

Knee Arthroplasty Update

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Non-operative Management for Hip and Knee Osteoarthritis

- 1. Acetaminophen
- 2. NSAIDs
- 3. Opioids and opiates
- 4. Chondroitin sulfate and glucosamine
- 5. Corticosteroid injections
- 6. Hyaluronic acid injections
- 7. Platelet-rich plasma (PRP) injections
- 8. Mesenchymal stem cell (MSC) treatments

Management of Osteoarthritis of the Knee (Non-Arthroplasty)

Evidence-Based Clinical Practice Guideline

Adopted by:

The American Academy of Orthopaedic Surgeons Board of Directors
August 31, 2021

Endorsed by:



AAOS Clinical Practice Guidelines

- Strong

- Lateral wedge insoles are NOT recommended for patients with knee osteoarthritis
- Topical NSAIDs should be used to improve function and quality of life for treatment of osteoarthritis of the knee, when not contraindicated
- Supervised exercise, unsupervised exercise, and/or aquatic exercise are recommended over no exercise to improve pain and function for treatment of knee osteoarthritis
- Self-management programs (home exercise programs) are recommended to improve pain in patients with knee osteoarthritis
- Patient education programs are recommended to improve pain in patients with knee osteoarthritis
- Oral acetaminophen is recommended to improve pain and function in the treatment of knee osteoarthritis when not contraindicated.
- Oral narcotics, including tramadol, result in a significant increase of adverse events and are NOT effective at improving pain or function for treatment of osteoarthritis of the knee.

Weight Loss

- Effect beyond objective measures is apparent with weight loss. Those who lost just 5 to 10% of their body weight reported a decrease in pain, disability, and increase in quality of life.
 - A systematic review and meta-analysis
 - Obesity Reviews 2018
- A single blind RCT evaluating weight loss by intensive diet, exercise and combined. The diet and exercise group demonstrated the most significant differences in degree of weight loss, reductions in fat mass, improved pain, and improved function.
 - JAMA 2013

Supervised and self-managed exercise

- 94 study systematic review evaluated different varieties of training and found that 3 things were found to consistently reduce pain
 - 1 – Increased quadricep strength
 - 2 – Decreased extension impairment
 - 3 – Increased proprioception
 - Osteoarthritis and Cartilage 2015
- Meta-analysis of RCTs demonstrated significant improvements in function and pain, specifically WOMAC and Short Form 36 score outcomes.
 - Journal of Physical Therapy Science 2015

AAOS Clinical Practice Guidelines

- Moderate
 - Canes could be used to improve pain and function in patients with knee osteoarthritis.
 - Brace treatment could be used to improve function, pain, and quality of life in patients with knee osteoarthritis.
 - Neuromuscular training (balance, agility, coordination) programs in combination with traditional exercise could be used to improve performance-based function and walking speed for treatment of knee osteoarthritis.
 - Sustained weight loss is recommended to improve pain and function in overweight and obese patients with knee osteoarthritis.
 - Hyaluronic acid intra-articular injections are not recommended for routine use in the treatment of symptomatic osteoarthritis of the knee.
 - Intra-articular corticosteroids could provide short-term relief for patients with symptomatic osteoarthritis of the knee.
 - Arthroscopy with lavage and/or debridement in patients with a primary diagnosis of knee osteoarthritis is NOT recommended.
 - Arthroscopic partial meniscectomy can be used for the treatment of meniscal tears in patients with concomitant mild to moderate osteoarthritis who have failed physical therapy or other nonsurgical treatments.

Intra-articular corticosteroids could provide short-term relief for patients with symptomatic osteoarthritis of the knee.

- Efficacy of triamcinolone hexacetonide versus methylprednisolone acetate intraarticular injections in knee osteoarthritis: a randomized double blinded study – journal of rheumatology
 - Very limited evidence supporting one type of intra-articular steroid over others.
- Potential for chondrotoxicity based on in vitro and ex vivo studies
 - still no consensus in human studies
 - One double blind RCT noted no radiographic decrease in mean knee joint width after steroid injections every 3 months for 2 years compared to a saline control
 - Journal of Arthritis and Rheumatology 2003
 - One similar RCT more recently demonstrating significantly greater cartilage loss on MRI in the corticosteroid group versus saline group
 - JAMA 2017

Hyaluronic acid intra-articular injections are not recommended for routine use in the treatment of symptomatic osteoarthritis of the knee.

- Naturally occurring compound found in the synovial fluid of joints.
- Thought to provide therapeutic effect by lubricating the articular surfaces, dissipating frictional energy and absorbing shock.
- Does not meet the AAOS minimum clinically important improvement measures.
 - May be beneficial to trial in patients who do not benefit from other treatments.



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STANDING KNEE
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AAOS Clinical Practice Guidelines

- Limited

- The following supplements may be helpful in reducing pain and improving function for patients with mild to moderate knee osteoarthritis; however, the evidence is inconsistent/limited and additional research clarifying the efficacy of each supplement is needed
 - Turmeric, ginger extract, glucosamine, chondroitin, Vitamin D
- Manual therapy in addition to an exercise program may be used to improve pain and function in patients with knee osteoarthritis. (downgraded for heterogeneity of studies)
- Massage may be used in addition to usual care to improve pain and function in patients with knee osteoarthritis.
- FDA-approved laser treatment may be used to improve pain and function in patients with knee osteoarthritis
- Acupuncture may improve pain and function in patients with knee osteoarthritis.
- Transcutaneous electrical nerve stimulation (TENS) modalities be used to improve pain and/or function in patients with knee osteoarthritis.
- Percutaneous electrical nerve stimulation/Pulsed electromagnetic field therapy may be used to improve pain and/or function in patients with knee osteoarthritis.
- Extracorporeal shockwave therapy may be used to improve pain and function for treatment of osteoarthritis of the knee.
- Platelet-rich plasma may reduce pain and improve function in patients with symptomatic osteoarthritis of the knee.
- Denervation therapy may reduce pain and improve function in patients with symptomatic osteoarthritis of the knee.
- High tibial osteotomy may be considered to improve pain and function in properly indicated patients with unicompartmental knee osteoarthritis.

AAOS Clinical Practice Guidelines

- Consensus

- In the absence of reliable evidence, it is the opinion of the workgroup that the utility/efficacy of dry needling is unclear and requires additional evidence.
- In the absence of reliable or new evidence, it is the opinion of the work group not to use free-floating (un-fixed) interpositional devices in patients with symptomatic medial compartment osteoarthritis of the knee.

Opioids

- Opioid Use for the treatment of osteoarthritis of the Hip and Knee
 - American Association of Hip and Knee Surgeons 2019
 - AAHKS does not recommend use of opioids in the normal management of osteoarthritis

Chondroitin Sulfate and Glucosamine

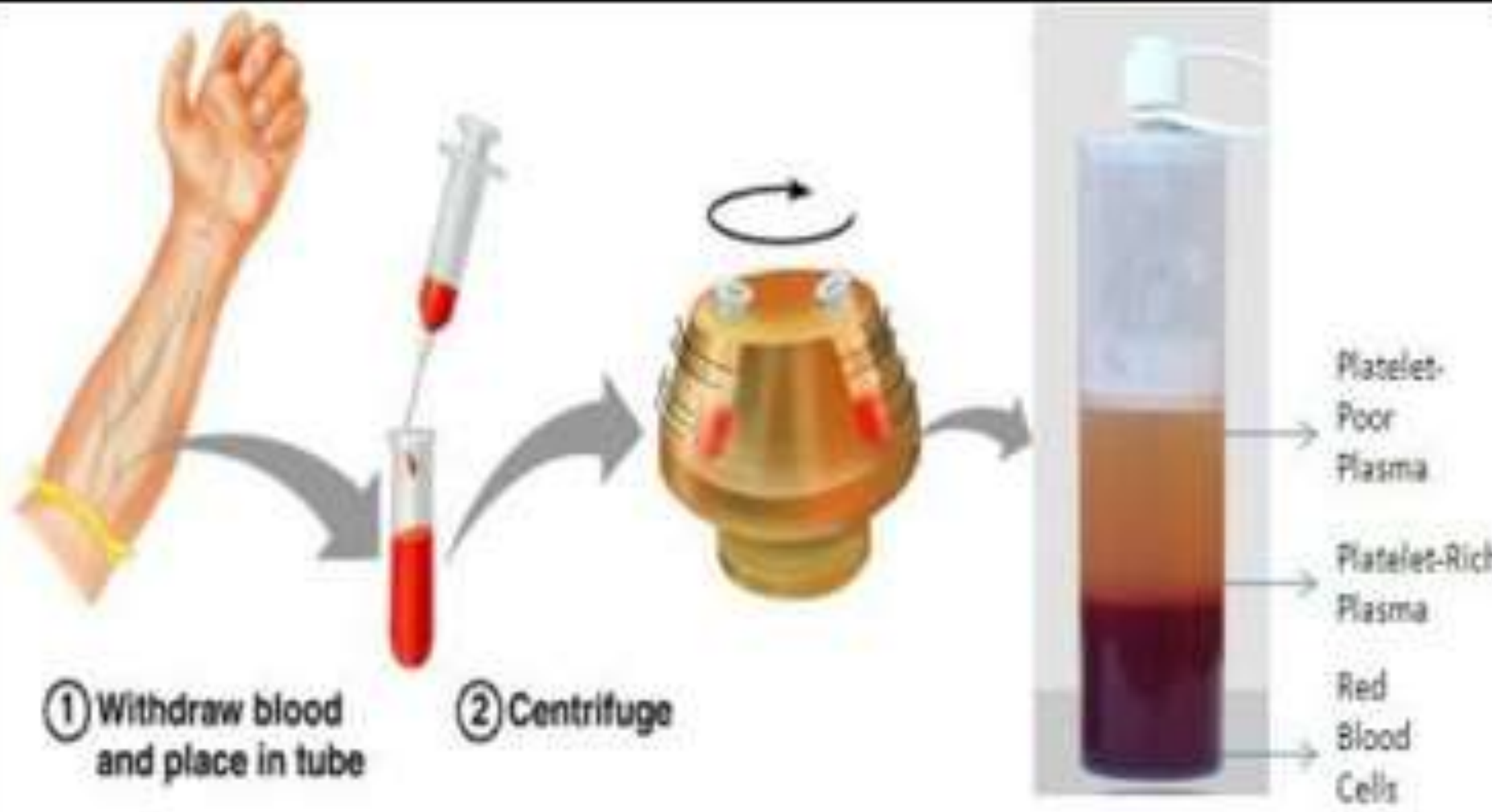
- Necessary substrates in the production of proteoglycans for the formation of cartilage. Supplementation aims at increasing bioavailability of the proteoglycan precursors.
 - Good absorption
 - Excellent safety profile
- Meta-analysis of 15 studies found there were moderate to large improvements in pain and/or mobility
 - Poorly designed studies or had financial support from the manufacturer
- Independent double-blind RCT of more than 1500 patients compared CS&G with placebo + celecoxib did not show a clinically significant improvement.

Biologic Injection Therapies

- Therapies derived from living systems derived from mammalian cell lines to products from a person's own body.
 - Goal: Mitigate progression of osteoarthritis or reverse its process to avoid joint arthroplasty.
 - Examples:
 - Platelet-Rich Plasma (PRP)
 - Mesenchymal Stem Cells (MSC)
 - Bone marrow, amnion, adipose tissue

Platelet-rich plasma may reduce pain and improve function in patients with symptomatic osteoarthritis of the knee. (limited)

- Autologous platelets containing growth factors and cytokines that may inhibit the inflammatory cascades and possibly heal various tissues.
- FDA approved in producing platelet-rich preparations to mix with bone graft materials to help with bone graft handling
 - Off-label use injecting into hip and knee joints.
- Most commonly used form is leukocyte poor and platelet rich plasma as it has been shown to have improved functional outcomes
 - Review of 15 hip and knee RCTs – Journal of knee Surgery 2017



① Withdraw blood and place in tube

② Centrifuge

Platelet-Poor Plasma

Platelet-Rich Plasma

Red Blood Cells

Platelet Rich Plasma

- Meta-analysis found PRP to be more effective in treating pain and improving function than hyaluronic acid in Kellgren-Lawrence grade 2 and 3.
 - Journal of pain medicine 2019
 - No significant difference in pain relief and function between the two groups within the first 3 months after injection however when followed over 1 year, there were significantly better scores.
- RCT involving Kellgren-Lawrence grade 3 and 4 patient comparing PRP with HA showed no difference
 - American journal of sports medicine 2015
- Earlier stage of knee and hip osteoarthritis appear to have improved pain and function scores

Platelet Rich Plasma

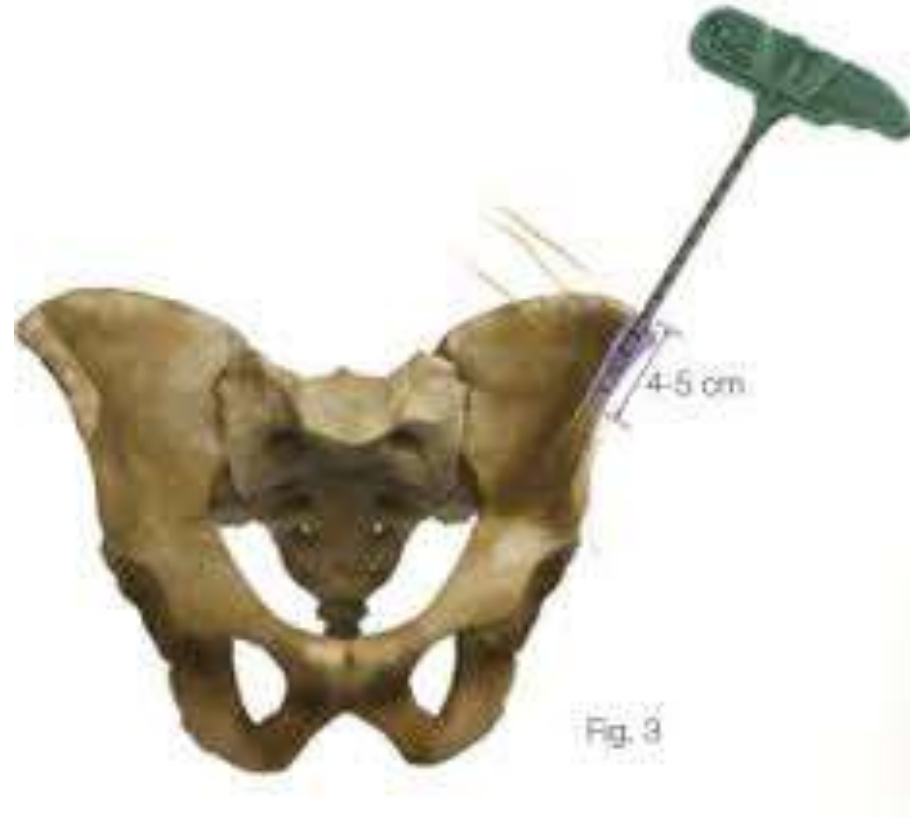
- The variety of outcomes, metrics, study protocols prevents generalizability between studies.
 - Number of injections, timing of injections, quantity of injections
- Future consistent studies may change recommendations for use of PRP in knee and hip osteoarthritis.
- **AAOS Position: Limited Evidence Recommendation - Platelet-rich plasma may reduce pain and improve function in patients with symptomatic osteoarthritis of the knee.**

Mesenchymal Stem Cells (MSCs)

- Bone marrow aspirate concentrate (BMAC) derived
- Adipose-derived stem cells (ADSC)
- Amnion-derived stem cells

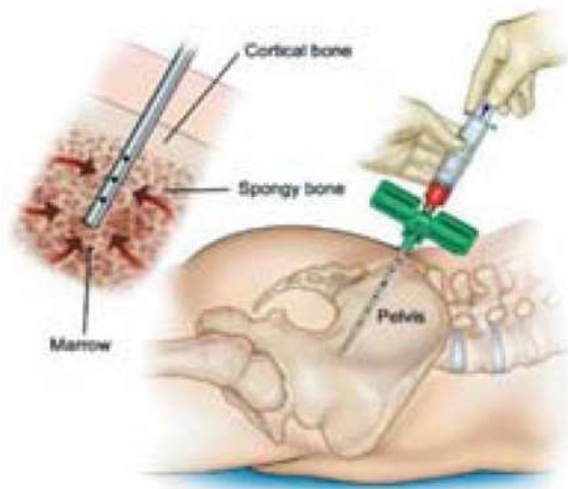
Bone Marrow Aspirate Concentrate (BMAC)

- Prepared by extracting bone marrow percutaneously from iliac crest through a specialized needle.
 - 60-100ml is aspirated



BMAC

- Aspirate is filtered and centrifuged to separate the aspirated fluid into plasma, buffy coat layer and red cell layers.
- MSCs derived from the bone marrow are expanded and then injected into the knee.



Aspirate



Concentrate



Apply to Injury

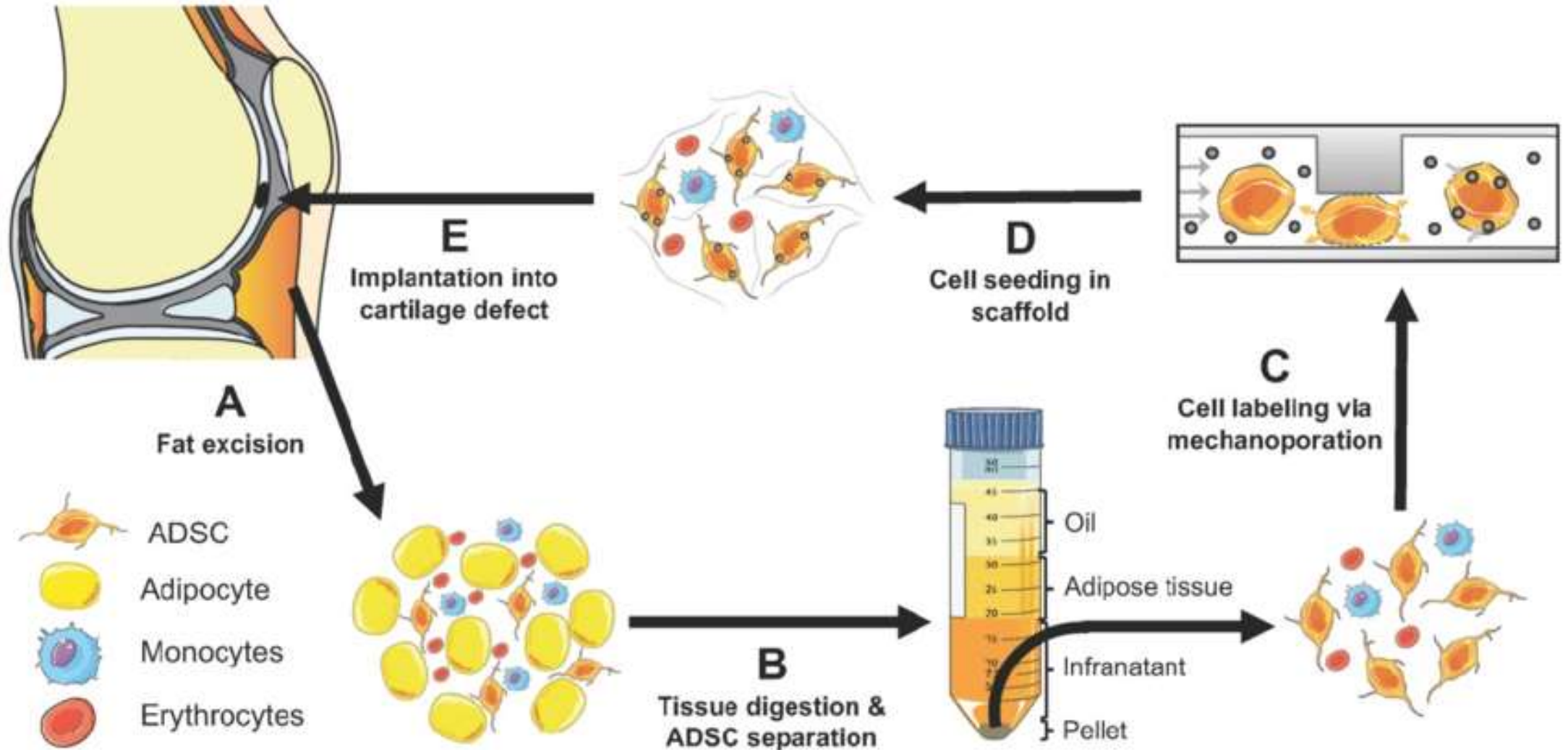
BMAC

- What is the mechanism of BMAC's interaction with hyaline cartilage?
 - We don't know
 - Differentiates into chondrocytes?
 - High concentrations of growth factors (VEGF, platelet derived growth factor, tgf-b) promote repair of cartilage and prevent damage
 - Still considered an investigational treatment

BMAC Clinical Science?

- Science? –
 - 2 RCTs using BMAC derived MSCs versus hyaluronic acid control demonstrated significant improvement in pain and function. No change was noted on radiographic joint space but MRI quality was found to have improved.
 - Journal of translational medicine 2018
 - Journal of transplantation 2015
 - Systematic review of three articles showed improvement in pain and function.
 - Orthopaedic journal of Sports Medicine 2016
 - 1 RCT compared BMAC and placebo and demonstrated no difference in improving pain although they found that both had significant improvements in pain.
 - American Journal of Sports Medicine 2017
- Studies have been plagued with small sample sizes, short-term follow-up, different techniques for BMAC harvesting, differing concentrations of MSCs used, differing frequency of injections, and different forms of outcome measurement

Adipose-Derived Stem Cells (ADSCs)



Adipose-Derived Stem Cells (ADSCs)

- Fat is harvested from the fat pad of the knee or other site
- Collagenase is used to separate out cell types
- Cells are suspended back into a scaffold
- Product is injected into the knee

ADSC Clinical Science?

- 1 RCT of 20 patients showed improvements in VAS scores, WOMAC and mobility scores.
 - Journal of Translational Medicine 2018
- More studies required to consider for expanded use in treatment

Amnion-Derived Stem Cells

- Placental derived MSCs found in amniotic fluid, amnion, chorion, and the umbilical cord
 - Harvested immediate after delivery
- Shown to proliferate more and have improved differentiation potential than MSC sourced from adult tissues
 - Journal of Korean Medical Science 2010

Amnion-Derived Stem Cells

- Not regulated by the FDA
- The amnion-derived MSCs are preserved (concentrated, cryopreserved) and used as a product without living stem cells
- 1 study including single knee injections with an amniotic suspension in K-L grade III and IV osteoarthritis showed improved knee function/pain scores over 1 year period of time.
 - Journal of Knee Surgery 2016

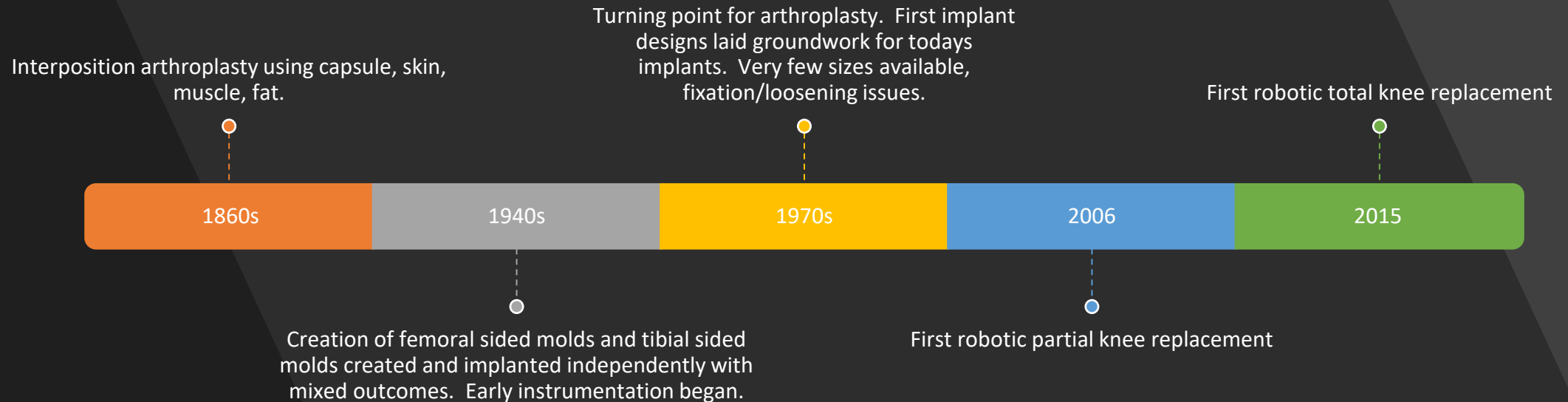
Biologic Therapies Statement

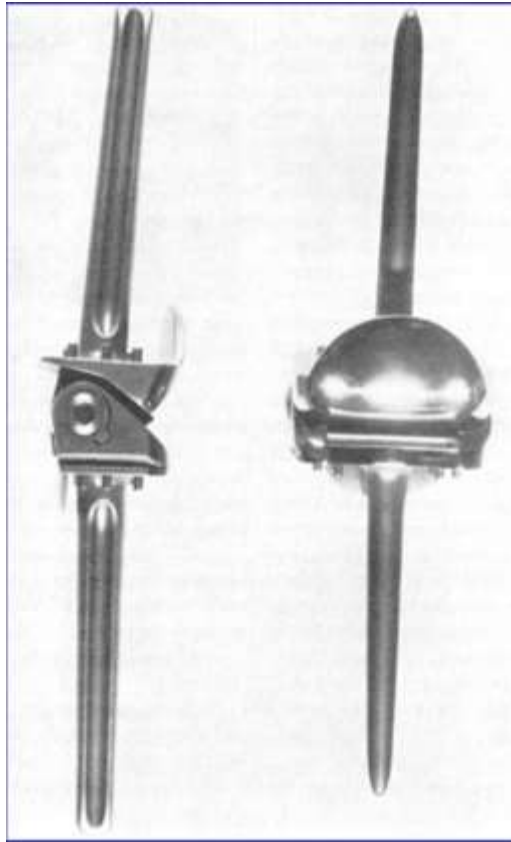
- The American Association of Hip and Knee Surgeons (AAHKS), the Hip Society, and the Knee Society issued a statement in 2019 that biologic therapies may have promising applications in orthopaedics however they **cannot be recommended for advanced hip or knee osteoarthritis at their current level of development.**

Robotic surgery
Advanced pain control
Minimally invasive
surgery
Rapid recovery
programs

What is the state of the
art for knee replacement
procedures?

Knee Replacement Timeline

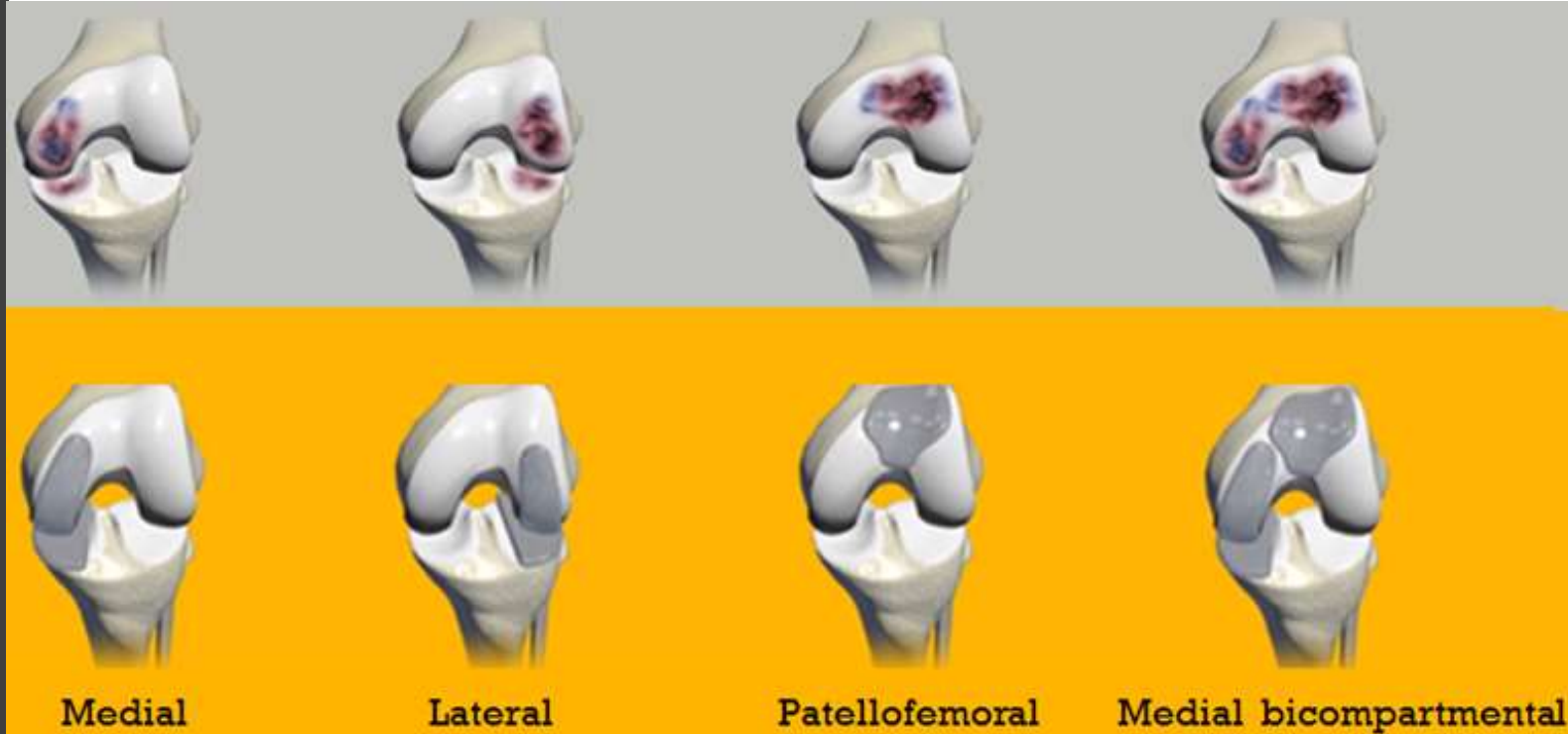




Historical Implants

Partial Knee Arthroplasty

- Partial knee arthroplasty involves removing one or two parts of the knee with worn out cartilage and leaving the healthy ligaments and cartilage in place.



Total Knee Arthroplasty



- Total knee arthroplasty involves removing the areas of diseased cartilage on the end of the femur, tibia, and patella and replacing it with durable implants.

Implant Advances – Cementless Total Knee

- **Why cementless TKA?**
- **Advancements in cementless TKA technology**

Why cementless TKA?

- Challenging patient demographic: younger, more active, living longer, heavier¹
- Cementless TKA showed increased survivorship compared to cemented TKA in
 - Male patients age <65²
 - Heavier patients³
- Shorter operating room time⁴
- Enhanced biomaterials and cementless TKA implant design

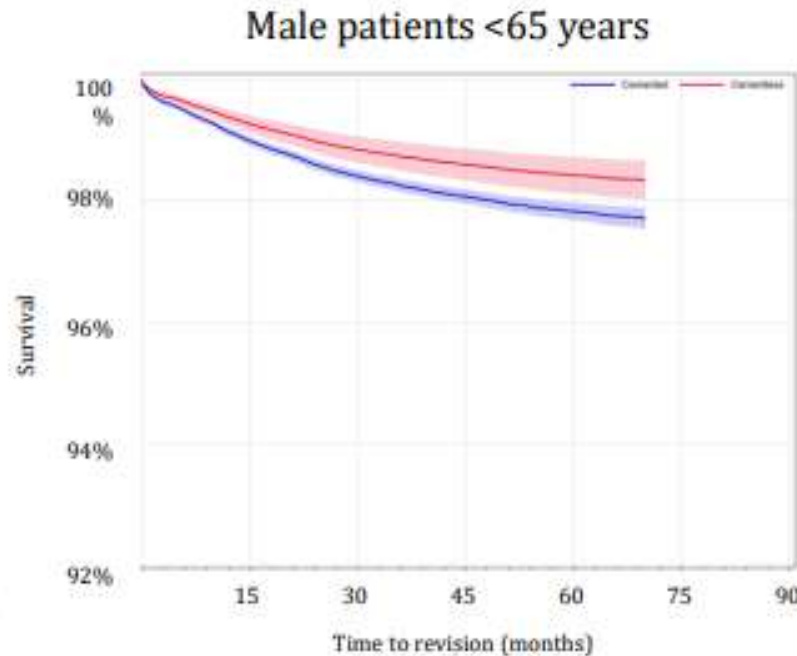
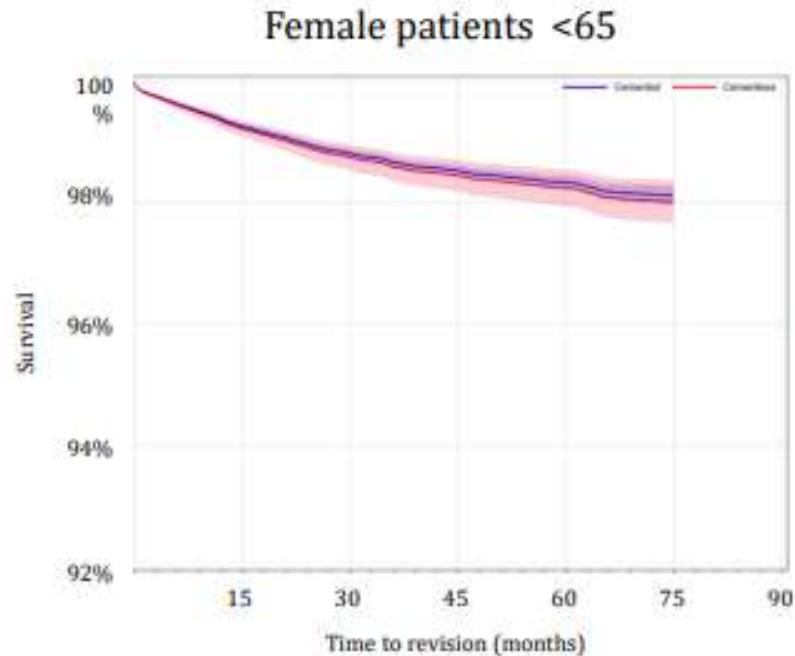


Why cementless TKA?

Enhanced survivorship for younger male patients²

Insights from AJRR 2019 annual report: survivorship of cemented versus cementless primary TKA by patient's age and gender

- Females <65 years showed no difference in survivorship between cemented and cementless TKA
- Males <65 years showed better survivorship with cementless TKA than cemented TKA



— Cemented
— Cementless

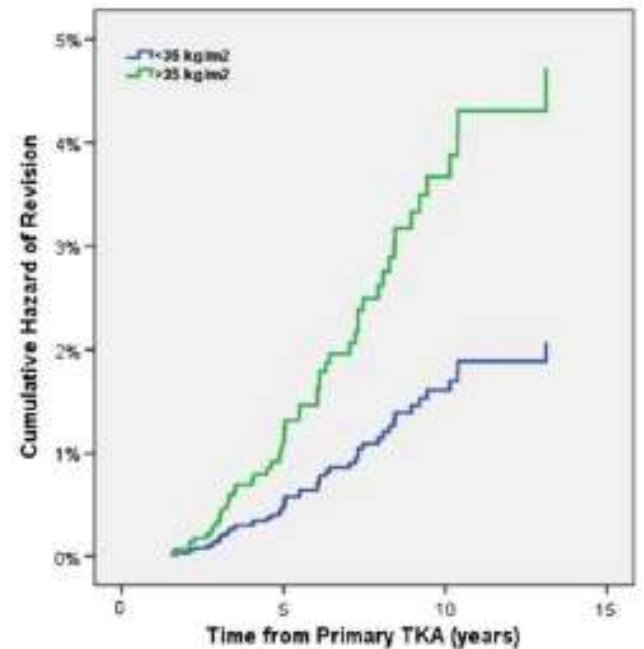
The American Joint Replacement Registry reported male patients younger than 65 years adjusted for age receiving a cementless TKA showed a better survivorship than those who received cemented TKA; however the difference is small (<1%) and does not account for other potential confounders.

Why cementless TKA?

Cemented vs. cementless TKA for obese patients

Mayo Clinic study on well-aligned, cemented TKAs with seven-year follow-up⁵

- Patients experiencing aseptic tibial loosening were younger and had a higher BMI
- Risk for aseptic tibial loosening was almost two times greater for patients with BMI ≥ 35

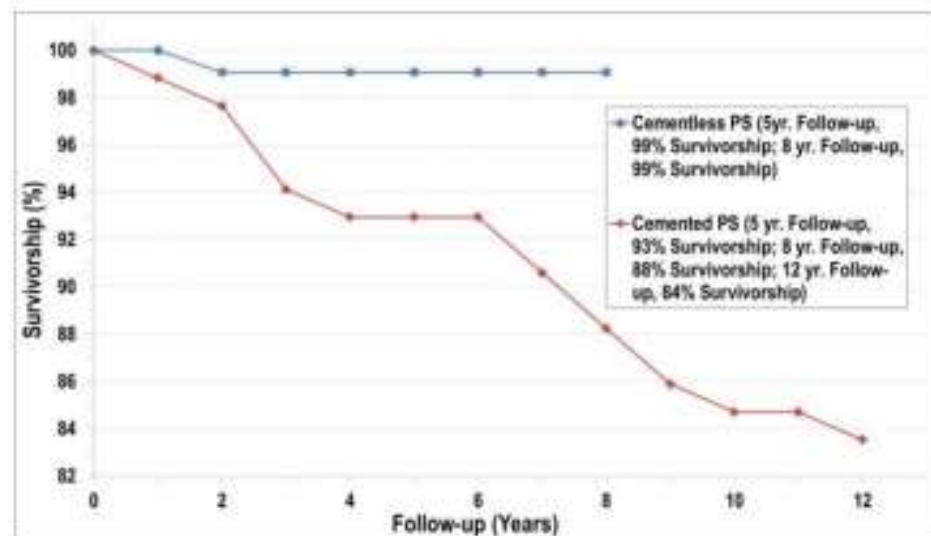


Why cementless TKA?

Cemented vs. cementless Triathlon TKA for obese patients

Cemented vs cementless Triathlon TKA in patients with BMI >40 at eight-year follow-up³

- Beaded Peri-Apatite (PA) femur and beaded PA or Tritanium tibia
- Aseptic survivorship for cemented cohort: 88%
- Aseptic survivorship for cementless cohort: 99%



Why cementless TKA?

AAOS evidence-based clinical practice guideline⁶

Strong evidence supports the use of tibial component fixation that is cemented or cementless in total knee arthroplasty due to similar functional outcomes and rates of complications and reoperations.

[Surgical Management of Osteoarthritis of the Knee](#)

Endorsed by: The Knee Society, SOMOS, AAHKS, ACR, AGS, AANA

★★★★ STRONG EVIDENCE

Robotic Surgery: How It Works

1. Personalized surgical plan



2. Arthritic bone removal

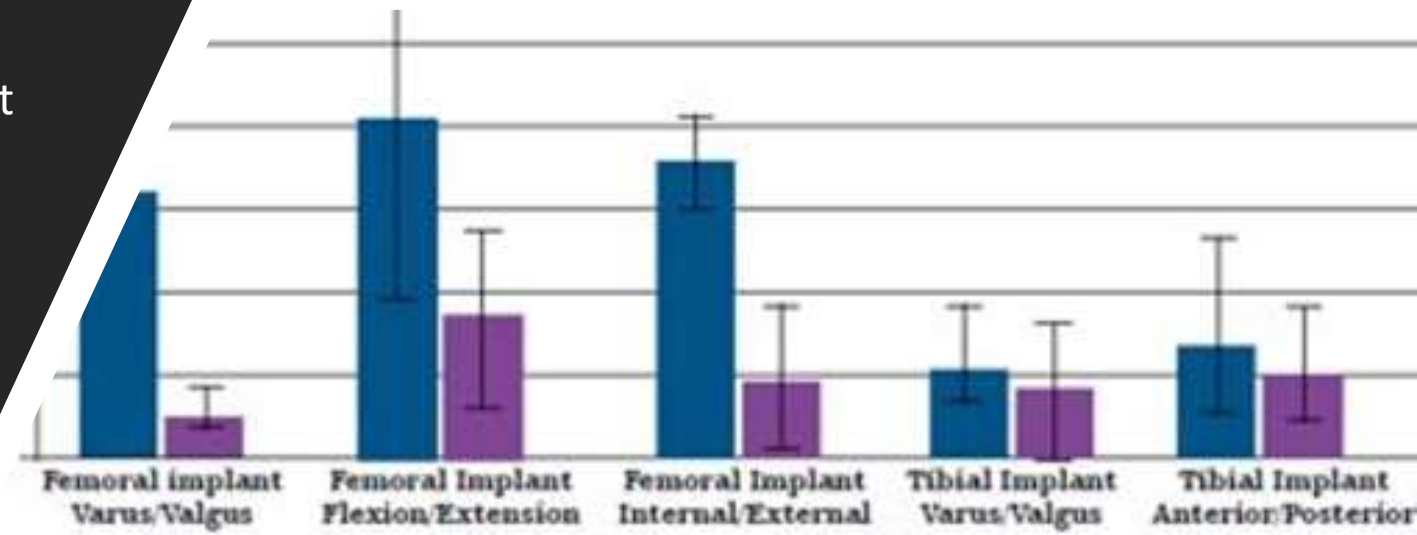


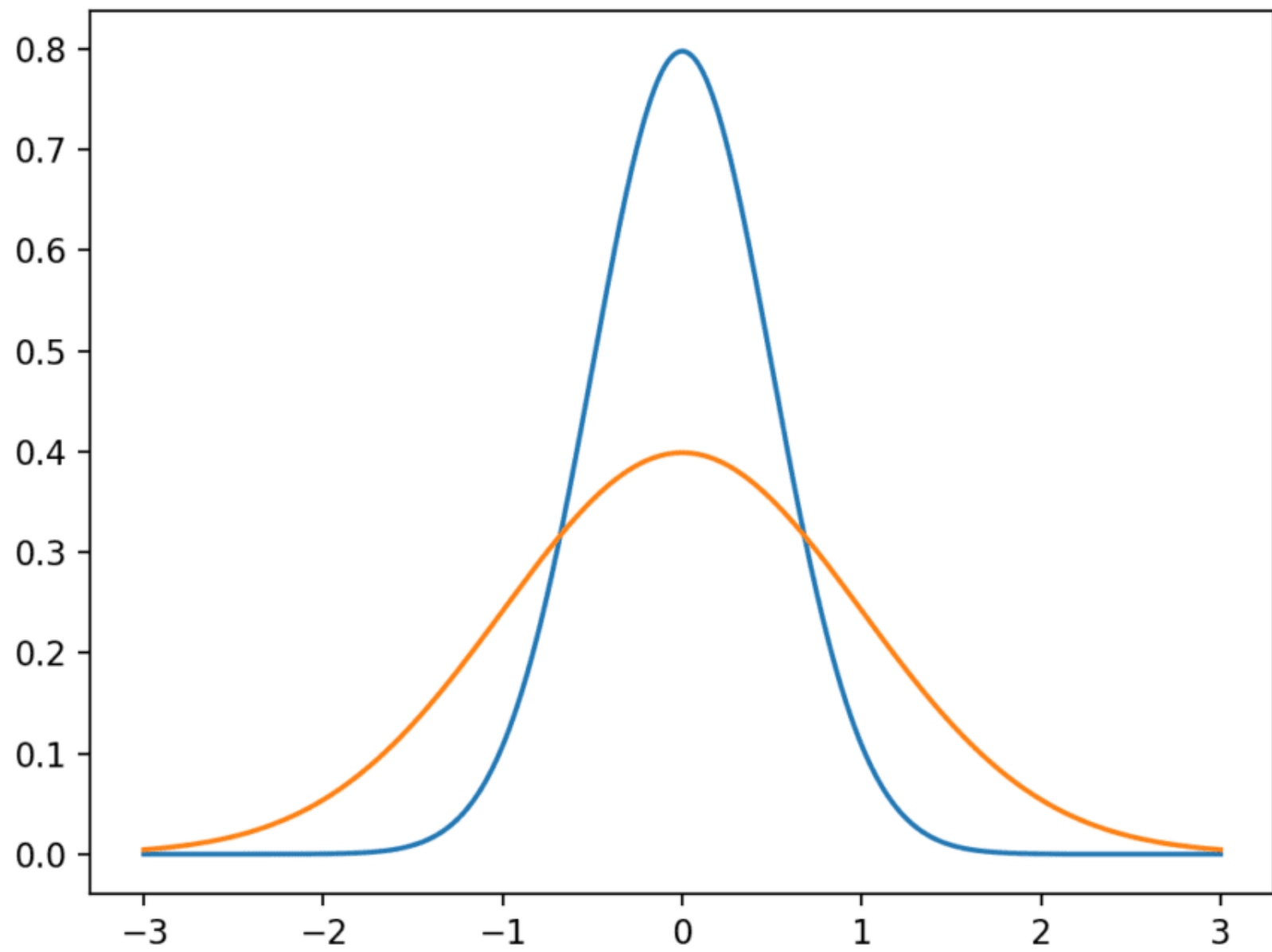
3. Implant trialing and final placement



Why Robotic Surgery?

- CT scan based pre-operative templating allows for extremely precise measurements for implant sizing and position.
 - 96% accuracy of femoral pre-operative templating vs standard x-ray templating ~43.6-68% of cases.
- Minimal ligament and soft tissue releases required to correct even large deformities
- Sub-millimeter accuracy with balancing of the knee
 - Standard instrumented knee replacement alignment was found to be 3 or more degrees malaligned in 32% of cases.
- Plan bone cuts PRIOR to making them



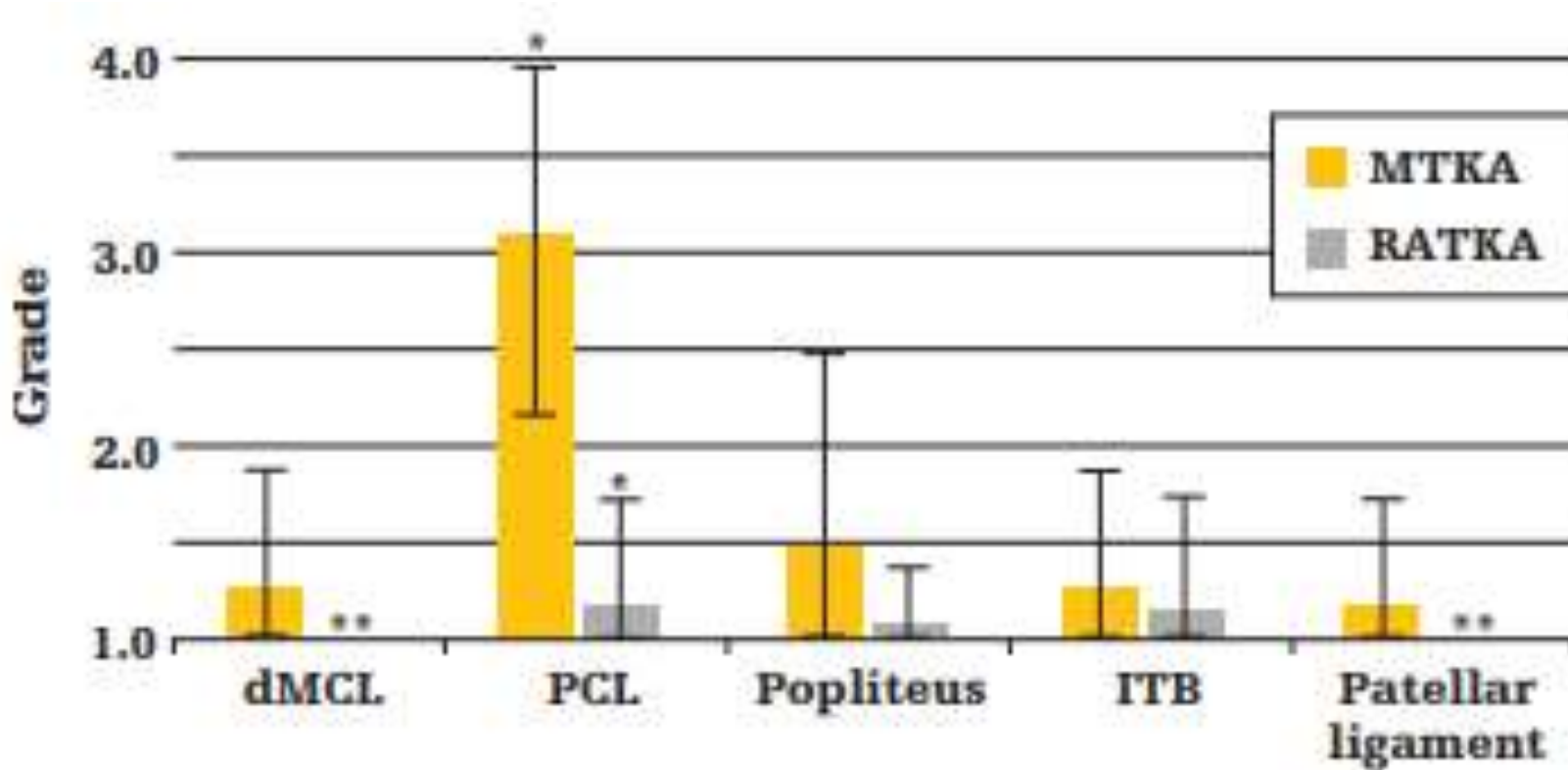




Robotic Surgery

- Less bone and soft tissue damage
 - Journal of Arthroplasty 2018
- Less need for opiate medications
 - Journal of Arthroplasty 2018
- Less time in the hospital
 - The Bone and Joint Journal 2018
- Less admissions to in-patient rehabilitation facilities
- Less post-operative pain
 - The Bone and Joint Journal 2020
- Surgical plans are executed more accurately than conventional systems

Soft Tissue Preservation





State of the Art - Pain Control

- Advances in pain control
 - Ultrasound-guided peripheral nerve blocks
 - Adductor canal blocks/saphenous nerve block
 - iPACK block
 - Local Anesthetic Injections into knee wound
 - Anesthesia medical protocols
 - Corticosteroids
 - Limited narcotics
 - Neuromodulators

Minimally Invasive Surgery (MIS)

- Muscle sparing approaches to total knee replacement
 - Earlier functional recovery
 - Quicker advancement with rehabilitation after surgery
 - Less pain
 - Less blood loss
 - Improved early range of motion

State of the Art

- Rapid recovery programs decrease hospital length of stay
 - 1987 – 21 days
 - 1990s – 12 days
 - 2000s – 4 days
 - 2013 – 2.8 days
 - Now outpatient/23 hour observation in increasing number of cases...

How long does a knee replacement last?

- 82% of total knee replacements lasted at least 25 years

- 72% of partial knee replacements lasted at least 25 years

- Data collected from national registries with 299,291 total knee replacements in 47 registry groups and 7,714 Partial knee replacements in 5 registry groups.

- Lancet Journal February 2019

	Number of series	Total number of arthroplasties at the start of the series	Pooled survival estimate (95% CI)
Total knee replacement			
15 years	15	4137	96.3% (95.7-96.9)
16-8 years	2	228	96.3% (93.5-99.0)
18 years	2	572	93.8% (81.0-96.0)
19 years	2	356	96.1% (92.8-99.4)
20 years	5	763	94.8% (92.5-97.1)
20-8 years	1	160	86.9% (80.4-91.5)
22 years	1	163	82.1% (76.2-88.0)
23 years	1	489	89.0% (82.0-93.0)
Unicondylar knee replacement			
15 years	4	387	85.5% (82.2-88.7)
16 years	1	113	81.3% (67.7-94.8)
20 years	4	437	81.9% (77.8-85.9)
22 years	1	140	84.0% (75.0-93.0)
25 years	1	136	72.0% (58.0-95.0)