



Problem Knees

an artisan's science

Jai Chitnavis MA MChir FRCS
Consultant Orthopaedic Surgeon
The Cambridge Knee Clinic

Senior Demonstrator in Anatomy
University of Cambridge

Stability versus Mobility



Knee problems are common

Knee pain

adults 20%, children 5%

Sports injury

40% are to knees. (Majewski 2006)

Osteoarthritis OA

2% > 55ys need knee replacement. (Tennant 1995)

Number of Operations in UK, 2012, (NJR/HESS)

Knee arthroscopies	80,000
Hip replacements	90,000
Knee replacements	100,000 (97% for OA)

Evolution of Knee Structure

- Preservation
- Bipedalism
- Rotation



Christs 1828-1831

Triceratops



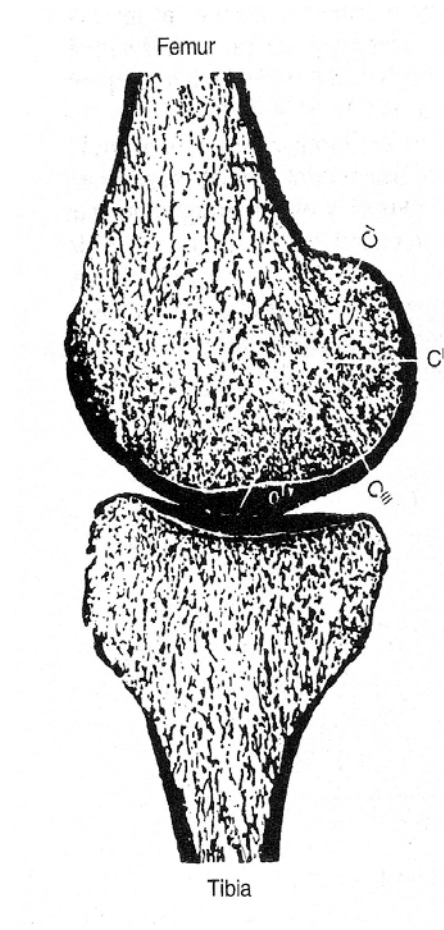
Sabre Tooth Tiger



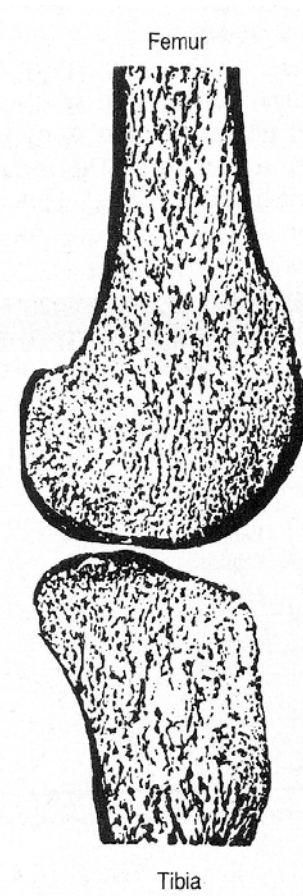
Chimpanzee



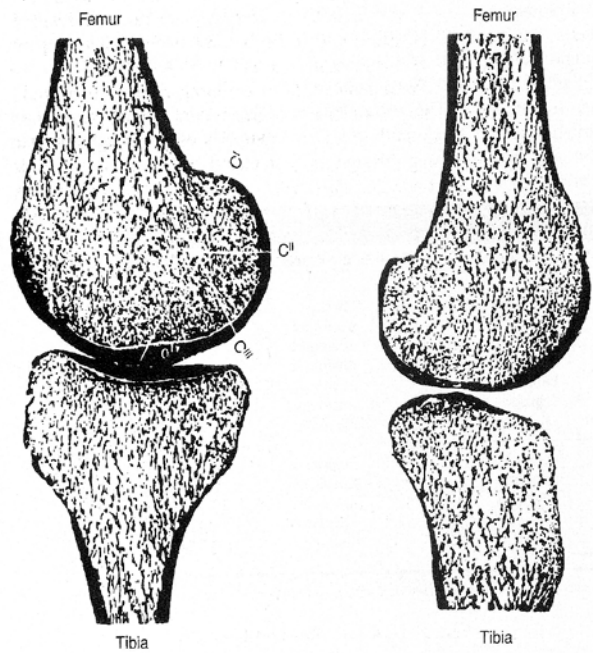
Medial Condyle



Lateral Condyle



Weber Brothers
1836



Webers 1836

Medial Condyle

Lateral Condyle

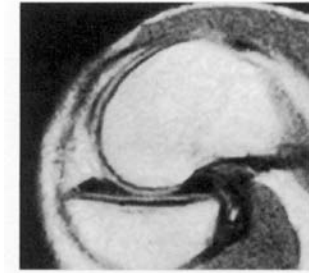


Fig. 2a



Fig. 2b

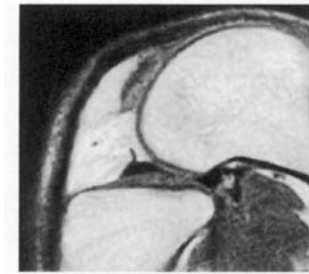


Fig. 2c

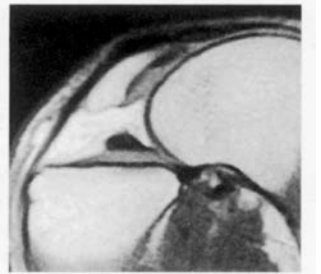
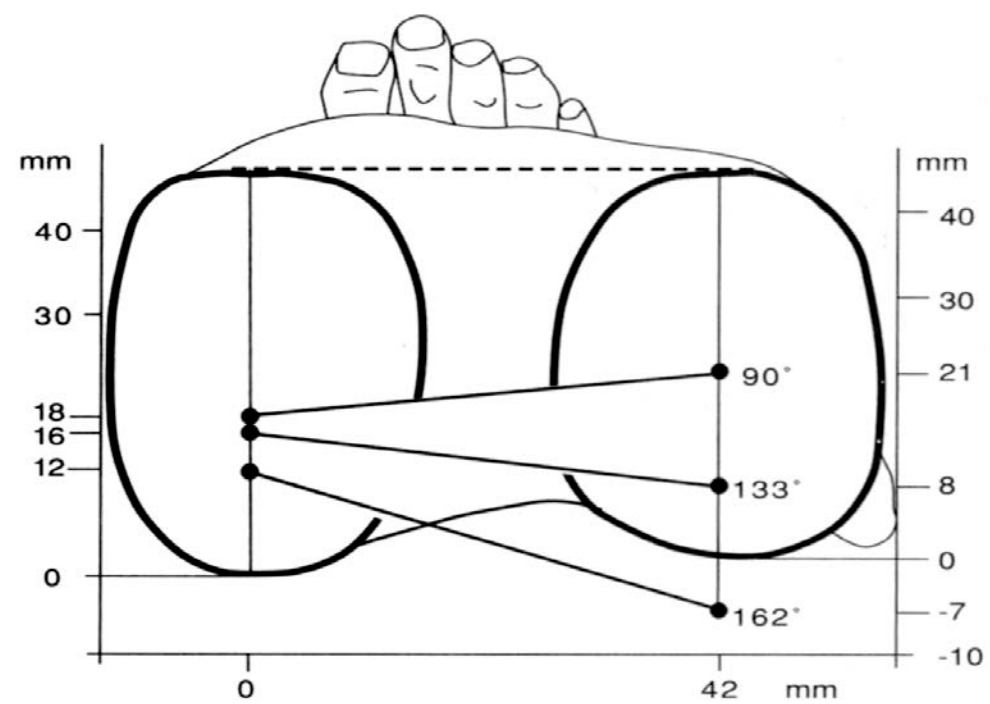
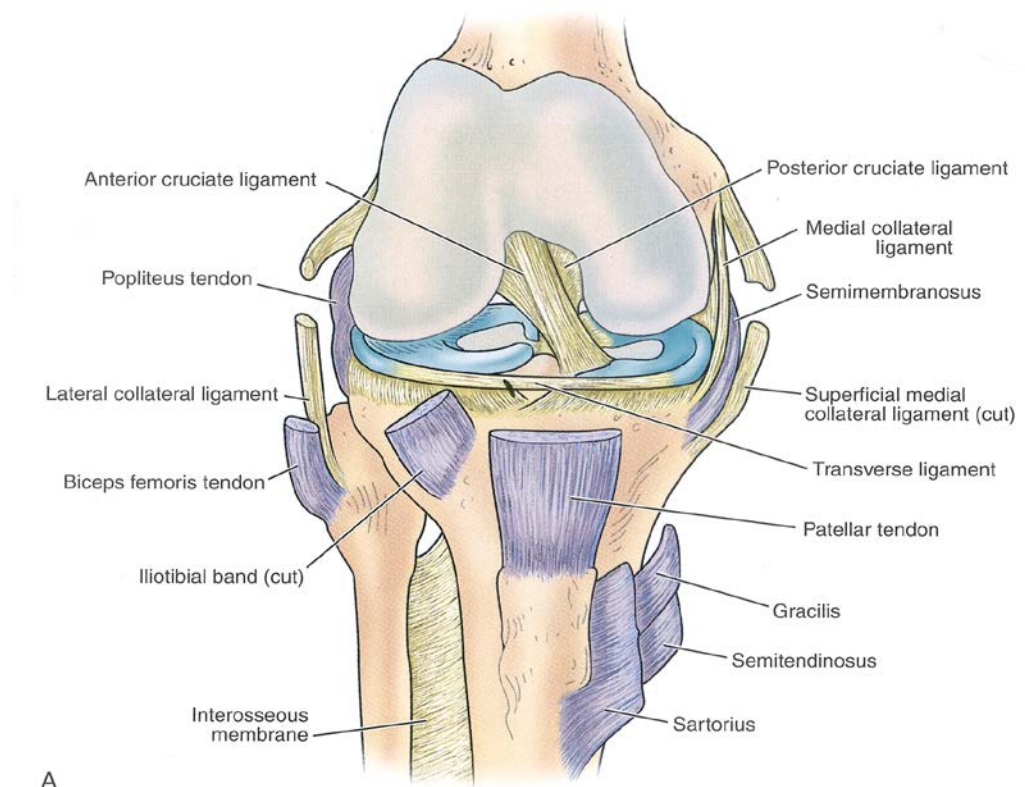


Fig. 2d

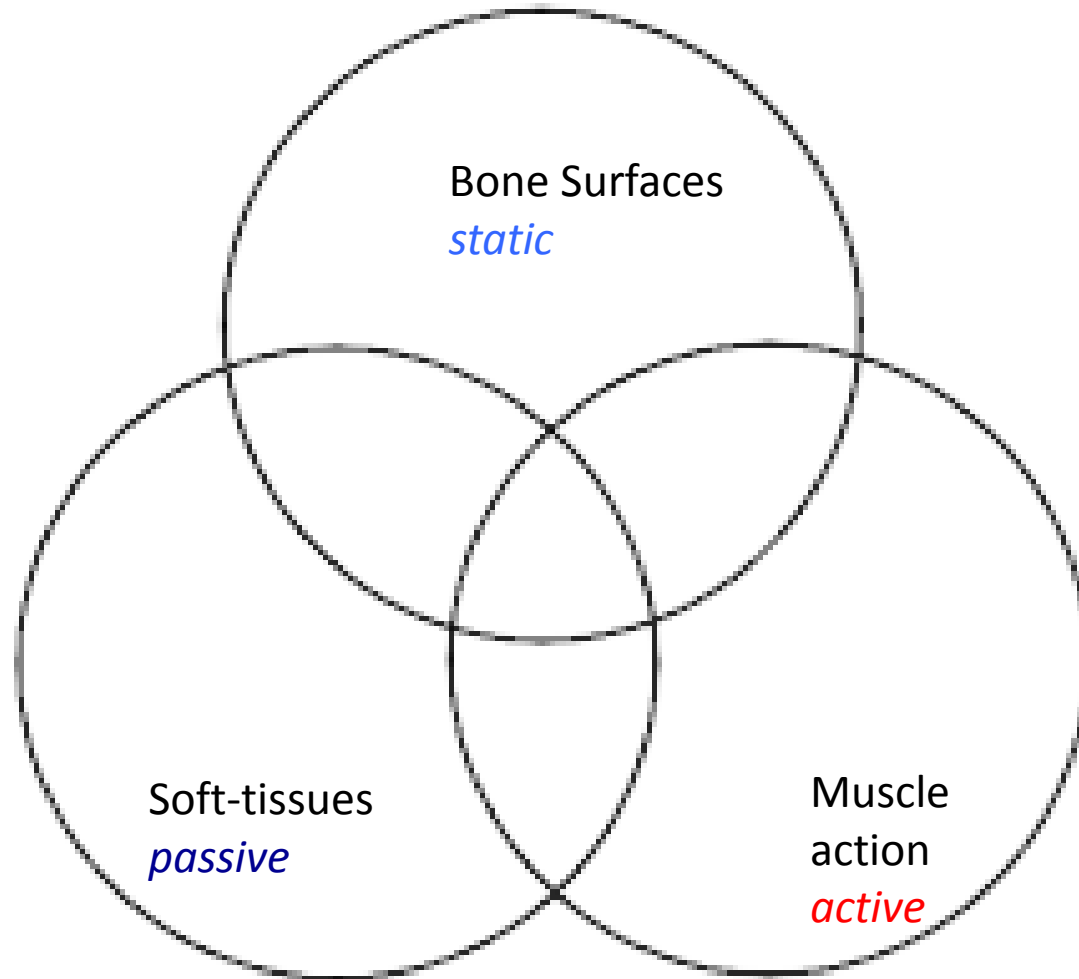
Pinskerova et al 1999



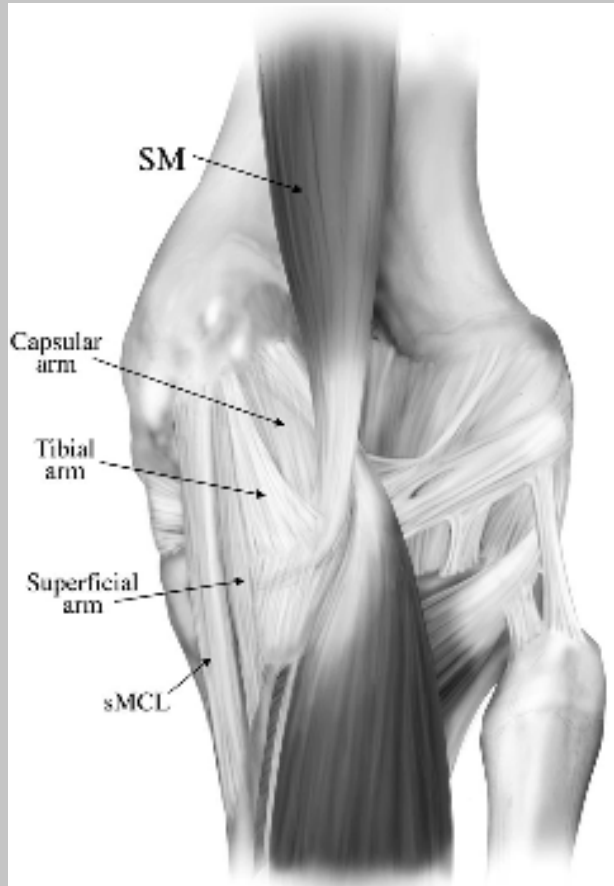


A

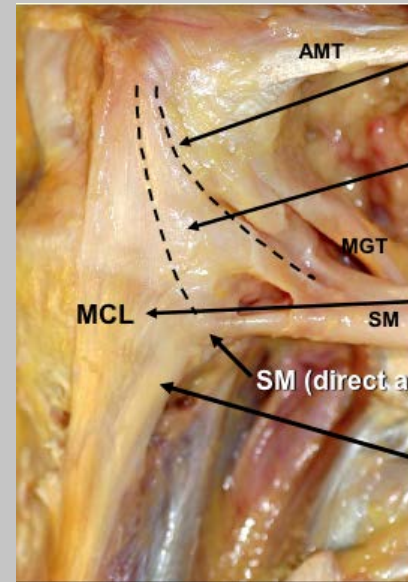
Stability and Mobility



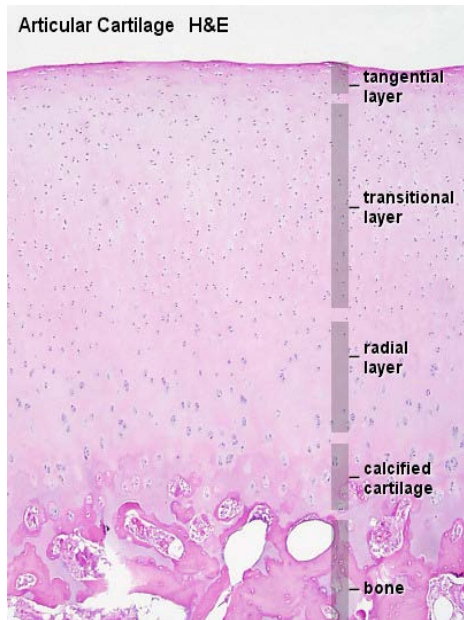
Stability and Mobility : multi-factorial and collaborative



Posterior view

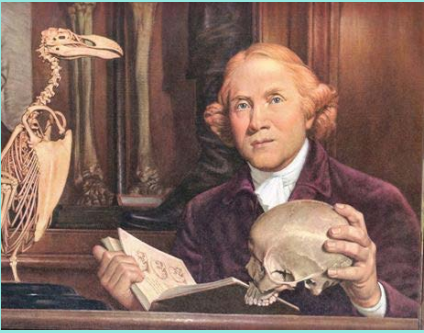


Articular cartilage

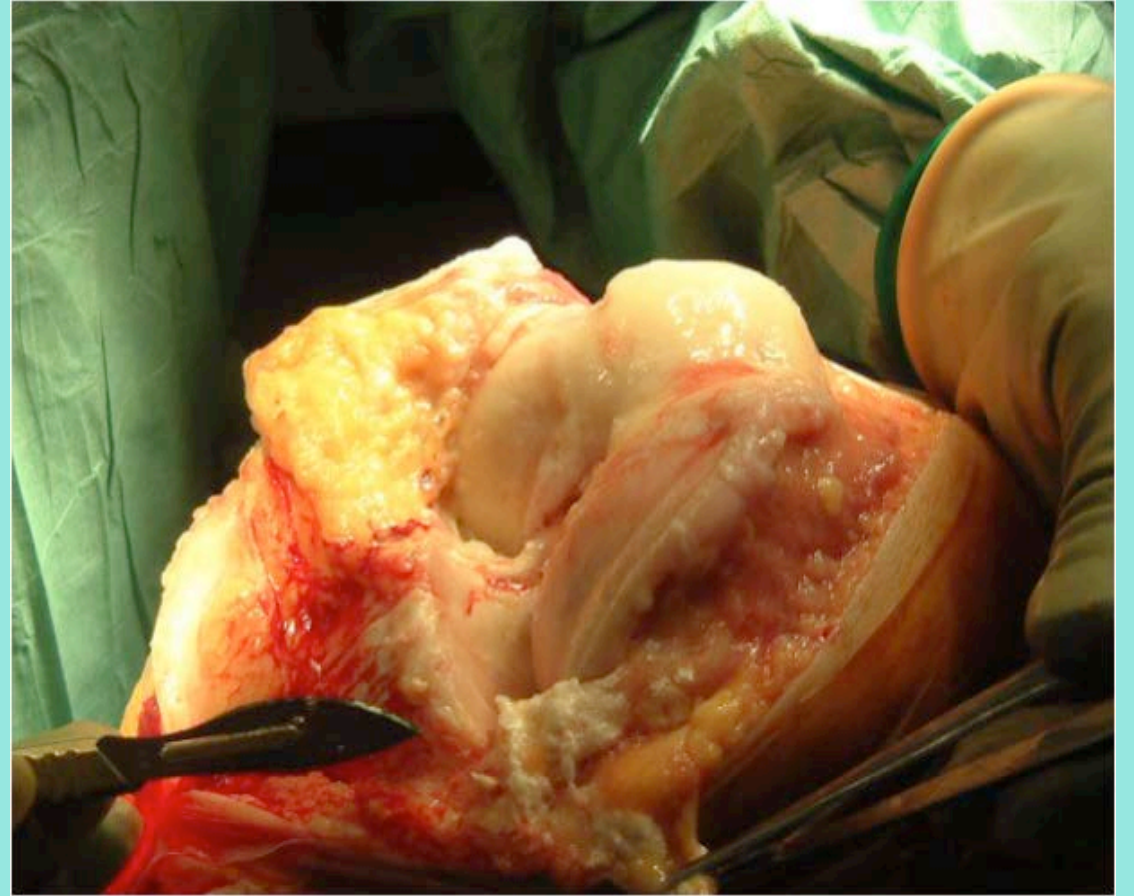


- Low friction
- Fibre-enforced gel
- Avascular
- Cannot regenerate





*"From Hippocrates to the present age
we shall find that ulcerated cartilage is universally...
a very troublesome disease"*
JOHN HUNTER 1743



Osteoarthritis

‘Wear and tear’



**THE GENETIC EPIDEMIOLOGY OF
SEVERE SYMPTOMATIC
OSTEOARTHRITIS
OF THE HIP AND KNEE**



A THESIS SUBMITTED TO THE
UNIVERSITY OF CAMBRIDGE
IN CANDIDATURE FOR THE DEGREE OF
MASTER OF SURGERY (M CHIR)

by
JAISINGH PRABHAKAR CHITNAVIS
M.A. M.B.BChir.
FRCS FRCSEd.

CHRIST'S COLLEGE CAMBRIDGE

LENT TERM 2000



An Oxfordshire shepherd known to have painful knees stands beside his grandson in 1922.

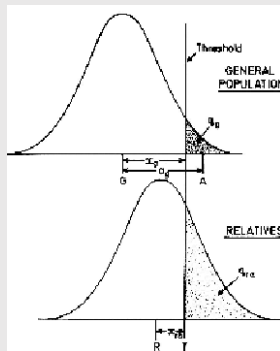


The grandson's knees, 1989, prior to bilateral knee replacement for idiopathic osteoarthritis.

Relative risk to siblings (λ_s)

$$\lambda_s = \frac{\% \text{ Siblings with Total Joint Replacement for idiopathic OA}}{\% \text{ Spouses with Total Joint Replacement for idiopathic OA}}$$

<i>Total joint replacement</i>	<i>Number of probands</i>	<i>Relative risks to all 1,171sibs and 376 spouses (95% CI)</i>	<i>Relative risks to sibs and spouses over 64 years (95% CI)</i>	<i>Heritability (h²)</i>
<i>TJR</i>	402	1.98 (1.11-3.51)	2.32 (1.22-3.69)	31% (all relatives)
<i>THR</i>	281	1.78 (0.92-3.45)	1.86 (0.93-3.69)	27% (all relatives)
<i>TKR</i>	121	4.8 (0.64-36.4)	Insufficient numbers	Insufficient numbers



h²= additive genetic variance
total phenotypic variance

a measure of the extent to which parental characteristics are transmitted to their children

Medical Condition / Topic	Heritability Est.	References
Acne	81%	[PMID 12485434]
Age-related macular degeneration	49 - 71%	[PMID 9869796]
Alcoholism	50 - 60%	[PMID 19785977]
Alzheimer's disease	58 - 79%	[PMID 16461860]
Androgenic alopecia (females)	80%	[PMID 18849991]
Anorexia nervosa	57 - 79%	[PMID 19828139]
Asthma	30%	[PMID 16117840]
Autism	30 - 90%	[PMID 17033636]
Bipolar disorder	70%	[PMID 14601036]
Bladder cancer	7 - 31%	[PMID 21927616]
Blood pressure, diastolic	49%	[PMID 19858476]
Blood pressure, systolic	30%	[PMID 22479213]
Body mass index	23 - 51%	[PMID 25383972,
Bone mineral density	44 - 87%	[PMID 15750698,
Breast cancer	25 - 56%	[PMID 11979442,
Celiac disease	57 - 87%	[1]
Celiac disease	57 - 87%	[PMID 16354797]
Cervical cancer	22%	[PMID 11979442]
Colon cancer	13%	[PMID 11979442]
Coronary artery disease	49%	[PMID 15710764]
Crohn's disease	53%	

OA: *not* random 'wear and tear'

Symmetrical disease

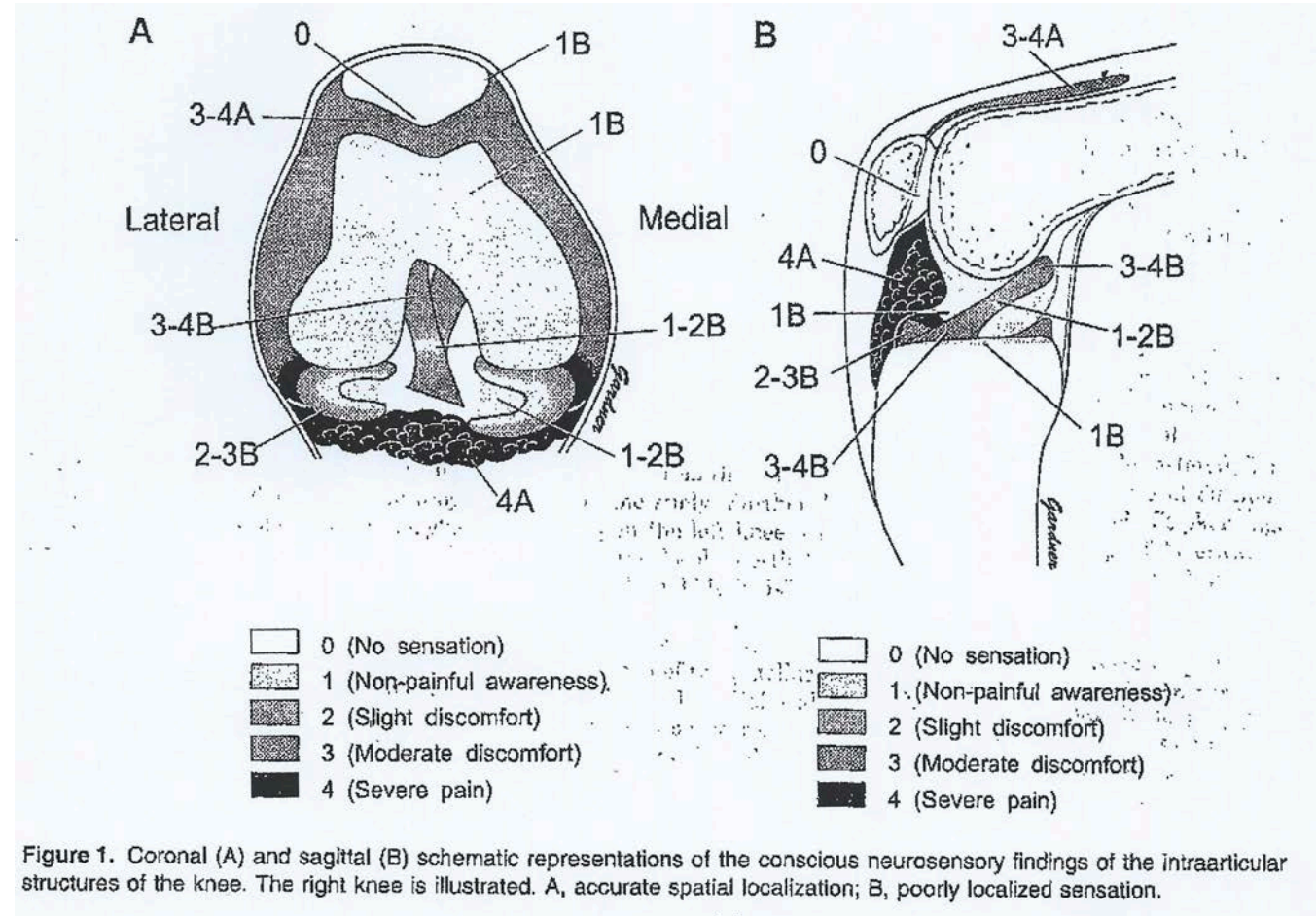


Nodal arthropathy

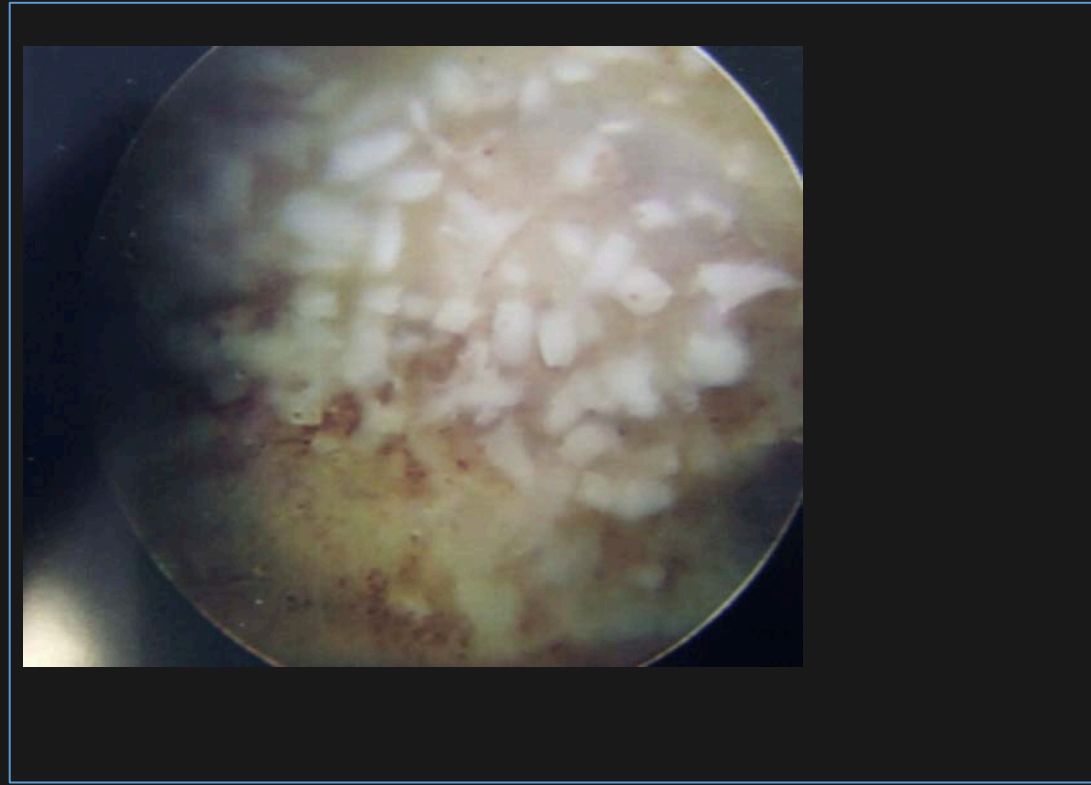


Subtle deformities

Source of pain in OA



Synovium peppered with fragmented articular cartilage



Knee Arthritis: Symptoms

- Pain
- Function
 - Walking
 - Stair-climbing
 - (activities of daily living)

Post-Op Exam - _____ Date: 5/27/1960 (Male) 293095
 Dr. J. Chalmers

Clinical Evaluation Sheet

Diagnosis: OA ☐ RA ☐ Polyarthrosis ☐
 Today's Date: 5/24/60 P.A. ☐ AVN ☐ Patella OA ☐
 Date of Operation: _____ Infection ☐ Trauma ☐ Fractured Prosthesis ☐
 Inst. _____ Loose Prosthesis ☐ Other ☐

Pain	R	L	Reductions	R	L
None	30	30	Flexion Contracture		
Mild	45	45	5-10 degrees	-2	-2
Stairs Only	40	40	11-15 degrees	-5	-5
Moderate	30	30	16-20 degrees	-10	-10
Occasional	20	20	> 20 degrees	-15	-15
Continued	10	10	Extensor Lag		
Severe	0	0	Less than 10 degrees	-5	-5
Range of Motion		0-130	11-20 degrees	-10	-10
Subtract 1 point for every 5 degrees lost (0-125)		75	> 20 degrees	-15	-15
Stability			Alignment		
Anterior/Posterior			5-10° Valgus	0	0
Less than 1mm	10	10	0-5/11-15° Valgus	-5	-5
5-10mm	5	5	> 15° Valgus/any Varus	-20	-20
10mm	0	0	Asymmetry		
Modiolateral			One Cond.	-5	-5
Less than 1mm	15	15	Two Cond.	-10	-10
4-8mm	10	10	Crankiness/Walk	-20	-20
10-14mm	5	5			
> 14mm	0	0			
Function					
Walking Unlimited	30	30			
After 10 Blocks	40	40			
5-10 Blocks	30	30			
Below 5 Blocks	20	20			
Household	10	10			
Unable to walk	0	0			
Stairs					
normal up & down	30	30			
up & down w rail	40	40			
up & down	30	30			
up, unable down	15	15			
unable	0	0			
Subtotal					

TOTAL SCORE 140

Effusion 140 Y / N

Complications

DVT: _____

Infection: _____

Prosthesis Complications: _____

Medical Complications: _____

Weight: _____ kg / lb

Arthritis: Signs

Stiffness



Alignment





Tablets



Arthroscopy

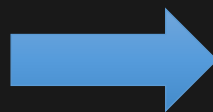


Osteotomy

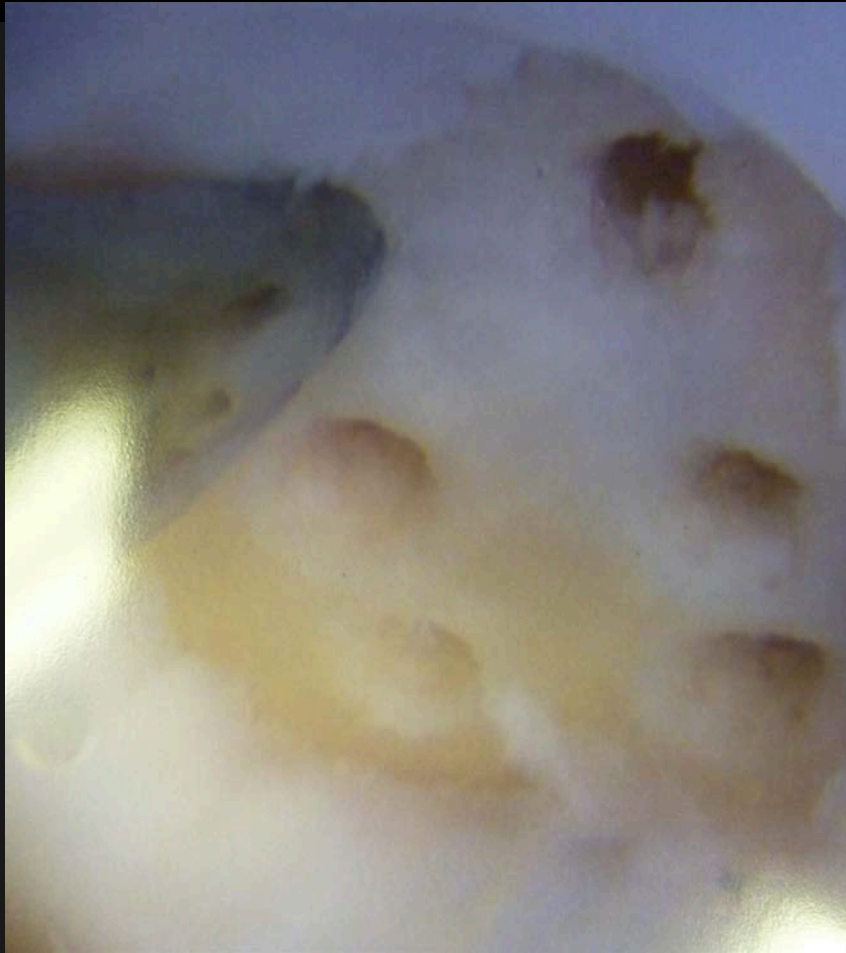


Partial or total knee replacement

Arthroscopic removal of loose cartilage

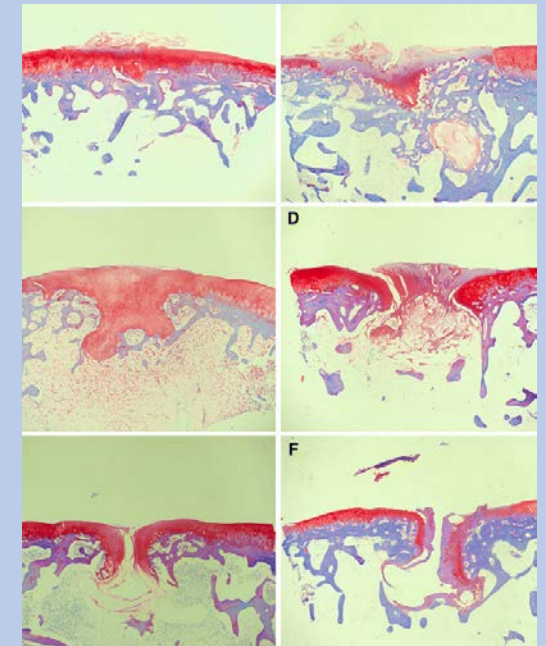
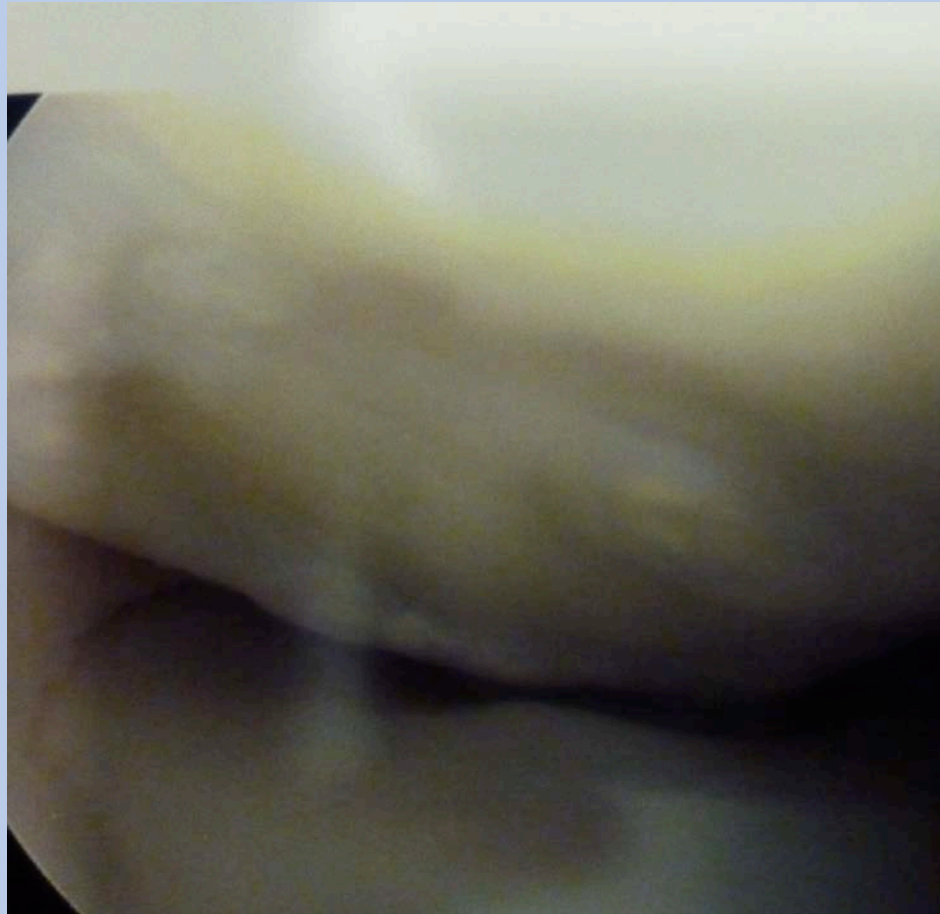


Microfracture



Stem cells?!

One year after microfracture



June 2013

'Half an hour with a drill meant I didn't need a new knee'



JOHN



We may be close to a tipping point where the weight of evidence against arthroscopic knee surgery for pain is enough to overcome concerns about the quality of the studies, confirmation bias, and vested interests

Arthroscopic surgery for degenerative knee disease

Overused, ineffective, and potentially harmful

Andy Carr professor and director, Botnar Research Centre, Oxford University Institute of Musculoskeletal Sciences, NIHR Oxford Musculoskeletal Biomedical Research Unit, Oxford OX3 7LD, UK andrew.carr@ndorms.ox.ac.uk

The most frequent indication for knee arthroscopy is degenerative joint disease in middle aged and older patients. Each year, more than 700 000 knee arthroscopies are done in the United States and 150 000 in the United Kingdom.¹ Magnetic resonance imaging evidence of meniscal abnormality, osteophytes, cartilage damage, and bone marrow lesions is often present. All these imaging abnormalities are common in the general population and are often asymptomatic.² The evidence base for arthroscopic surgery is known to be weak, and a pressing need exists for more high quality multicentre randomised controlled trials, systematic reviews, and meta-analyses to inform clinicians and improve care for patients.³ Researchers have already reported that trials of arthroscopic surgery find no benefit over control interventions ranging from exercises to placebo surgery.⁴

A linked paper by Thorlund and colleagues adds substantially to the debate by systematically reviewing all the evidence on arthroscopic knee surgery for middle aged and older adults with knee pain and degenerative knee disease.⁵ The authors report that the small benefit seen after arthroscopic surgery of the knee is short lived and disappears within one to two years.

In the light of this evidence, why is arthroscopy still so common? It even seems to be increasing in both North America and Europe.⁶⁻⁷ Is the published evidence flawed? This is certainly the view of some surgeons, including the editors of the journal *Arthroscopy* who believe that "the *New England Journal of Medicine* is biased against knee surgery."⁸ In the journal's defence, the available evidence is certainly of low quality in places. Only two of the nine trials reviewed by Thorlund and colleagues were adequately blinded, and many of the other trials had a high risk of bias. In five of the nine trials, the comparator was exercise therapy that was poorly described and given at a suboptimal dose.

Ask Leo Tolstoy



Close to the tipping point?

or entrenched attitudes. Such bias is not new and was well described by Leo Tolstoy in 1899: "I know that most men not only those considered clever, but even those who are very clever, and capable of understanding most difficult scientific, mathematical, or philosophic problems can very seldom discern even the simplest and most obvious truth if it be such as to oblige them to admit the falsity of conclusions they have formed, perhaps with much difficulty conclusions of which they are proud, which they have taught to others, and on which they have built their lives."¹⁰

One thing is clear from all randomised trials: patients improve after arthroscopy. This is in line with surgeons' own observations and with evidence from uncontrolled observational studies. However, in robust and bias-free trials that use placebo controls, active treatment works no better than control treatment. In response, leaders of the arthroscopic surgery community have asserted that patients who participate in placebo controlled trials "may not be of entirely sound mind" and that "ethically, sham surgery is a questionable research method, which may be harmful."⁹

A recent systematic review of the use of placebo in surgical trials shows that in more than half of these studies surgery had no greater effect than a placebo.¹¹ This review also reported that very few harms occurred after placebo surgery. Placebo surgery was safer than the treatment under investigation. These findings make a strong case for the use of placebo controls when a placebo effect may be present and for the discontinuation of procedures

in pain is the main justification for the procedure. Placebo effects can be modified and substantially enhanced by a variety of factors that alter beliefs and expectations.¹²

Importantly, Thorlund and colleagues also review the harms associated with arthroscopic knee surgery. They were unable to identify harm from randomised trials alone because the trials were too small, so they did a wider review including observational studies. These studies were heterogeneous and inconsistent, but the risks associated with non-surgical treatment including exercises are clearly rare and minor. Harms associated with arthroscopic surgery are also rare but include serious adverse events such as deep venous thrombosis, infection, pulmonary embolus, and death.

Supporting or justifying a procedure with the potential for serious harm, even if this is rare, is difficult when that procedure offers patients no more benefit than a placebo. If, as reported, the mortality associated with arthroscopic knee surgery is 0.96 (95% confidence interval 0.04 to 23.9) per 1000 cases and the rate of deep venous thrombosis is 4.13 (1.78 to 9.60) per 1000 cases then, with rates of surgery at their current level, a substantial number of lives could be saved and deep venous thromboses prevented each year if this treatment were to be discontinued or diminished.

We may be close to a tipping point where the weight of evidence against arthroscopic knee surgery for pain is enough to overcome concerns about the quality of the studies, confirmation bias, and vested interests. When that point is reached, we should anticipate a swift reversal of established



¹University of Southern Denmark, Department of Sports Science and Clinical Biomechanics, Campusvej 55, 5230 Odense M, Denmark

²Department of Orthopedics, Copenhagen University Hospital, Gentofte, Denmark

³Department of Orthopedics and Traumatology, Odense University Hospital, Odense, Denmark

⁴Department of Orthopedics, Clinical Sciences Lund, University of Lund, Sweden

Correspondence to: J B Thorlund
jthorlund@health.sdu.dk

Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bmj.h2747>)

Cite this as: *BMJ* 2015;350:h2747
doi: 10.1136/bmj.h2747

Accepted: 22 April 2015

Arthroscopic surgery for degenerative knee: systematic review and meta-analysis of benefits and harms

J B Thorlund,¹ C B Juhl,^{1,2} E M Roos,¹ L S Lohmander^{1,3,4}

ABSTRACT

OBJECTIVE

To determine benefits and harms of arthroscopic knee surgery involving partial meniscectomy, debridement, or both for middle aged or older patients with knee pain and degenerative knee disease.

DESIGN

Systematic review and meta-analysis.

MAIN OUTCOME MEASURES

Pain and physical function.

DATA SOURCES

Systematic searches for benefits and harms were carried out in Medline, Embase, CINAHL, Web of Science, and the Cochrane Central Register of Controlled Trials (CENTRAL) up to August 2014. Only studies published in 2000 or later were included for harms.

ELIGIBILITY CRITERIA FOR SELECTING STUDIES

Randomised controlled trials assessing benefit of arthroscopic surgery involving partial meniscectomy, debridement, or both for patients with or without radiographic signs of osteoarthritis were included. For harms, cohort studies, register based studies, and case series were also allowed.

RESULTS

The search identified nine trials assessing the benefits of knee arthroscopic surgery in middle aged and older patients with knee pain and degenerative knee disease. The main analysis, combining the primary endpoints of the individual trials from three to 24 months postoperatively, showed a small difference in favour of interventions including arthroscopic surgery compared with control treatments for pain (effect size 0.14, 95% confidence interval 0.03 to 0.26). This difference corresponds to a benefit of 2.4 (95% confidence interval 0.4 to 4.3) mm on a 0-100 mm visual analogue scale. When analysed over time of

follow-up, interventions including arthroscopy showed a small benefit of 3-5 mm for pain at three and six months but not later up to 24 months. No significant benefit on physical function was found (effect size 0.09, -0.05 to 0.24). Nine studies reporting on harms were identified. Harms included symptomatic deep venous thrombosis (4.13 (95% confidence interval 1.78 to 9.60) events per 1000 procedures), pulmonary embolism, infection, and death.

CONCLUSIONS

The small inconsequential benefit seen from interventions that include arthroscopy for the degenerative knee is limited in time and absent at one to two years after surgery. Knee arthroscopy is associated with harms. Taken together, these findings do not support the practise of arthroscopic surgery for middle aged or older patients with knee pain with or without signs of osteoarthritis.

SYSTEMATIC REVIEW REGISTRATION

PROSPERO CRD42014009145.

Introduction

Arthroscopic knee surgery with meniscus resection is common for middle aged or older people with persistent knee pain.^{1,3} The knees of these patients often show "degenerative" lesions of cartilage, meniscus, and other tissues, suggestive of osteoarthritis. However, population based studies using magnetic resonance imaging show that incidental findings of such lesions are also very common among people without knee symptoms and among those without plain radiographic signs of osteoarthritis, suggesting that the clinical significance of such findings is unclear.⁴⁻⁶ All but one of the nine randomised clinical trials to date of arthroscopic surgery in middle aged or older people with persistent knee pain failed to show an added benefit of interventions including arthroscopic surgery over a variety of control treatments.⁷⁻¹⁵ Uncertainty thus exists about the benefit of arthroscopic surgery including meniscus resection for these patients. However, many specialists are convinced of the benefits of the procedure from their own experience,¹⁶⁻¹⁹ and several recent reports show an increase, or no decrease, in the incidence of arthroscopic knee surgery with meniscus resection during the past decade.^{3,20-23} The arthroscopic procedures discussed here are reported to be associated with adverse events, including deep venous thrombosis, infections, cardiovascular events, pulmonary embolism, and death.²⁴⁻²⁶

The balance of benefits and harms weighs importantly in the choice of treatment. To inform the choice of treatment for these patients, we did a comprehensive, up to date systematic review and meta-analysis of the benefits and harms of arthroscopic surgery

WHAT IS ALREADY KNOWN ON THIS TOPIC

Arthroscopic knee surgery is frequently and increasingly used to treat middle aged and older patients with persistent knee pain

All but one published randomised trials have shown no added benefit for arthroscopic surgery over that of the control treatment, but many specialists are convinced of the benefits of the surgical intervention

WHAT THIS STUDY ADDS

Interventions that include arthroscopy are associated with a small benefit and with harms; the small benefit is inconsequential and of short duration

The benefit is markedly smaller than that seen from exercise therapy as treatment for knee osteoarthritis

These findings do not support the practice of arthroscopic surgery as treatment for middle aged or older patients with knee pain with or without signs of osteoarthritis

Knee surgery 'waste of time', researchers argue

Arthroscopic Knee Surgery Shows No Long-term Benefit

Thumbs Down on Arthroscopic Knee Surgery

Benefits may be dubious for many arthroscopic knee surgery patients

Keyhole knee surgery 'does little good and could kill patients'

Does knee surgery do more harm than good?

Arthroscopic knee surgery offers no lasting pain benefit

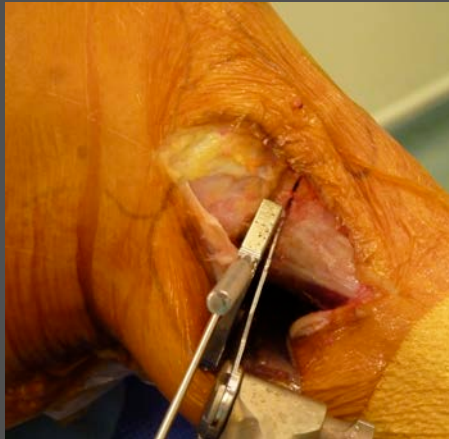
Outcomes

Of 80 arthroscopic partial menisectomies undertaken in those of middle age or older in 2012.....

9 (11%) had undergone knee replacement by 2015.

Osteotomy: re-aligning the knee

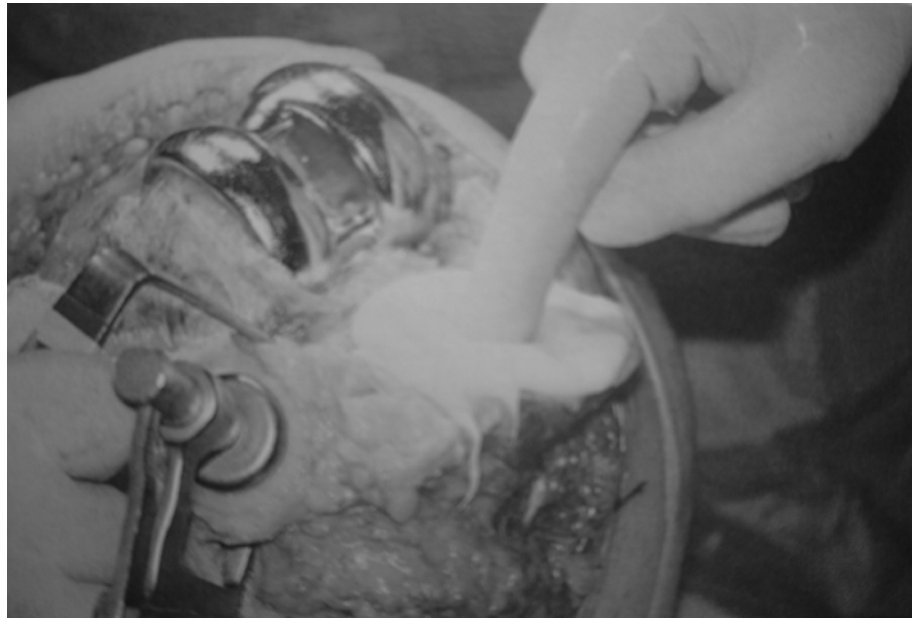
run, jump, ski



Hinged, stemmed



Condylar design



Early cementing methods



Stability versus mobility.....





Partial knee 'replacement'

'Uni-compartmental' OA

Bone conserving

Recovery

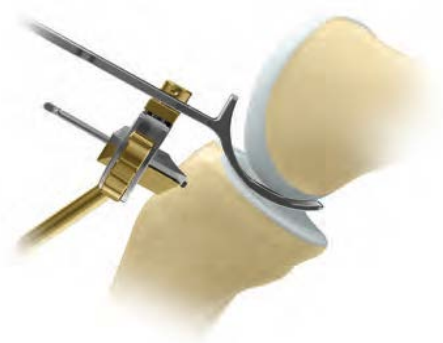
Longevity

Revision



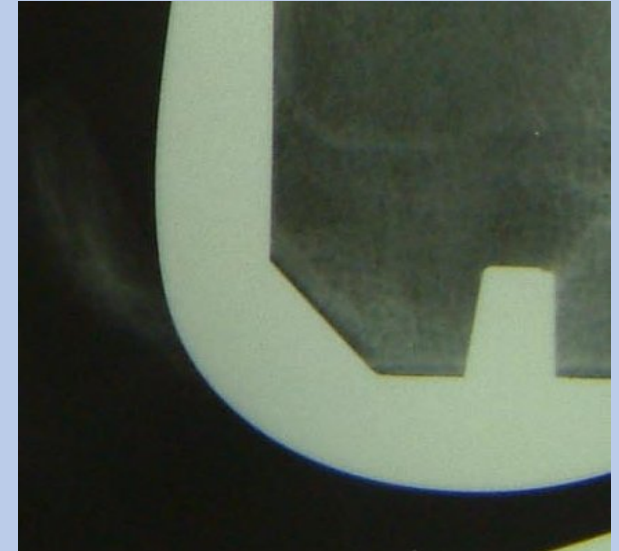
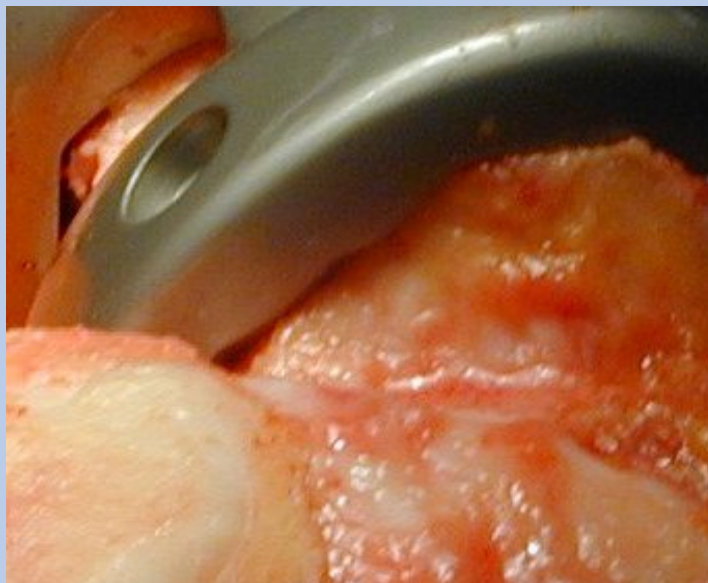
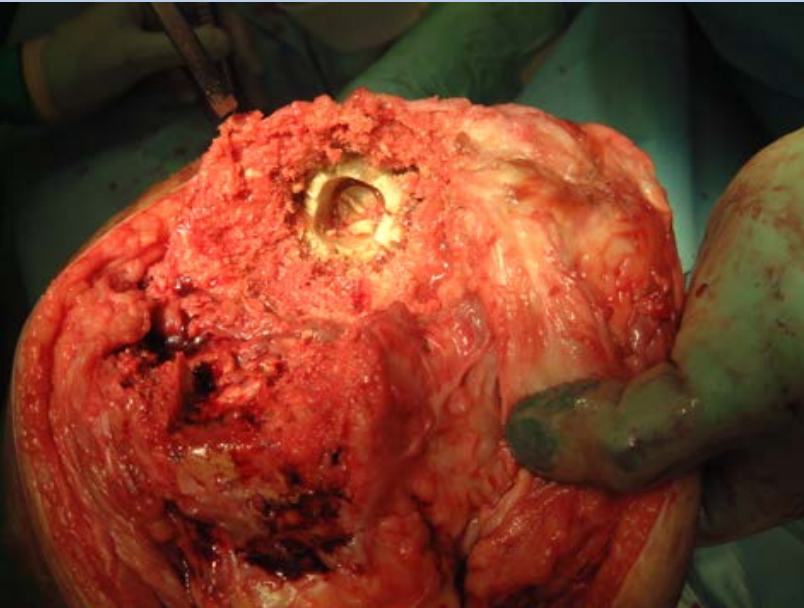
Advances in Arthritis Surgery

Partial 'replacements' using precision jigs



Advances in Arthritis Surgery:

Cementless implants coated with
Hydroxyapatite $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$



Hydroxyapatite coated:
partial knee replacement



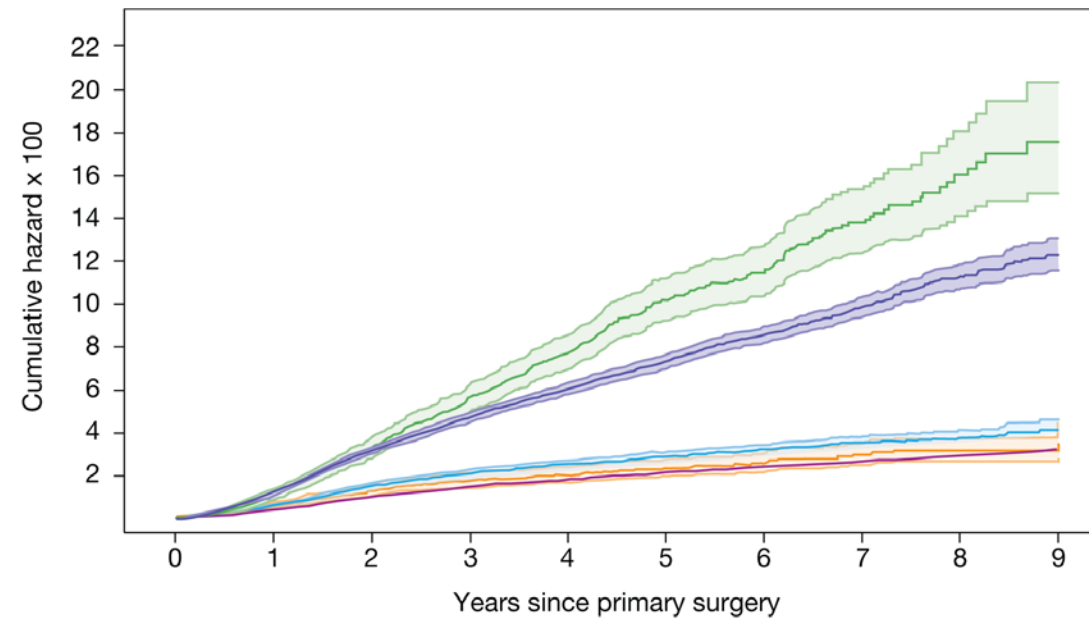
total knee replacement



How long do they last ?

Figure 3.6

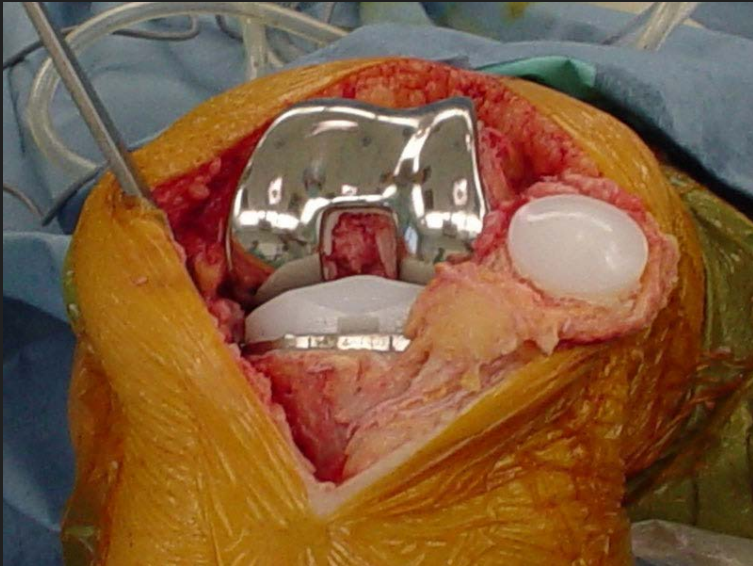
Cumulative hazard (x100) of a first revision for different types of primary knee replacement at increasing years after the primary surgery (with 95% CI).



Numbers at risk

Cemented	490,939	413,315	337,600	267,439	202,689	142,760	91,079	54,676	25,627	7,913
Uncemented	31,382	28,199	24,441	20,415	15,975	11,425	7,320	4,369	2,142	670
Hybrid	7,307	6,845	6,295	5,471	4,508	3,504	2,595	1,778	896	280
Patello-femoral	7,881	6,679	5,361	4,181	3,071	2,028	1,202	712	335	105
Unicondylar	51,474	44,107	36,376	28,915	21,999	15,428	9,918	5,825	2,762	828

How good are knee replacements?



85% pain free

60% return to full work

50% forget it's artificial

Best to avoid jumping and running

'Strong as an ox with half the brain'.....



Orthopaedic Surgeon

References

- Bollen S. Injuries of the sporting knee. Epidemiology of knee injuries: diagnosis and triage. British Journal of Sports Medicine. 2000. 227-228.
- Majewski M, Susanne H, Klaus S. Epidemiology of athletic knee injuries: A 10 year study. Knee 2006 Jun;13(3):184-8.
- Schindler O. Synovial plicae of the knee. Current Orthopaedics 18, 210-219. 2004.
- Jackson AM. Anterior knee pain. Journal of Bone and Joint Surgery (Br) 83-B(7) Sept 2001.
- Klenerman, L. Human anatomy. A very short introduction. Oxford University Press. 2015.
- Karel Hamelynck. The history of Total Knee Replacement. Vinenzezgruppe.at
- Borja MJ et al. Prefemoral fat pad impingement syndrome: identification and diagnosis. American Journal of Orthopedics. January 2013. E9-E11.
- Dye SF, Vaupel GL and Dye CC. Conscious neurosensory mapping of the Human knee without intra-articular anaesthesia. American Journal of Sports Medicine 1998 Nov-Dec;26(6):773-7.
- Tennant A et al. Prevalence of knee problems in the population aged 55 and over: identifying the need for knee arthroplasty. BMJ 1995 May 20;310(6990):1291-1293.
- Wright G, Chitnavis J. Which design of Total Knee Replacement – does it matter? Bone and Joint Journal. 2011.
- Cerejo R et al. The influence of alignment on risk of knee osteoarthritis progression according to baseline stage of disease. Arthritis and Rheumatism. 46(10);2632-2636 October 2002.
- Cross MJ, Dixon P, Chitnavis J, Parish EN. Key Engineering Materials 240-242:857-58. 2003.
- Chitnavis Jai. Is the evidence for popular knee operations scandalously poor? BMJ 2015;350.