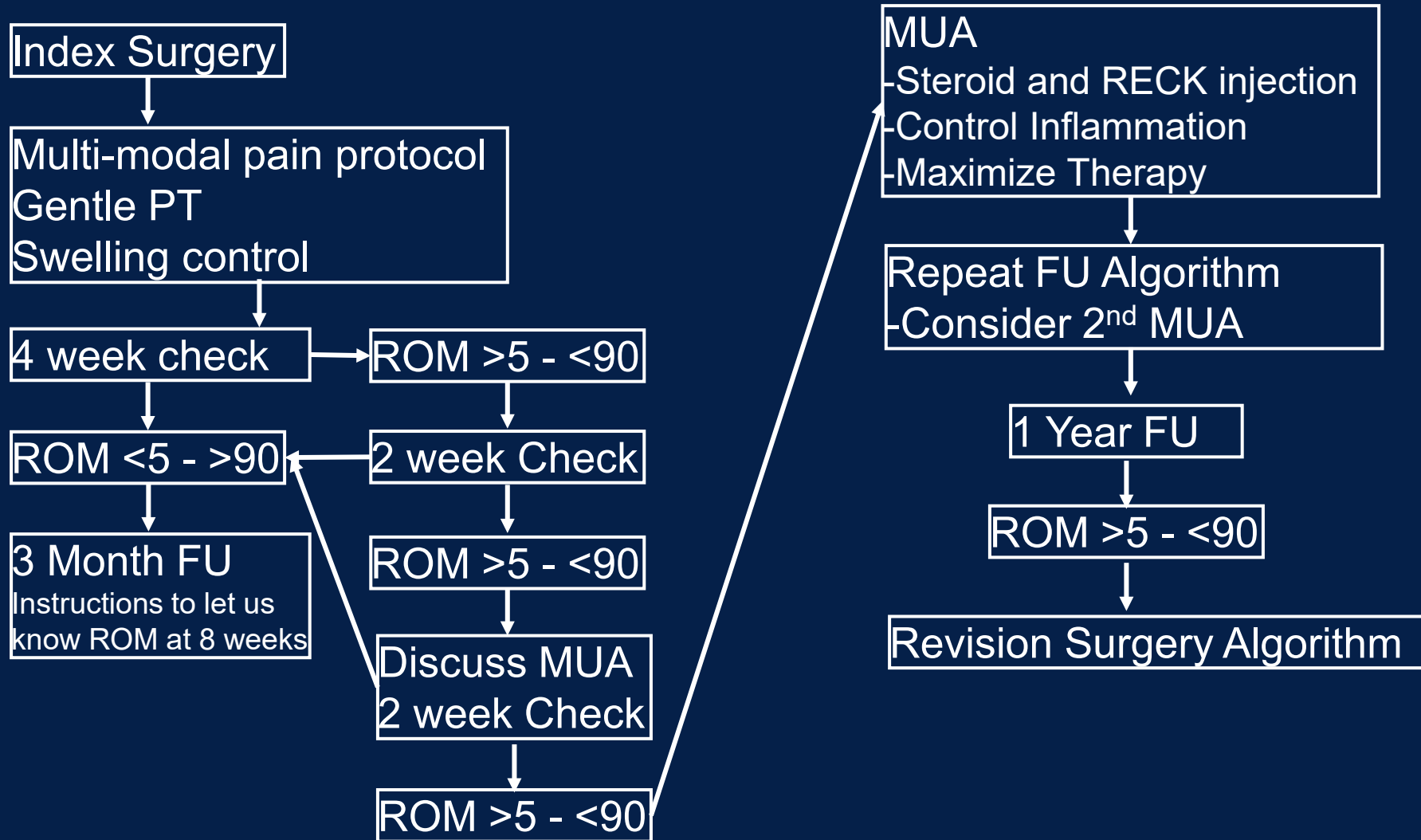
Study, Year	Number of RH Prostheses (N)	Mean Follow-Up (years)	Low-Dose Radiation	Mean ROM Improvement (Degrees)	Implant Survivorship
Farid et al., 2013	9	2.7	+	55	100
Hermans et al., 2019	22	3.4	-	33.9	100
Bingham et al., 2019	34	6	-	19.7	75.0
Schneider et al., 2023	60	6	+	60	86.7 (10 years)
Liow et al., 2025	20	5	-	41.3	85.0
Current Study	41	3.6	-	34.7	90.2

RH, rotating hinge; ROM, range of motion.

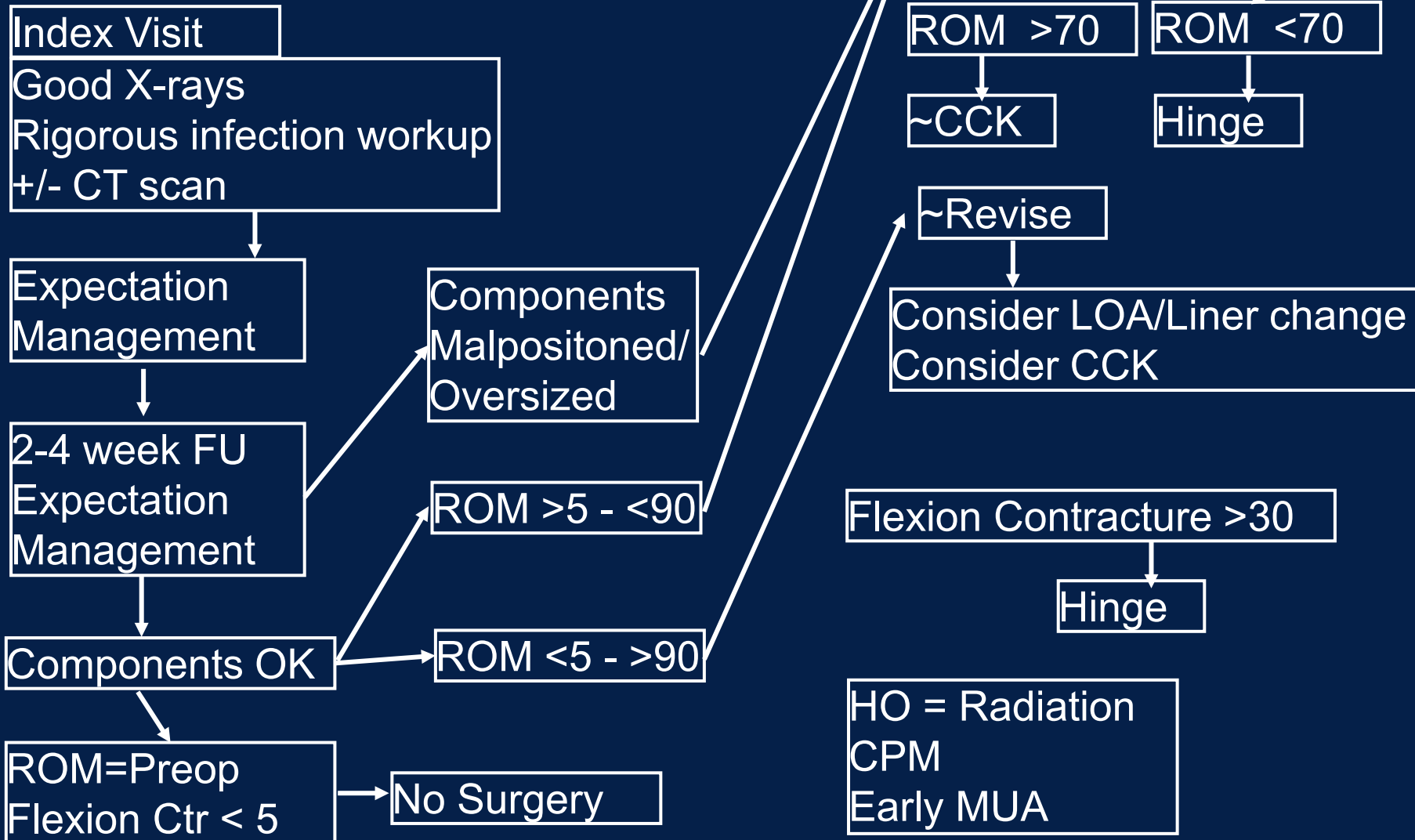
Hinges

- Reasonable evidence for providing better motion
- Unclear if this leads to improved satisfaction
- Possible higher long term risks?

Algorithm – Primary TKA



Algorithm – Revision TKA



Caveat – Psychology and Patient Choice

Huge Role in Satisfaction and Perceived Outcomes

- When it's your patient?



Conclusions

- Arthrofibrosis remains a debilitating and challenging problem
- Prevention is critical
- Appropriate trend towards hinged revisions to improve motion
- Future directions – RCTs for adjuncts (medications, radiation)

Thank you!

