
The Outcome of Revision Knee Arthroplasty

Mr Paul Baker

Consultant Orthopaedic Surgeon

James Cook University Hospital, Middlesbrough, UK

&

Honorary Clinical Senior Lecturer

University of Durham, UK

Importance

- Increasing revision burden
 - 2009 to 2010: 13.5% increase in Revision TKR in US (Kurtz 2014)
- Increasing scrutiny
 - GIRFT / NJR
- Expensive
 - The mean cost of revision for infection = £30 011 and aseptic revision = £9655 *Kaballa – BJJ 2015;97-B:197–201*

GETTING IT RIGHT FIRST TIME

Improving the Quality of Orthopaedic Care
within the National Health Service in England

Increasing burden

Year of revision surgery	Number of revision joint operations of each revision stage type per year (% of all revision joint operations in a year)			Total revision joint operations
	Single stage	Stage one of two-stage	Stage two of two-stage	
2003*	520 (82.5)	2 (0.3)	108 (17.1)	630
2004	928 (76.0)	80 (6.6)	213 (17.4)	1,221
2005	1,469 (73.6)	212 (10.6)	314 (15.7)	1,995
2006	1,932 (75.1)	283 (11.0)	359 (14.0)	2,574
2007	2,589 (74.7)	388 (11.2)	489 (14.1)	3,466
2008	3,265 (75.4)	474 (10.9)	592 (13.7)	4,331
2009	3,628 (75.9)	527 (11.0)	625 (13.1)	4,780
2010	4,097 (76.8)	574 (10.8)	665 (12.5)	5,336
2011	4,249 (77.1)	615 (11.2)	647 (11.7)	5,511
2012	4,910 (78.3)	624 (10.0)	739 (11.8)	6,273
2013	4,555 (78.0)	624 (10.7)	660 (11.3)	5,839
2014	4,580 (78.0)	658 (11.2)	635 (10.8)	5,873
All years	36,722	5,061	6,046	47,829

Problem - Interpretation is difficult

- Heterogeneous
- Low level evidence - No RCTs
- Unstandardised outcomes
- Procedures performed in small numbers



It's not like TKR analysis

- TKR group is consistently consistent:
 - 97% OA (Varus), 94% cemented, 93% fixed bearing (NJR)
- Revision group is more varied:
 - Indication, Surgical procedure, Number of previous revisions

Heterogeneous cohort!

Table KT6: Primary Total Knee Replacement by Reason for Revision

Reason for Revision	Number	Percent
Loosening/Lysis	3473	29.7
Infection	2536	21.7
Patellofemoral Pain	1540	13.2
Pain	1042	8.9
Instability	690	5.9
Arthrofibrosis	435	3.7
Fracture	289	2.5
Patella Erosion	282	2.4
Malalignment	265	2.3
Wear Tibial Insert	186	1.6
Incorrect Sizing	166	1.4
Metal Related Pathology	165	1.4
Other	635	5.4
TOTAL	11704	100.0

Table KT7: Primary Total Knee Replacement by Type of Revision

Type of Revision	Number	Percent
TKR (Tibial/Femoral)	2951	25.2
Patella Only	2510	21.4
Insert Only	2381	20.3
Tibial Component	1286	11.0
Insert/Patella	1022	8.7
Femoral Component	785	6.7
Cement Spacer	655	5.6
Removal of Prostheses	66	0.6
Minor Components	32	0.3
Reinsertion of Components	7	0.1
Cement Only	6	0.1
Total Femoral	2	0.0
Patella/Trochlear Resurfacing	1	0.0
TOTAL	11704	100.0

Heterogeneous cohort!

Table KT6: Primary Total Knee Replacement by Reason for Revision

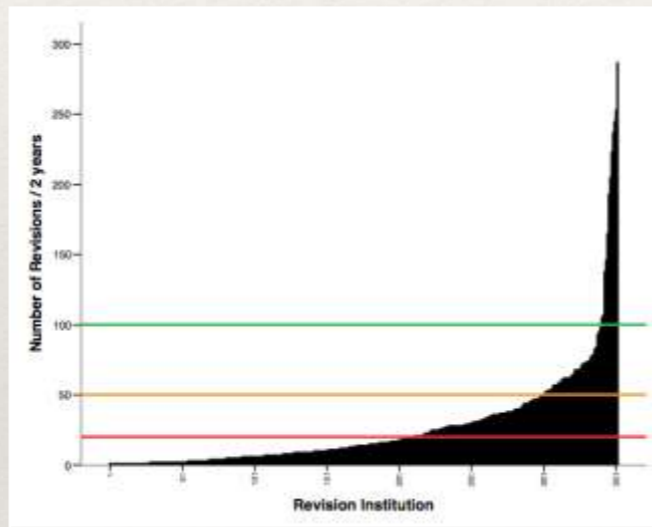
Reason for Revision	Number	Percent
Loosening/Lysis	3473	29.7
Infection	2536	21.7
Patellofemoral Pain	1540	13.2
Pain	1042	8.9
Instability	690	5.9
Arthrofibrosis	435	3.7
Fracture	289	2.5
Patella Erosion	282	2.4
Malalignment	265	2.3
Wear Tibial Insert	186	1.6
Incorrect Sizing	166	1.4
Metal Related Pathology	165	1.4
Other	635	5.4
TOTAL	11704	100.0

Table KT7: Primary Total Knee Replacement by Type of Revision

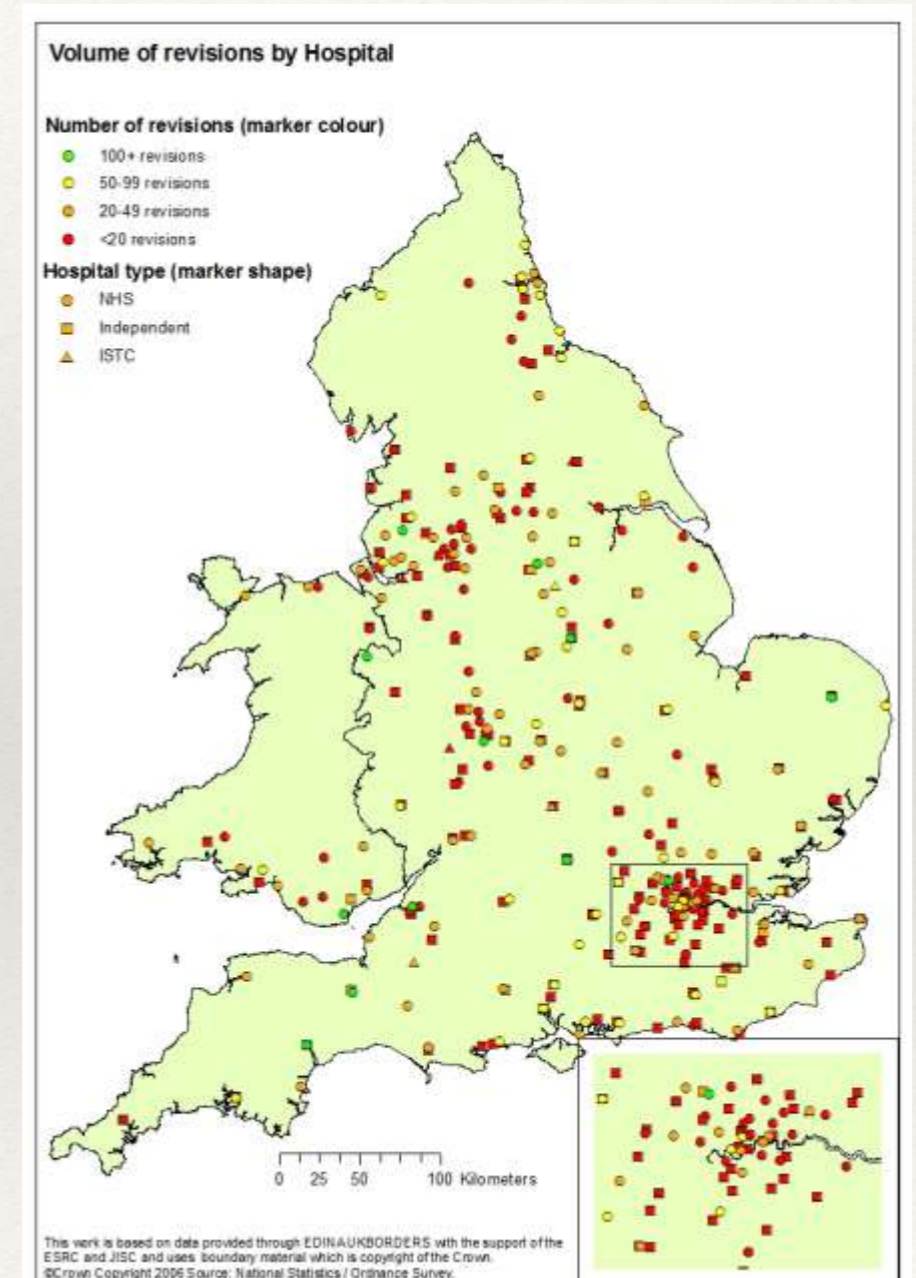
Type of Revision	Number	Percent
TKR (Tibial/Femoral)	2951	25.2
Patella Only	2510	21.4
Insert Only	2381	20.3
Tibial Component	1286	11.0
Insert/Patella	1022	8.7
Femoral Component	785	6.7
Cement Spacer	655	5.6
Removal of Prostheses	66	0.6
Minor Components	32	0.3
Reinsertion of Components	7	0.1
Cement Only	6	0.1
Total Femoral	2	0.0
Patella/Trochlear Resurfacing	1	0.0
TOTAL	11704	100.0

Most surgeons do low volumes

- Low volume surgery limits acquisition of experience



- High volume centres more likely to publish + they do the most complex cases / tertiary practice
—> bias



Revision Outcomes

- Re-revision / survival
- Patient reported outcomes
 - Knee specific function
 - General health measures
- Satisfaction

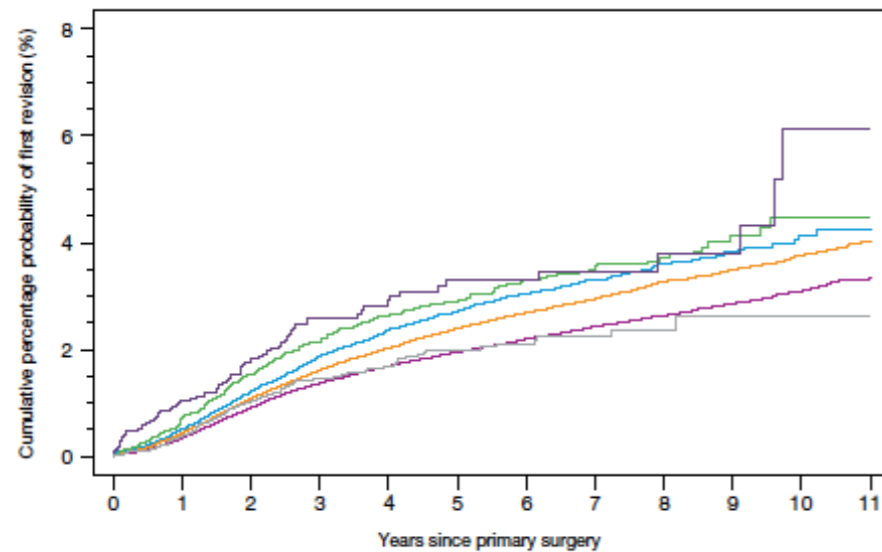


Re-Revision / Survival

Primary Versus First time revision

Comparison of the Kaplan-Meier cumulative percentage probability estimates of a knee prosthesis first revision for different constraint and bearing types at increasing years after the primary surgery when the primary arthroplasty method of fixation is cemented only.

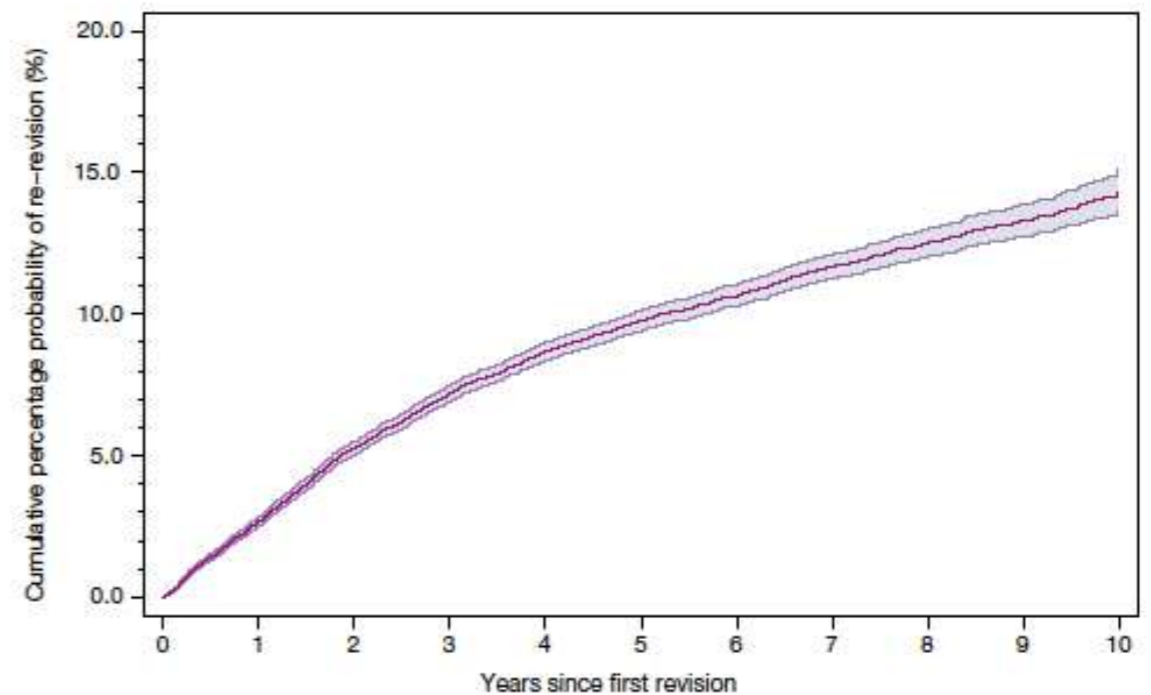
(a) Cemented



Number at risk

	0	1	2	3	4	5	6	7	8	9	10	11
Unconstrained, fixed	426,644	365,548	308,967	253,702	204,212	160,035	119,857	83,828	53,827	32,352	19,285	4,631
Unconstrained, mobile	30,641	28,463	26,084	23,468	20,828	17,183	13,457	9,386	5996	2,906	1,150	335
Posterior-stabilised, fixed	161,305	140,298	119,927	99,952	80,866	63,089	46,861	32,323	20,292	12,089	5,804	1,778
Posterior-stabilised, mobile	10,258	9,213	8,044	6,965	5,904	4,727	3,671	2,675	1,678	879	320	97
Constrained, condylar	3,976	2,855	2,054	1,501	1,142	850	637	464	279	178	82	21
Monobloc polyethylene tibia	9,785	7,872	5,925	4,153	2,814	2,028	1,473	910	433	195	78	30

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision. The shaded area indicates point-wise 95% CI.



Number at risk

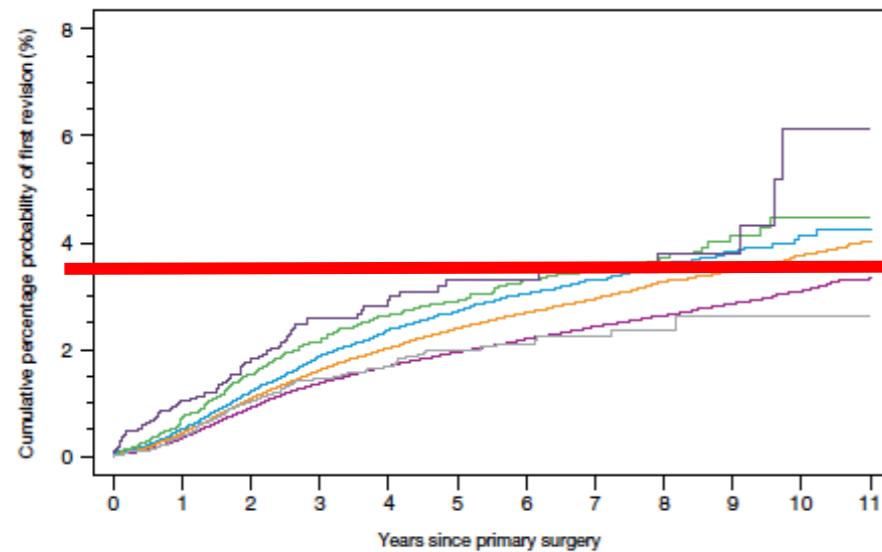
	0	1	2	3	4	5	6	7	8	9	10
	40,911	34,538	28,598	22,743	17,905	13,418	9,658	6,433	3,989	2,283	1,054

Re-revision / Survival

Primary Versus First time revision

Comparison of the Kaplan-Meier cumulative percentage probability estimates of a knee prosthesis first revision for different constraint and bearing types at increasing years after the primary surgery when the primary arthroplasty method of fixation is cemented only.

(a) Cemented

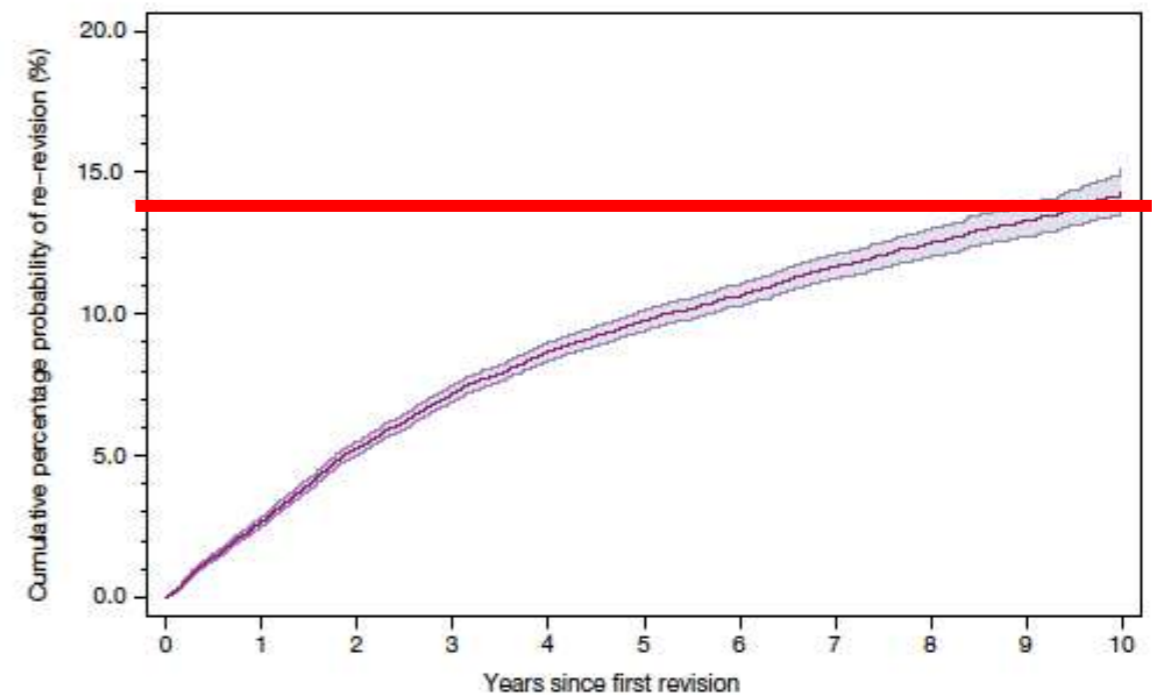


Number at risk

Unconstrained, fixed	426,644	365,548	308,967	253,702	204,212	160,035	119,857	83,828	53,827	32,352	19,285	4,631
Unconstrained, mobile	30,641	28,463	26,084	23,468	20,828	17,183	13,457	9,386	5996	2,906	1,150	335
Posterior-stabilised, fixed	161,305	140,298	119,927	99,952	80,866	63,089	46,861	32,323	20,292	12,089	5,804	1,778
Posterior-stabilised, mobile	10,258	9,213	8,044	6,965	5,904	4,727	3,671	2,675	1,678	879	300	97
Constrained, condylar	3,976	2,855	2,054	1,501	1,142	850	637	464	279	178	82	21
Monobloc polyethylene tibia	9,785	7,872	5,925	4,153	2,814	2,028	1,473	910	433	195	78	30

10 yr = 3-4%

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision. The shaded area indicates point-wise 95% CI.



Number at risk

40,911	34,538	28,598	22,743	17,905	13,418	9,658	6,433	3,989	2,283	1,054
--------	--------	--------	--------	--------	--------	-------	-------	-------	-------	-------

10 yr = 13-15
%

Re-revision / Survival

NZ AR 2013	Mean days	Range (days)	SD	Revisions /100 component years
Primary to 1st Rev	1112	1 to 4847	1001	0.50
1st to 2nd	754	3 to 3318	760	3.30
2nd to 3rd	664	28 to 2212	578	
3rd to 4th	366	23 to 1454	545	

Re-revision / Survival

NZ AR 2013	Mean days	Range (days)	SD	Revisions /100 component years
Primary to 1st Rev	1112	1 to 4847	1001	0.50
1st to 2nd	754	3 to 3318	760	3.30
2nd to 3rd	664	28 to 2212	578	
3rd to 4th	366	23 to 1454	545	

Reason for revision

Pain	590
Deep infection	495
Loosening tibial component	454
Patellar resurfacing	467
Loosening femoral component	219
Loosening patellar component	37
Fracture tibia	31
Fracture femur	28

Re-revision / Survival

NZ AR 2013	Mean days	Range (days)	SD	Revisions /100 component years
Primary to 1st Rev	1112	1 to 4847	1001	0.50
1st to 2nd	754	3 to 3318	760	3.30
2nd to 3rd	664	28 to 2212	578	
3rd to 4th	366	23 to 1454	545	

Reason for revision

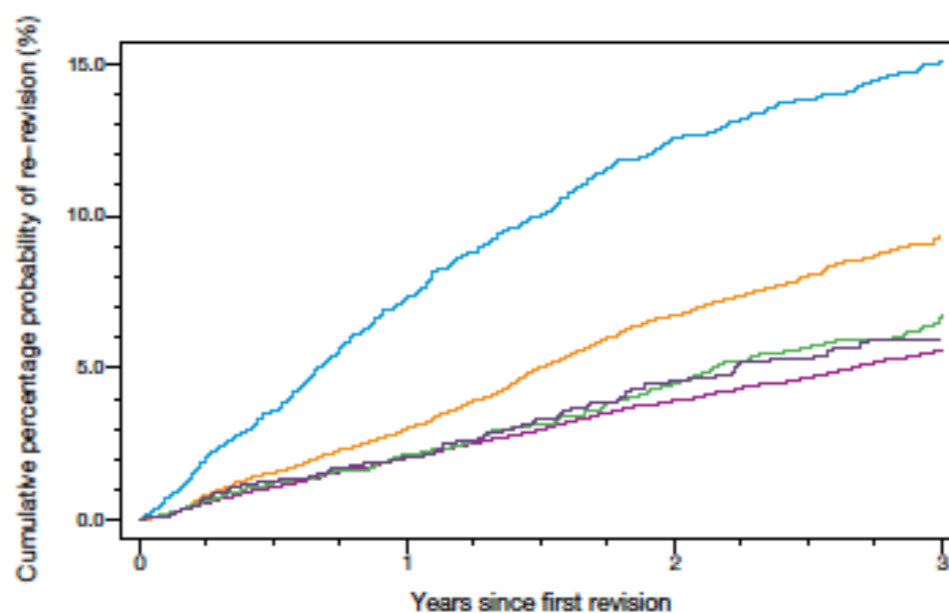
Pain	590
Deep infection	495
Loosening tibial component	454
Patellar resurfacing	467
Loosening femoral component	219
Loosening patellar component	37
Fracture tibia	31
Fracture femur	28

Reason for revision

Deep infection	120
Pain	64
Loosening fibial component	45
Loosening femoral component	37
Loosening patellar component	5
Fracture femur	1

Re-revision / Survival

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision up to three years from the first revision. Those with recorded primaries in the NJR are shown separately from the remainder and have been split into those that had their first revision within 1 year, 1 to 3, 3 to 5 years or more than 5 years after the initial primary.



Number at risk

	0	1	2	3
Primary not in the NJR	23,262	20,441	17,697	14,771
First revision <1 year	3,442	2,793	2,247	1,786
First revision 1-3 years	7,996	6,687	5,398	4,134
First revision 3-5 years	3,479	2,821	2,173	1,485
First revision 5+ years	2,732	1,796	1,083	567

Revised patient-sides	Number of first revised joints at risk of re-revision	Cumulative percentage probability of a re-revision (95% CI) at time shown if time elapsed since first revision is:	
		1 year	3 years
Primary not in the NJR	23,262	2.04 (1.86-2.23)	5.58 (5.27-5.91)
Primary in the NJR where the first revision took place:			
<1 year after primary	3,442	7.28 (6.44-8.24)	15.08 (13.82-16.44)
1-3 years after primary	7,996	3.02 (2.65-3.43)	9.31 (8.61-10.06)
3-5 years after primary	3,479	2.16 (1.71-2.73)	6.73 (5.80-7.81)
5+ years after primary*	2,732	2.04 (1.54-2.70)	5.94 (4.82-7.30)

Re-revision / Survival

- Norwegian registry (Leta et al 2014 Acta Orthop)
- 1016 first time aseptic revisions
 - 145 re-revisions: Infection (28%), Instability (26%), Tibial loosening (17%), Pain (10%)
- Re-revision rate:
 - 5 yrs = 84.5%, 10 yrs = 78.3%, 15 yrs = 71.2%

Re-revision / Survival




- Norwegian registry (Leta et al 2014 Acta Orthop)
- Other findings
 - Isolated vs Complete revision = RRR 1.7 (p=0.02)
 - Men vs Women RRR 2.0 (p<0.001)
 - Patient <60 vs >60 RRR 1.6 (p=0.03)

*RRR = Relative risk of re-revision

Re-revision / Survival

Midterm Assessment of Causes and Results of Revision Total Knee Arthroplasty

Clin Orthop Relat Res (2010) 468:1221–1228

Implant	Indication	n	10 yr survival	
PS (PFC PS)	VV stable	126 (36%)	90.3% (95%CI 84.9% to 95.8%)	
CCK (TC3)	F/E MM or VV intermediate (>15deg)	149 (43%)	89.3% (95%CI 84.7% to 95.0%)	
RH (SMILES / MRH / NOILES)	VV unstable	74 (21%)	92.5% (95%CI 85.6% to 99.3%)	

Functional outcomes

When Do Patient-reported Assessments Peak after Revision Knee Arthroplasty?

Clin Orthop Relat Res (2012) 470:1728–1734

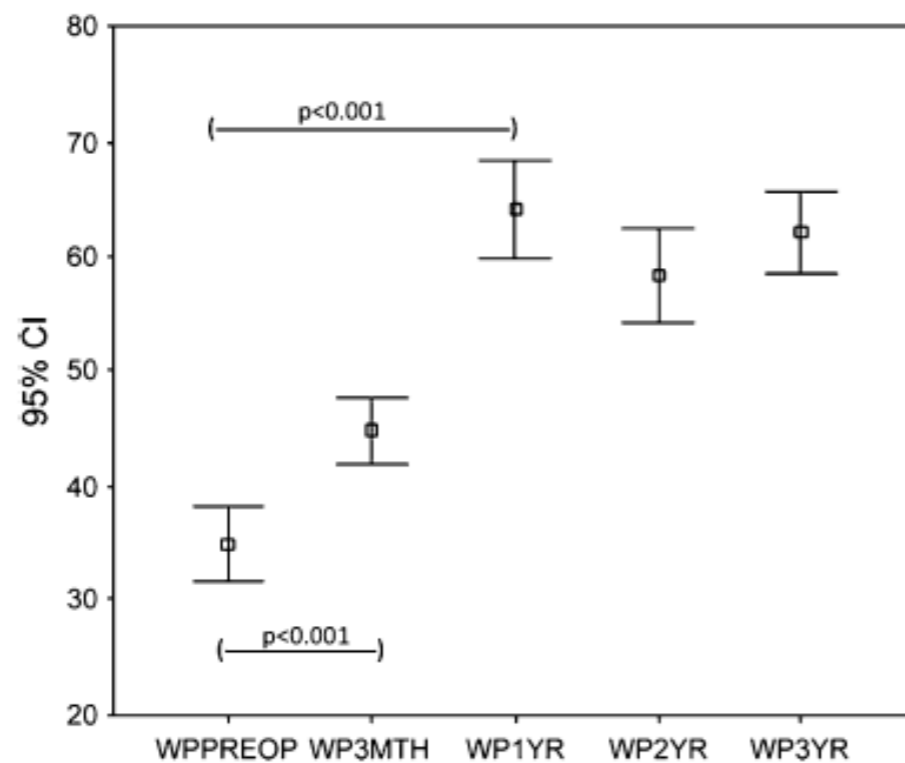


Fig. 1 The trend for WOMAC pain scores over 3 years for the whole group is shown. The scores increased at 3 months, reached a peak at 1 year, and then stabilized. WPPreop = preoperative WOMAC pain score; WP3Mth = 3-month WOMAC pain score; WP1 yr = 1-year WOMAC pain score; WP2 yr = 2-year WOMAC pain score; WP3 yr = 3-year WOMAC pain score.

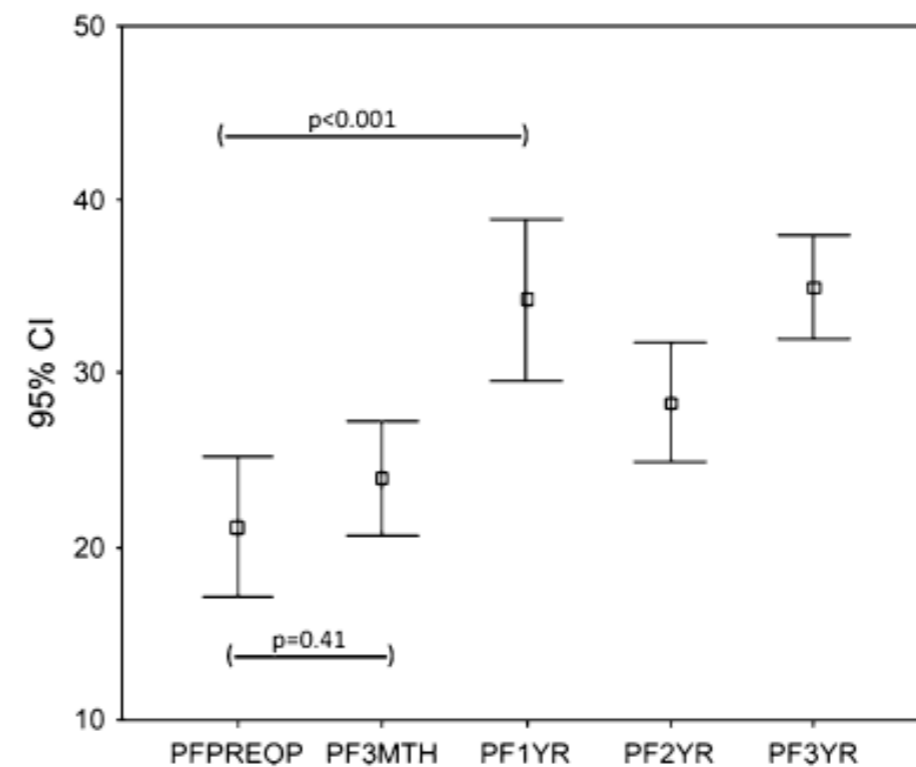


Fig. 3 The trend for the SF-36 physical function (PF) scores over 3 years for the whole group is shown. The scores increased only marginally at 3 months, reached a peak at 1 year, and then stabilized. PFPreop = preoperative SF-36 physical function score; PF3Mth = 3-month SF-36 physical function score; PF1 yr = 1-year SF-36 physical function score; PF2 yr = 2-year SF-36 physical function score; PF3 yr = 3-year SF-36 physical function score.

Functional outcome

Reason for Revision Influences Early Patient Outcomes After Aseptic Knee Revision Clin Orthop Relat Res (2012) 470:2244–2252

Score	Timepoint	TKA	Revision n=797	Relative change Revision vs TKA
OKS	Pre-op	18.9	16.2	69% (95%CI 64% to 74)
	>6M Post-op	34.0	26.6	
	Change	15.1	10.4	
	%Not better	7%	17%	
EQ-5D	Pre-op	0.407	0.310	76% (95%CI 71% to 81%)
	>6M Post-op	0.710	0.541	
	Change	0.303	0.231	
	%Not better	21%	34%	

*all differences p<0.001

Functional outcomes

Functional outcome following aseptic single-stage revision knee arthroplasty

Knee Surg Sports Traumatol Arthrosc (2012) 20:1994–2001

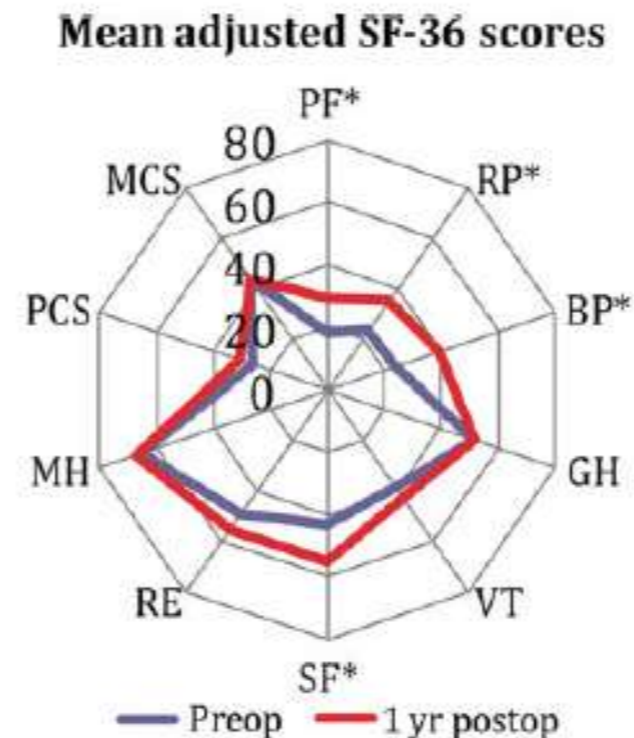
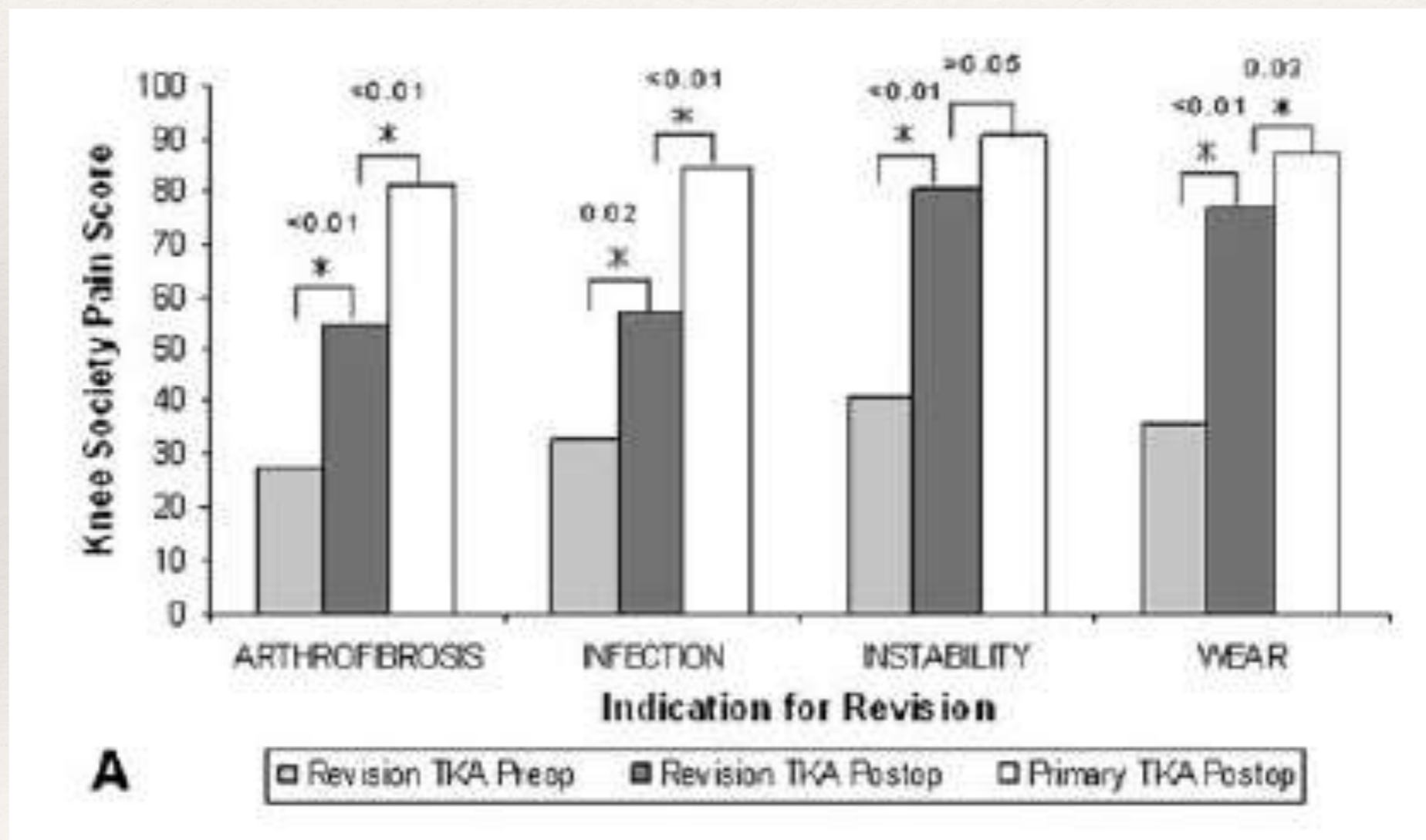


Fig. 2 Radar graph illustrating the mean-adjusted pre- and postoperative SF-36 scores for the whole group. Scores with *asterisk* show a statistically significant difference ($P < 0.05$). (*PF* physical function, *RP* role physical, *BP* bodily pain, *GH* generic health, *VT* vitality, *SF* social functioning, *RE* role emotional, *MH* metal health, *PCS* physical component score, and *MCS* mental component score)

n=175

Influence of revision indication

Effect of Gender and Preoperative Diagnosis on Results of Revision Total Knee Arthroplasty Clin Orthop Relat Res (2008) 466:2701–2705



n=212

Influence of revision indication

Reason for Revision Influences Early Patient Outcomes After Aseptic Knee Revision Clin Orthop Relat Res (2012) 470:2244–2252

Indication	n	OKS change	EQ-5D change	%Satisfied
Loosening / Lysis	367	11.3	0.232	72%
Malalignment	94	11.3	0.293	64%
Instability	81	7.2	0.208	60%
Unexplained pain	84	9.6	0.172	58%
Stiffness	33	5.6	0.176	47%
All Revisions		10.4	0.231	66%



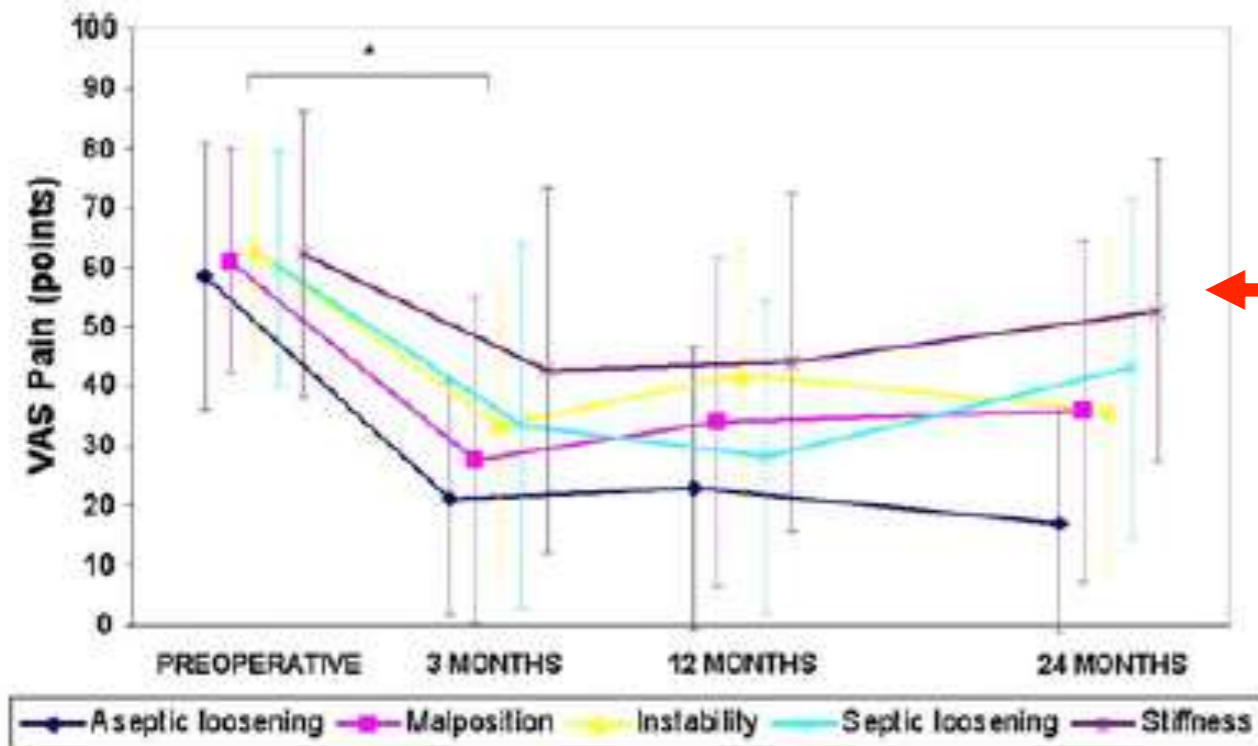
Aseptic vs Septic revision

Reason for Revision TKA Predicts Clinical Outcome: Prospective Evaluation of 150 Consecutive Patients With 2-years Followup

Outcome	Time point	Aseptic loosening n=40	Septic loosening* n=34
VAS pain	Pre-op	58	60
	24 months	17	43
KSS clinical score	Pre-op	52	48
	24 months	85	74
KSS function score	Pre-op	39	24
	24 months	69	61
ROM (degrees)	Pre-op	106	79
	24 months	112	101

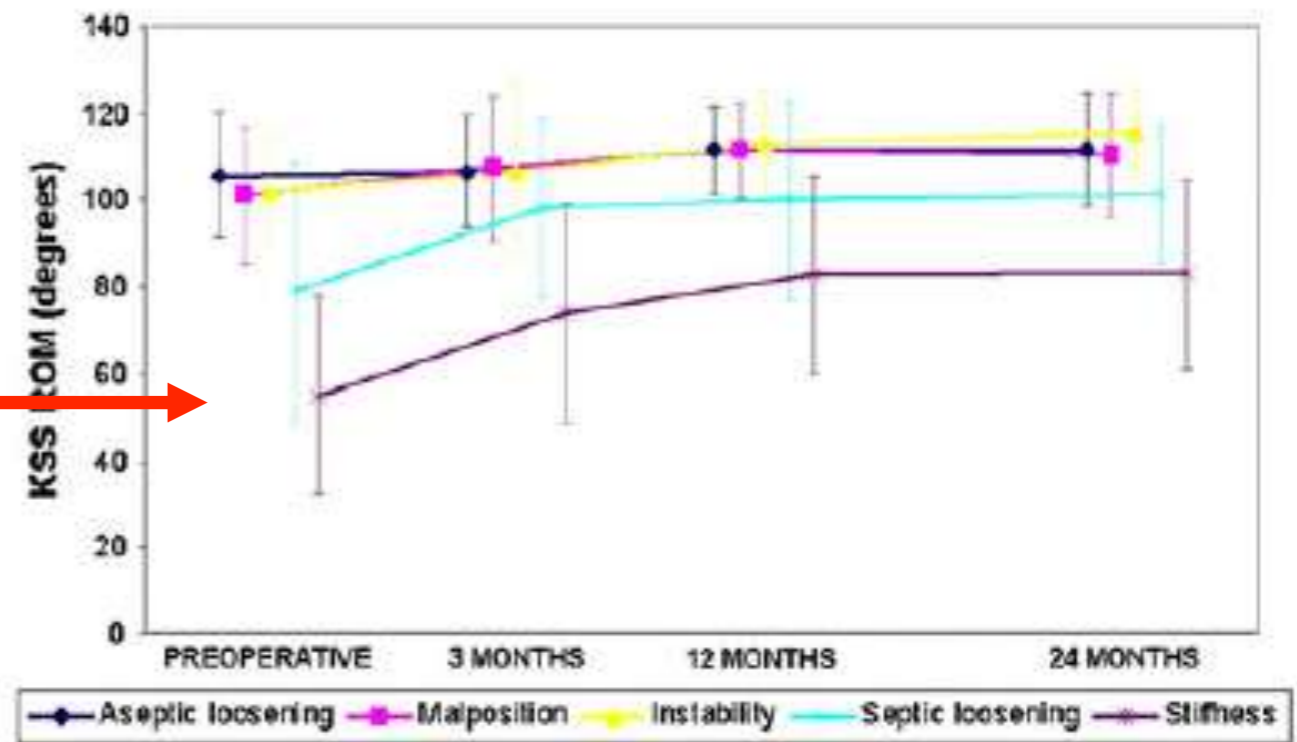
*All septic cases treated with 2 stage revision

Infection bad... Stiffness worse

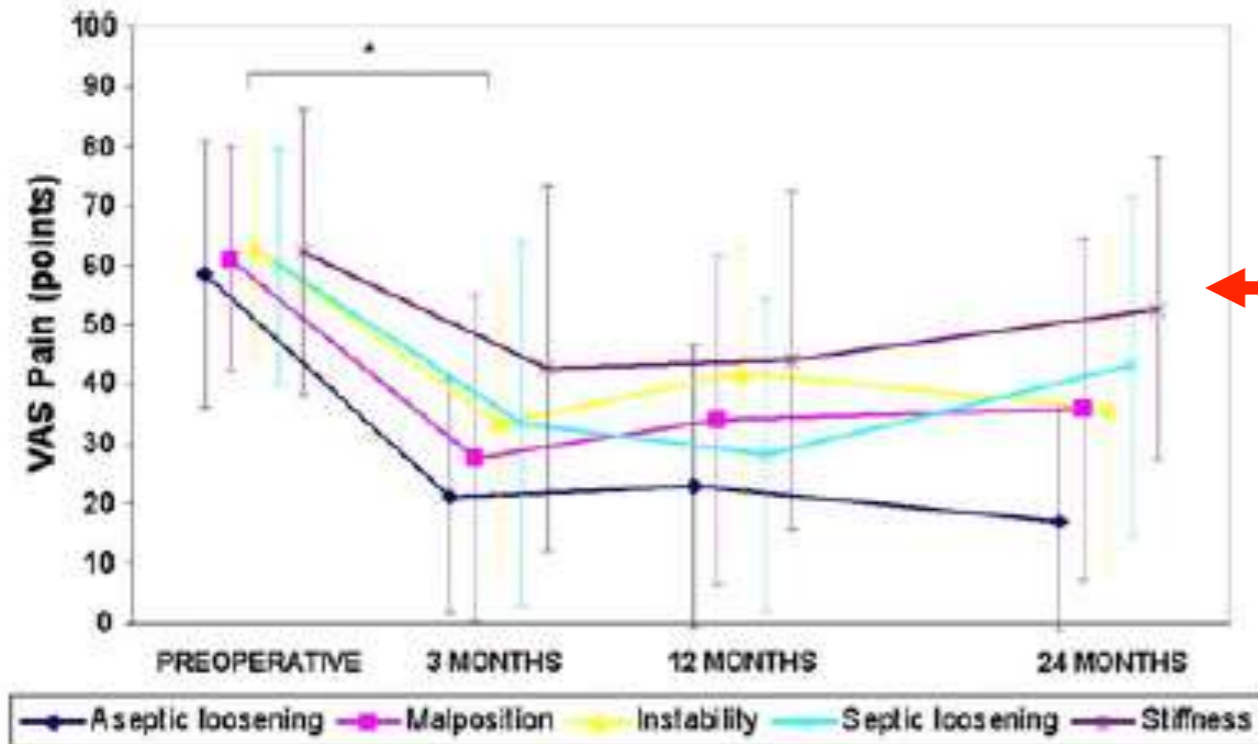


Most pain

Worst ROM

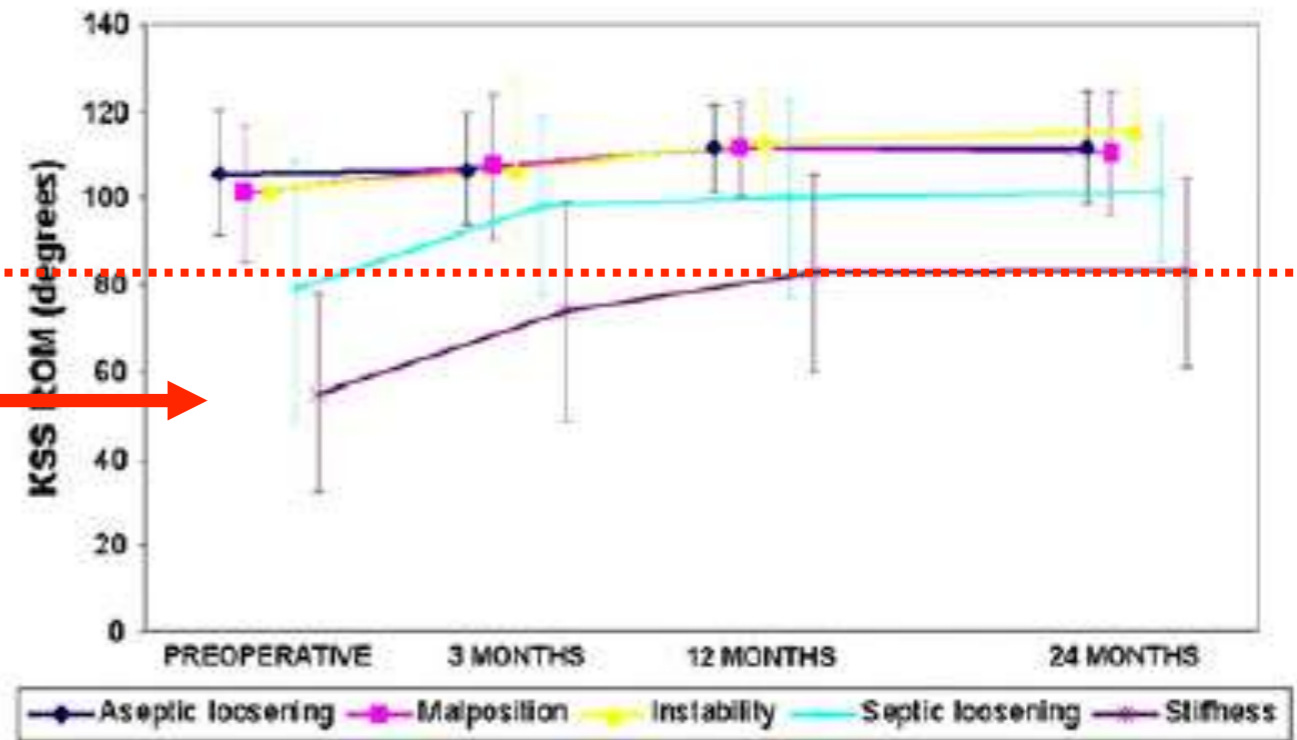


Infection bad... Stiffness worse



Most pain




Worst ROM



Impact of constraint upon function

Midterm Assessment of Causes and Results of Revision Total Knee Arthroplasty

Clin Orthop Relat Res (2010) 468:1221–1228

Implant	n	Time point	AKSS	ROM (degrees)	
PS (PFC PS)	126	Pre-op: Post-op:	35.2 89.0	103.0 108.7	
CCK (TC3)	149	Pre-op: Post-op:	34.1 88.9	102.0 110.0	
RH (SMILES / MRH / NOILES)	74	Pre-op: Post-op:	31.0 84.0	100.1 111.7	

AKSS: RH vs PS/CCK $p < 0.001$, ROM: CCK vs PS/RH $p < 0.001$ (adjusted for age/BMI)

Constraint vs Indication

Functional outcome following aseptic single-stage revision knee arthroplasty

Knee Surg Sports Traumatol Arthrosc (2012) 20:1994–2001

Implant	Aseptic Loosening (n=56)		Instability (n=32)	
	CCK	RH	CCK	RH
WOMAC Change				
Pain	42.1	26.7	19.5	23.0
Function	25.9	20.6	11.0	14.1
Stiffness	27.6	17.5	15.6	19.5

CCK vs RH all N.S (p>0.05)

Other factors.....

Predictor Variable	OKS improvement			EQ5D improvement		
	Estimate	95% CI	p value	Estimate	95% CI	p value
Patient variables						
Age	0.14	0.03 to 0.24	=0.001	-	-	-
Pre-operative OKS	-0.42	-0.55 to -0.29	<0.001	0.007	0.001 to 0.013	<0.001
Pre-operative EQ5D index	-	-	-	-0.922	-1.003 to -0.840	<0.001
Pre-operative general health						
Excellent	Reference			-	-	-
Very Good	1.42	-0.91 to 3.75	0.22	-	-	-
Good	2.01	0.07 to 3.95	0.04	-	-	-
Fair	-0.66	-2.84 to 1.51	0.55	-	-	-
Poor	-6.34	-10.26 to -2.42	0.002	-	-	-
Anxiety level						
No anxiety/depression	-	-	-	Reference		
Moderate anxiety/depression	-	-	-	0.052	-0.004 to 0.110	0.07
Severe anxiety/depression	-	-	-	-0.183	-0.278 to -0.088	<0.001

Aseptic loosening / lysis only n=367

Satisfaction

Reason for Revision Influences Early Patient Outcomes After Aseptic Knee Revision

Clin Orthop Relat Res (2012) 470:2244–2252

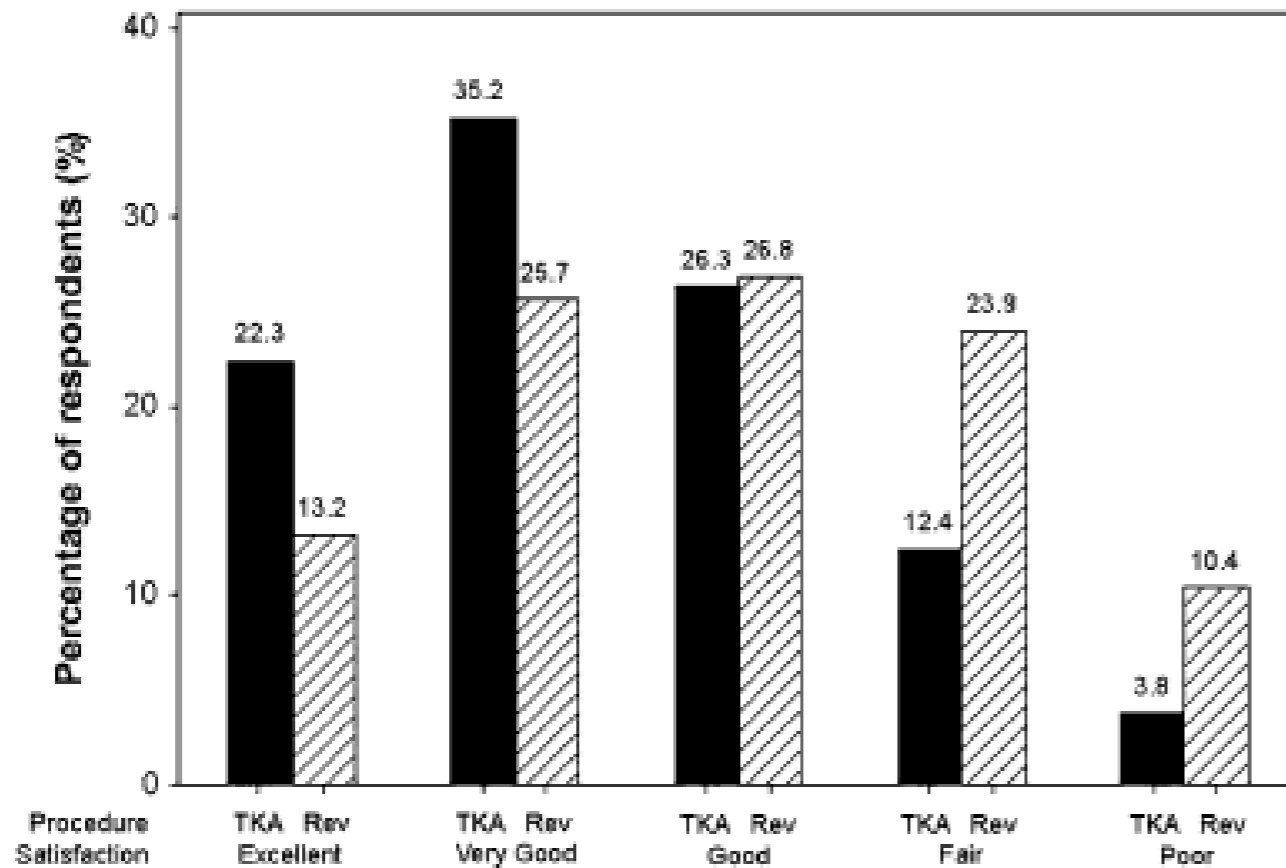


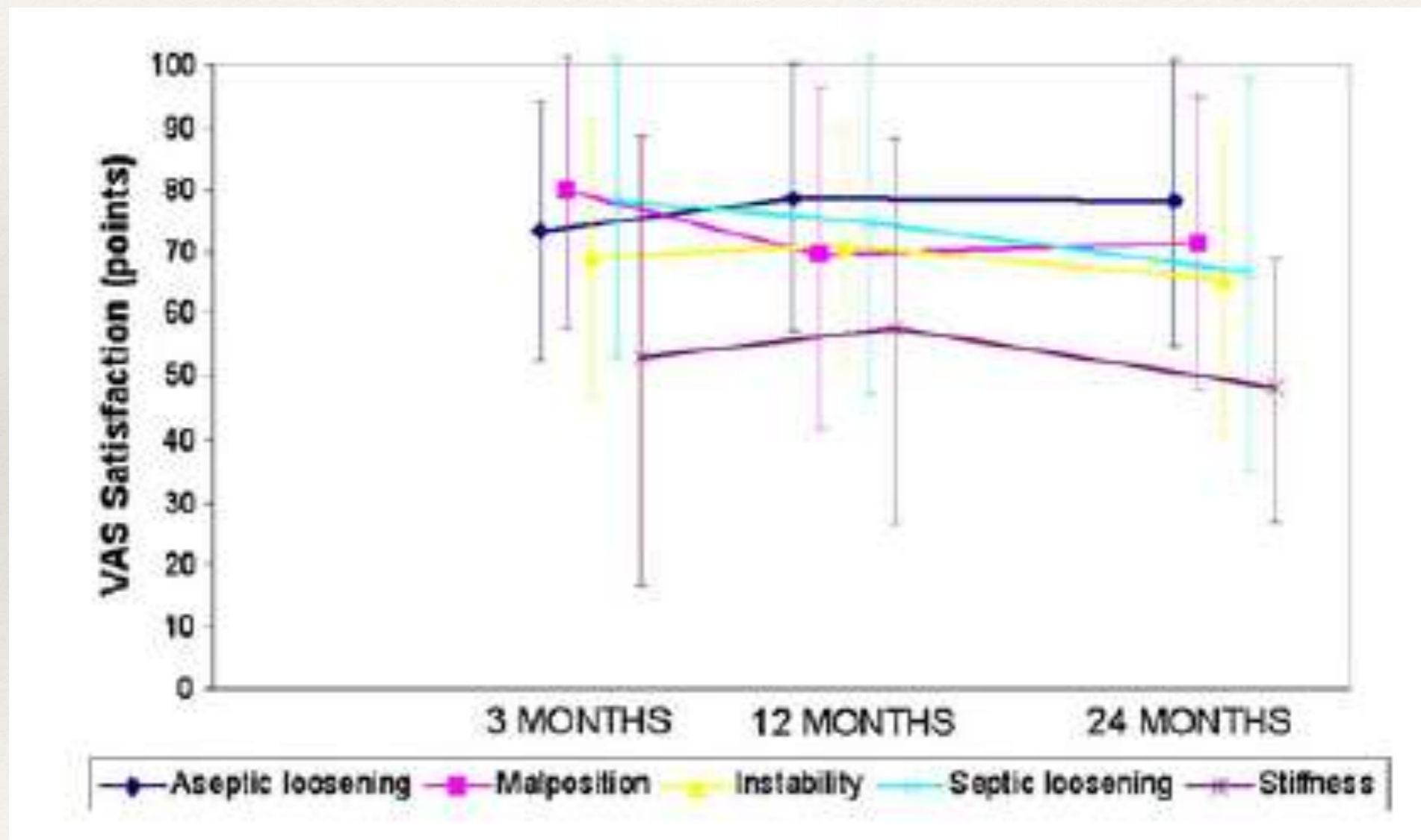
Fig. 1 Postoperative patient satisfaction was higher after primary TKA compared with revision (Rev) TKA.

TKA:
Fair / Poor - 16.2%

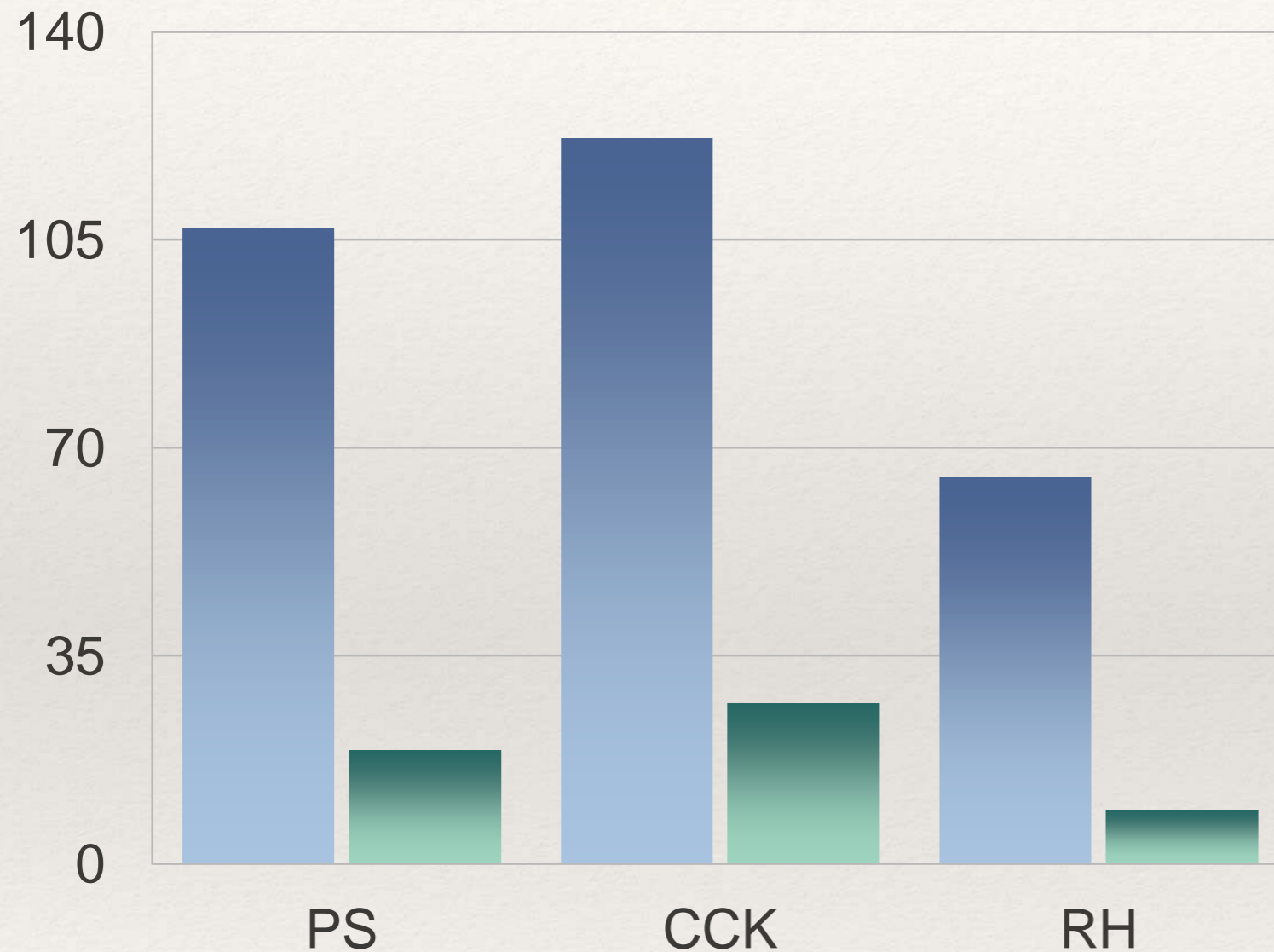
Revision
Fair/ Poor - 34.3%

Satisfaction vs Indication

Reason for Revision TKA Predicts Clinical Outcome: Prospective Evaluation of 150 Consecutive Patients With 2-years Followup

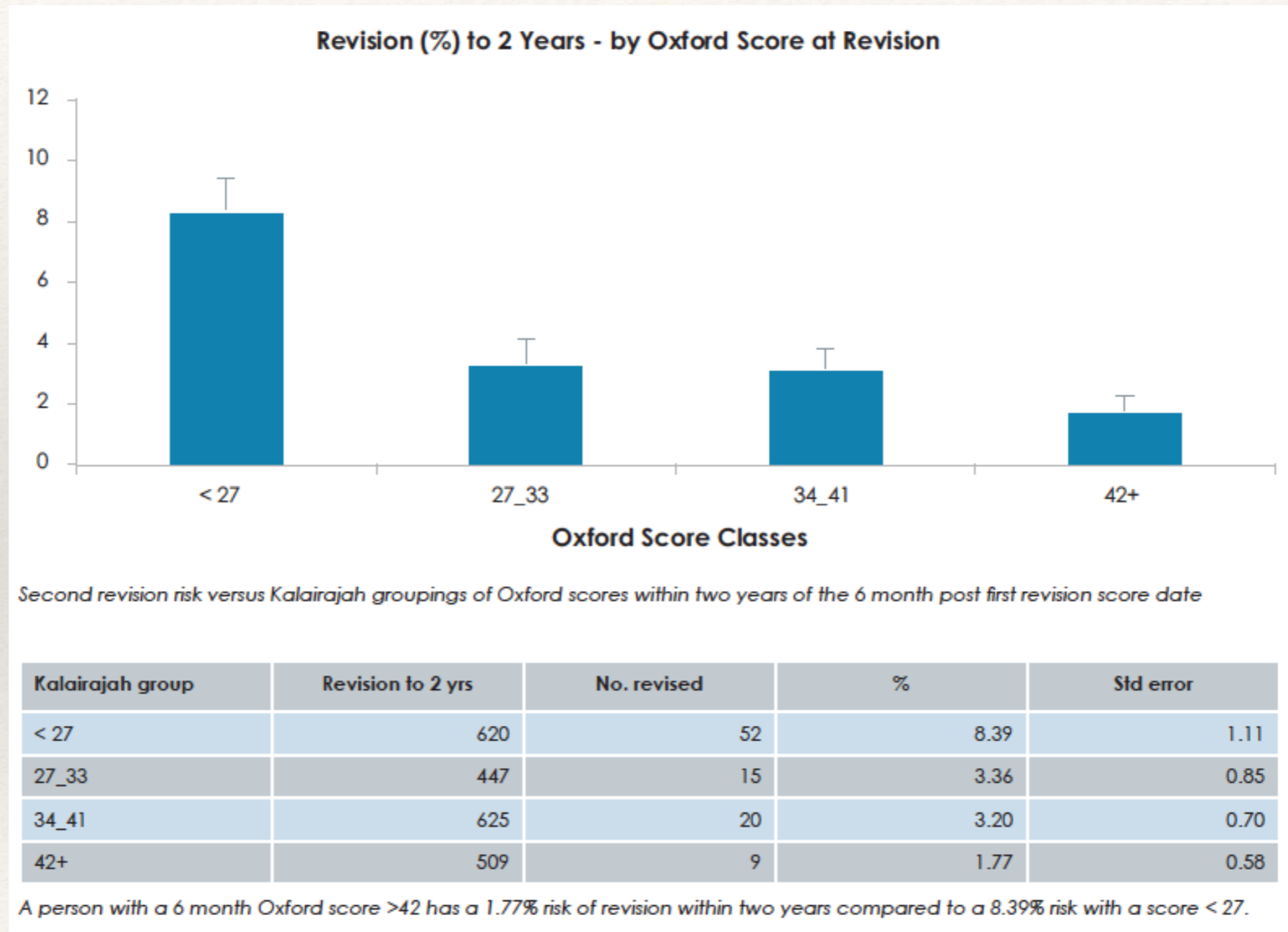


Satisfaction vs Constraint



- PS group - 85% satisfied
- CCK group - 82% satisfied
- RH group - 88% satisfied
- $p=0.50$

Function predicts re-revision



Summary

- Heterogenous group
 - Evidence from retrospective cohorts / small numbers
- Outcomes dependent upon indication for revision
 - TKR > Aseptic loosening > Instability > Infection > Pain > Stiffness
- Role of the implant not yet fully defined
 - Governed by bone loss / ligamentous stability / surgeon choice

Thank you for listening.....

