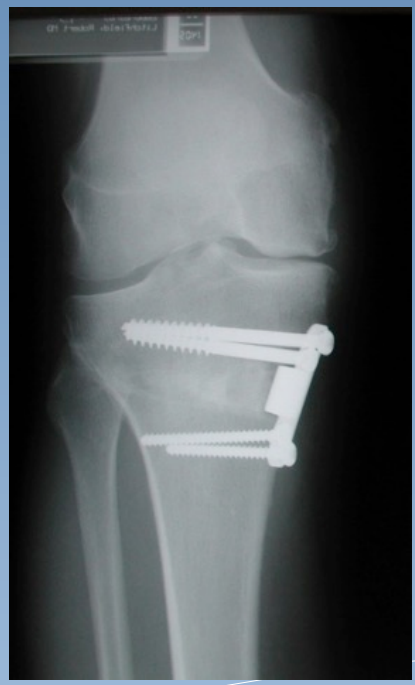
Results of High Tibial Osteotomy
A Review of Literature

Myles Coolican

Sydney Orthopaedic Research Institute



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Introduction

* High tibial osteotomy widely performed procedure treating medial compartment osteoarthritis
* Multiple techniques

-Closing wedge

-Opening wedge

-Dome

-Chevron

Introduction

Many debated issues

* Choice between opening or closing wedge
* Graft selection in opening wedge osteotomies
* Fixation-plates-locked-tooth-frame
* Additional surgery -MACI - Micro-fracture
* Post operative care-WB status-brace

* Measurement tools
  - KOOS
  - WOMAC
  - Lysholm
  - Activity scales
  - Gait analysis
  - Survivorship

Introduction

* Vast array of different HTO options
* Difficult to compare
* Older literature – older techniques
* Registries-limited follow up

  - not much use

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Questions for Literature

* Who should have an osteotomy
* What is the most reliable technique
* What are the outcomes after HTO
* Survivorship of HTO
* Are patients more satisfied with HTO or UKR
* Survivorship of UKR V HTO
* Survivorship of patients
* What are outcomes of post HTO TKR
* What are outcomes of post UKR TKR

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Age	Male	Female
50	31.4	35.2
51	30.5	34.2
52	29.6	33.3
53	28.7	32.4
54	27.8	31.4
55	27.0	30.5
56	26.1	29.6
57	25.2	28.7
58	24.3	27.8
59	23.5	26.9
60	22.6	26.0

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Older literature -HTO Survivorship

Authors	Year	Survivorship (%)			
		5 Years	10 Years	15 Years	20 Years
Naudie et al	1999	75	51	39	30
Sprenger and Doerzbacher	2003		65-74		
Koshino et al	2004	97.3 (7y)	95.1	86.9	
Tang and Henderson	2005	89.5	74.7	66.9	66.9
Papachristou et al	2006		80	66	53
Flecher et al	2006				85
Gstöttner et al	2008	94	79.9	65.5	54.1 (18y)
Akizuki et al	2008		97.6	90.4	
Hui et al	2011	95	79	56	
Niinimäki et al	2012	89	73		
Harris et al	2013	92.4	84.5	77.3	72.3

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Recent Literature-Outcome

European Journal of Orthopaedic Surgery & Traumatology
https://doi.org/10.1007/s00590-017-2112-8

GENERAL REVIEW • KNEE - OSTEOTOMY

CrossMark

Functional results following high tibial osteotomy: a review of the literature

Mark Webb[1] · Varun Dewan[2] · David Elson[3]

Received: 20 October 2017 / Accepted: 13 December 2017

- Systematic review-23 manuscripts appraised
- Different follow up periods
- Varied approach to the use of PROMs
- In **all** of the 14 studies that compared pre-operative to postop PROMs - significant improvements

Recent Literature-Outcome

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- Return to sport reviewed in 11 articles with 87.2% patients achieving this
- The published evidence confirms improved outcomes in symptoms function and return to activity
- PROMs are reliable to measure outcomes following HTO

Recent Literature-Outcome

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-017-4816-z

KNEE

Satisfactory functional and radiological outcomes can be expected in young patients under 45 years old after open wedge high tibial osteotomy in a long-term follow-up

Michael E. Hantes[1] · Prodromos Natsaridis[1] · Antonios A. Koutalos[1] · Yohei Ono[2] · Nikolaos Doxariotis[1] · Konstantinos N. Malizos[1]

Received: 3 September 2017 / Accepted: 21 November 2017

- 20 patients, 12.3yr average f/u
-Medial OWHTO –no bone graft-locked plate
- 1 conversion to TKR during study period
-Survivorship 95% average 12 years

Recent Literature-Outcome

Knee Surgery, Sports Traumatology, Arthroscopy
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Received: 3 September 2017 / Accepted: 21 November 2017

- All clinical outcome scores IKDC, KOOS, OKS, and SF-12 significantly improved postoperatively
- No deterioration over time
- No significant radiographic progression of was observed.

Recent Literature-Sports

* Return to sports and quality of life after high tibial osteotomy in patients under 60 years of age. Bastard et al(2017)

  - 30 patients, 1-1.5yrs

  - All returned to sports at 1 year:

    73.3% at their pre-surgery level

    23.3% at a higher level

  - Quality of life (SF-36) was significantly improved 65.3% pre-operatively to 72.5%

Recent Literature-Open vs Closed

* Lateral closing wedge HTO has been for a long time as the gold standard

* Requires fibular osteotomy or proximal tibiofibular joint disruption, lateral muscle detachment, bone stock removal & subsequent TKR more difficult

* Opening wedge HTO gained popularity and became a widely used alternative option- incremental change & navigate

7.Amendola A, Bonasia DE. Osteotomy (HTO/DFO). In: Cole B, Gomoll A (eds) AAOS complications in orthopaedics: articular cartilage repair.

8. Osteotomy for medial compartment arthritis of the knee using a closing wedge or an opening wedge controlled by a Puddu plate. A one-year randomised, controlled study.*Brouwer RW, Bierma-Zeinstra SM, van Raaij TM, Verhaar JA J Bone Joint Surg Br. 2006 Nov; 88(11):1454-9.*

Recent Literature-Open vs Closed

* Opening wedge not free from drawbacks
  - defect to fill
  - possible loss of correction[7]

* Brouwer- 2006-randomized controlled trial comparing the two techniques. At the one-year follow-up, both groups showed improvement in knee function and pain, without significant differences[8]

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Recent Literature-Open vs Closed

RESEARCH ARTICLE

Comparison of clinical and radiological outcomes between opening-wedge and closing-wedge high tibial osteotomy: A comprehensive meta-analysis

Lingfeng Wu[1], Jun Lin[2], Zhicheng Jin[3], Xiaobin Cai[1], Weiyang Gao[4]*

1 Department of Orthopedics, the Fifth Affiliated Hospital & Central Hospital of Lishui City of Wenzhou Medical University, Lishui, China, **2** Department of Orthopedics, Qingyuan Country People's Hospital, Lishui, China, **3** Department of Surgery, Second Clinical Medical College, Wenzhou Medical University, Wenzhou, China, **4** Department of Orthopedics, the Second Affiliated Hospital & Yuying Children's Hospital of Wenzhou Medical University, Wenzhou, China

- No significant difference regarding surgery time, duration of hospitalization, knee pain VAS, Lysholm score and HSS knee score
- Opening-wedge HTO group showed greater range of motion
- Opening-wedge HTO group showed greater posterior tibial slope angle and less patellar height

Recent Literature-Defect fillers

Multiple options

* Autologous bone graft most successful - osteoconductive, osteoinductive and osteogenic properties[9,10]

* Tibial wedge & shaped femoral head –less donor morbidity fear of disease transmission

* Bone substitutes reduce operative time & donor site morbidity, but concerns about resistance to loads and biological degradability.[11]

9.*Stoll T. New aspects in osteoinduction. Materialwiss Werkstofftech. 2004;35(4):198–202. doi: 10.1002/mawe.200400738*

10.Mechanism of bone incorporation of beta-TCP bone substitute in open wedge tibial osteotomy in patients.*Gaasbeek RD, Toonen HG, van Heerwaarden RJ, Buma P Biomaterials. 2005 Nov; 26(33):6713-9.*

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Recent Literature-Augmentation

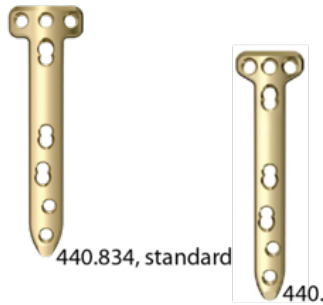
* The use of bone cement is not recommend [11]

* Dallari-encouraging results with the use of PRP, bone marrow stromal cells and growth factors added to both bone graft and bone substitute[12]
* Use still remains experimental and their efficacy compared to autologous iliac crest graft has not been demonstrated [11]

12. *Enhanced tibial osteotomy healing with use of bone grafts supplemented with platelet gel or platelet gel and bone marrow stromal cells.Dallari D, Savarino L, Stagni C, Cenni E, Cenacchi A, Fornasari PM, Albisinni U, Rimondi E, Baldini N, Giunti A J Bone Joint Surg Am. 2007 Nov; 89(11):2413-20.*

Recent Literature-Fixation

* Conventional plates-long or short
* Locking plates
* With or without tooth/spacer
* Staples
* External fixateurs



Recent Literature-Fixation

* *Stoffel et al.* compared the biomechanical properties of the modified Puddu plate and the TomoFix plate.
* Both plates create sufficient immediate stability
* Lateral hinge fracture -the TomoFix plate showed enough residual stability, while the Puddu plate required additional lateral fixation
* *Agneskirchner et al.* compared four different plates and stated that a rigid long plate fixator with fixed angle locking screws yields the best results

Recent Literature-HTO Vs UKR

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Unicompartmental Knee Arthroplasty vs High Tibial Osteotomy for Knee Osteoarthritis: A Systematic Review and Meta-Analysis

ZhenWu Cao, MM [a], XiuJun Mai, MM [b], Jun Wang, MM [a], EnHui Feng, MM [b], YongMing Huang, MD [b,*]

[a] Department of Orthopedic Surgery, Guangzhou University of Traditional Chinese Medicine, Guangzhou City, Guangdong Province, People's Republic of China
[b] Department of Orthopedic Surgery, The Second Affiliated Hospital of Guangzhou University of Traditional Chinese Medicine, Guangzhou, Guangdong Province, People's Republic of China

- 10 comparative studies
- f/u range 2-7.5 years
- UKA lower revision rates, complications and post-op pain
- HTO patients achieved superior ROM

Recent Literature-TKR after HTO

* All data published fail to demonstrate statistically significant differences between the patients treated with a primary TKR or with a TKR following an HTO

* *Amendola et al.* in their retrospective study compared primary TKR with TKR following HTO and concluded that previous osteotomy does not affect the outcome of TKR

* *Karabatsos et al.* in their retrospective cohort study stated that TKR after HTO was technically more challenging than primary TKR but there were no significant differences between the two groups at the five-year follow-up. Similar results were described by *Van Rajii et al* and *Kazakos et al.*

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Recent Literature- UKR converted to TKR

Pearse et al NZ Registry

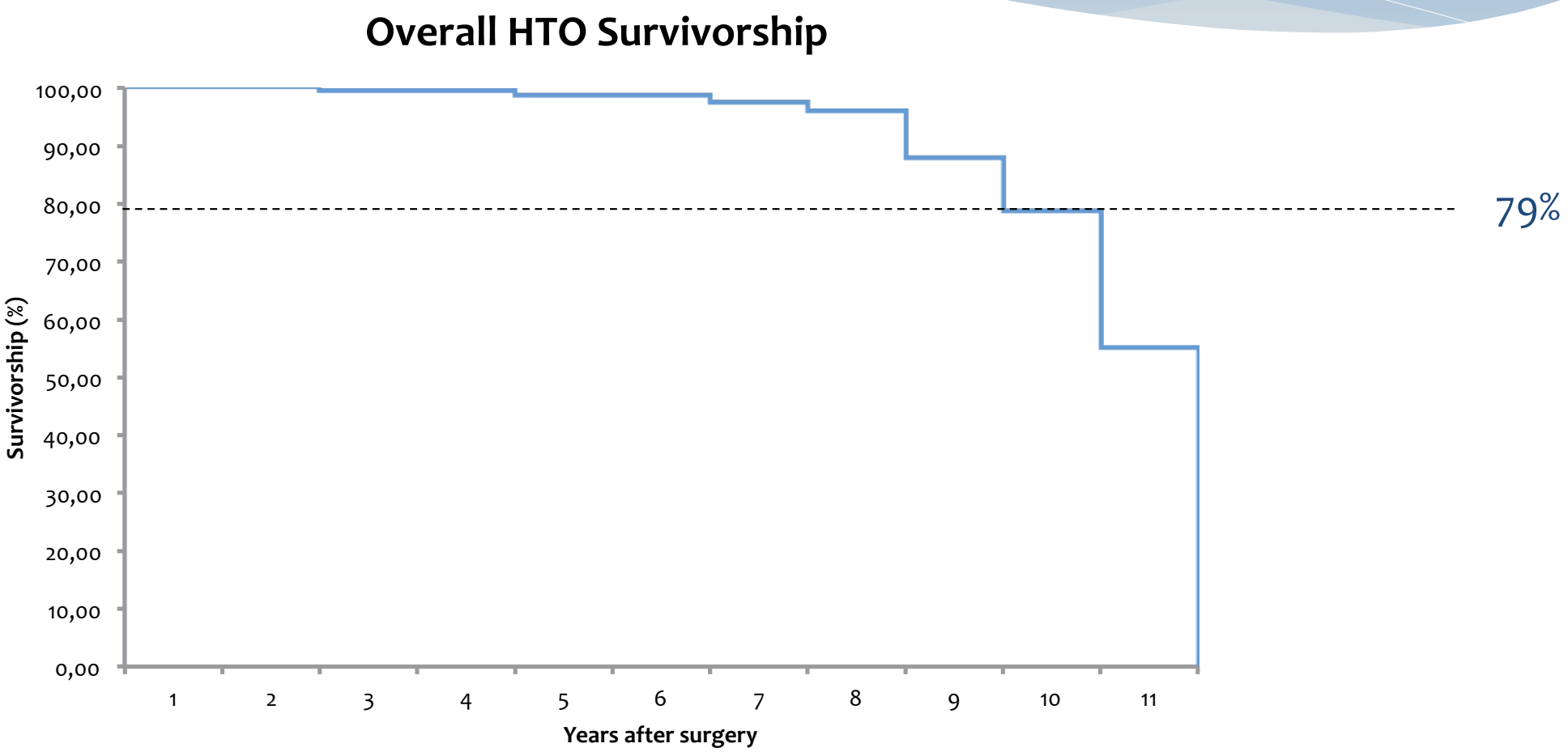
* Uni to TKR compared to Primary

* Revision rate 4 times that of Primary TKR
* Poorer outcome scores Oxford 30 V 37
* Uni converted to Uni-13 times revision

Chou et al

* 69% survival at 5 years
* Revisions more difficult
* Outcomes inferior

Literature-Survivorship



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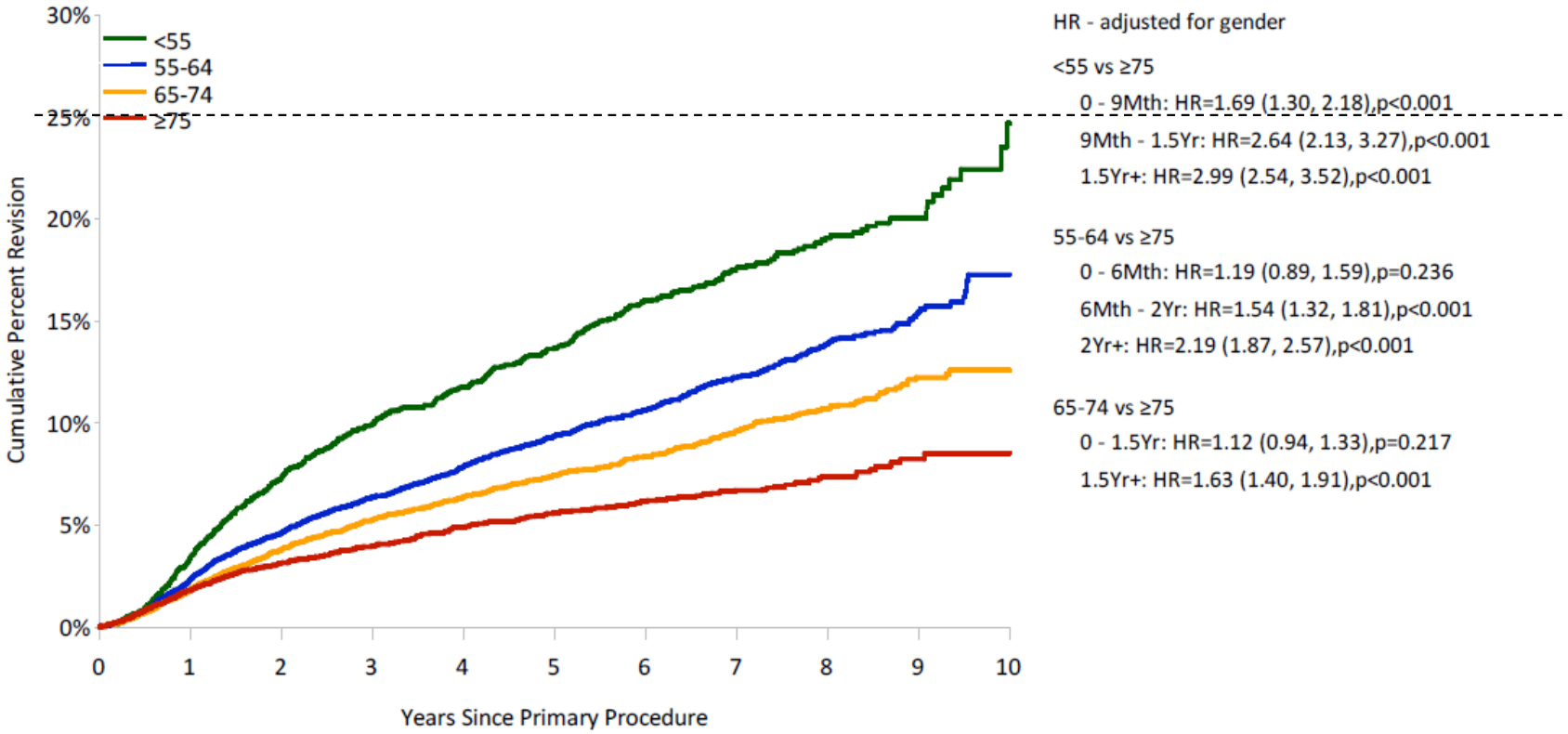
Literature-Survivorship

Figure KP12: Cumulative Percent Revision of Primary Unicompartmental Knee Replacement by Age (Prim Diagnosis OA)



HR - adjusted for gender

<55 vs ≥75

0 - 9Mth: HR=1.69 (1.30, 2.18),p<0.001

9Mth - 1.5Yr: HR=2.64 (2.13, 3.27),p<0.001

1.5Yr+: HR=2.99 (2.54, 3.52),p<0.001

55-64 vs ≥75

0 - 6Mth: HR=1.19 (0.89, 1.59),p=0.236

6Mth - 2Yr: HR=1.54 (1.32, 1.81),p<0.001

2Yr+: HR=2.19 (1.87, 2.57),p<0.001

65-74 vs ≥75

0 - 1.5Yr: HR=1.12 (0.94, 1.33),p=0.217

1.5Yr+: HR=1.63 (1.40, 1.91),p<0.001

75%

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HTO Registry Data

* Swedish Registry collecting data since 2013
* No outcome data in 2017 other than to state that 30 reported cases of re-operation since 2013 - nonunions
* Australian Registry collecting data since 2016
* The United Kingdom Knee Osteotomy Register (UKKOR) has been recently established to collect PROMs data

Literature-Conclusions

* Good to excellent results have been reported for both opening and closing wedge HTO.
* In open wedge osteotomy, the most reliable fixation and graft techniques are still controversial.
* Gold standard locked plates and autologous bone graft
* UKA achieves slightly better PROMS compared to HTO
* UKR lower survivorship
* Osteotomy is still the treatment of choice for the younger and more active patient with medial knee arthrosis.
* Different patient groups
* Revision of prior HTO to TKR is technically more demanding than a primary implant- there is no difference in the long-term outcomes
* Revision UKR to TKR yields inferior results than HTO to TKR

What we do now at SORI

* Choose patients wisely
* Navigated opening wedge
* 2.5 - 3 degrees valgus
* Allograft-tibial wedge or FH
* Locked plate –Tomofix
* Limited ROM brace
* Early weight bear-first steps
* Fully WB by 6 weeks

Choose patients wisely

* Avoid Osteotomy in conditions associated with poorer results

Advanced arthritis

Older patients-no absolute cut off

Patellofemoral arthritis

Markedly decreased range of motion

Inflammatory arthritis

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Indications

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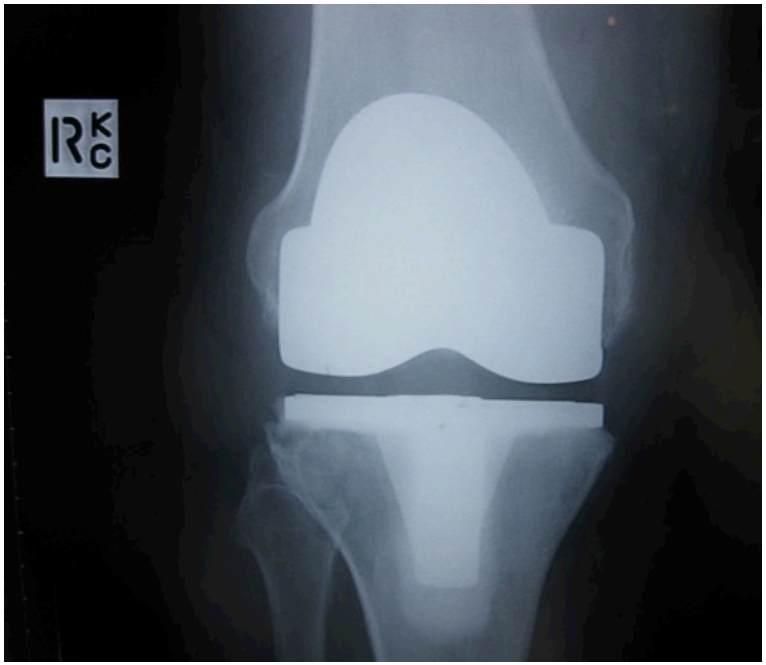

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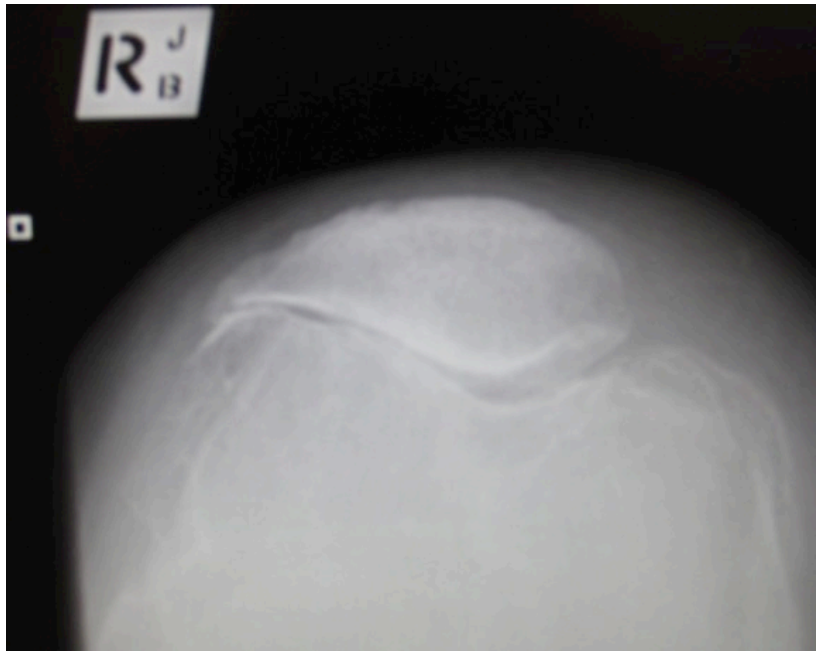

Indications

* Routinely obtain MRI to confirm lateral compartment satisfactory
* Happy to combine with ACL reconstruction
* Plan & assess with long films

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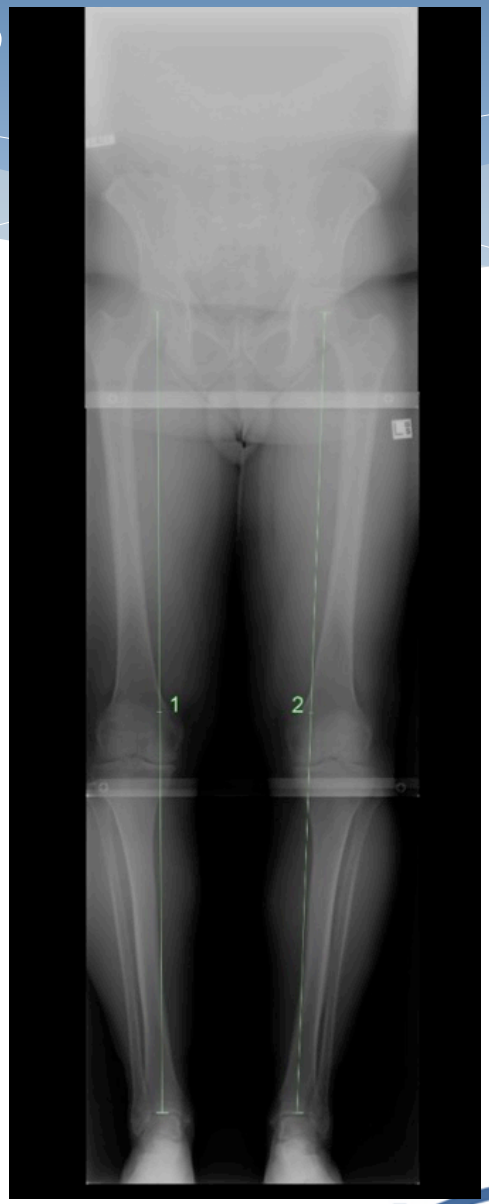

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Our Results

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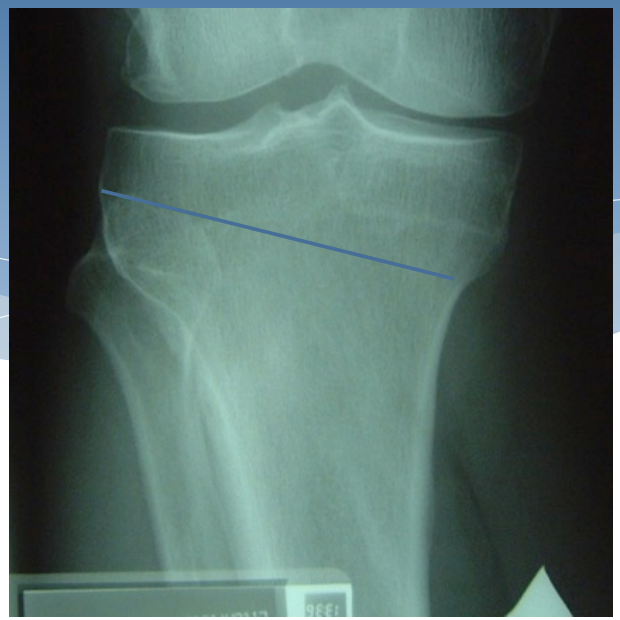
Methods

* 210 opening-wedge high tibial osteotomies
* November 2002 to October 2013
  * All procedures performed by 3 consultant surgeons

* Osteotomy for osteoarthritis or chondral defects with concomitant varus deformity
* From 2007 - all navigated

Osteotomy Technique



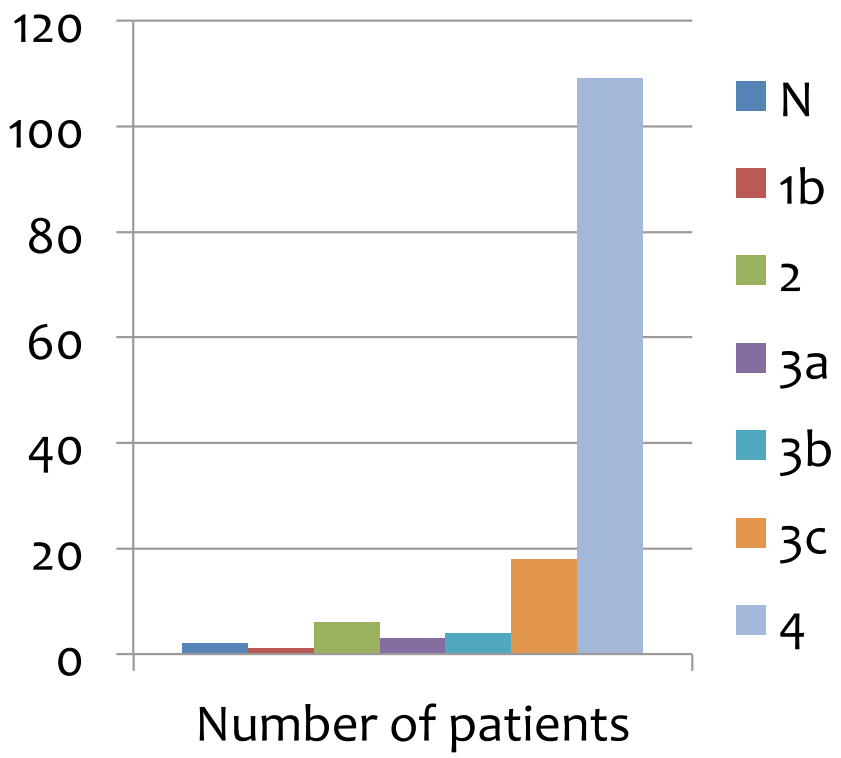
* Opening wedge
* Freehand guidewires
* Osteotomes
* Retractors
* Stable lateral hinge
* Gradual correction
* Moniter with navigation & fluroscopy

Methods – Survival Analysis

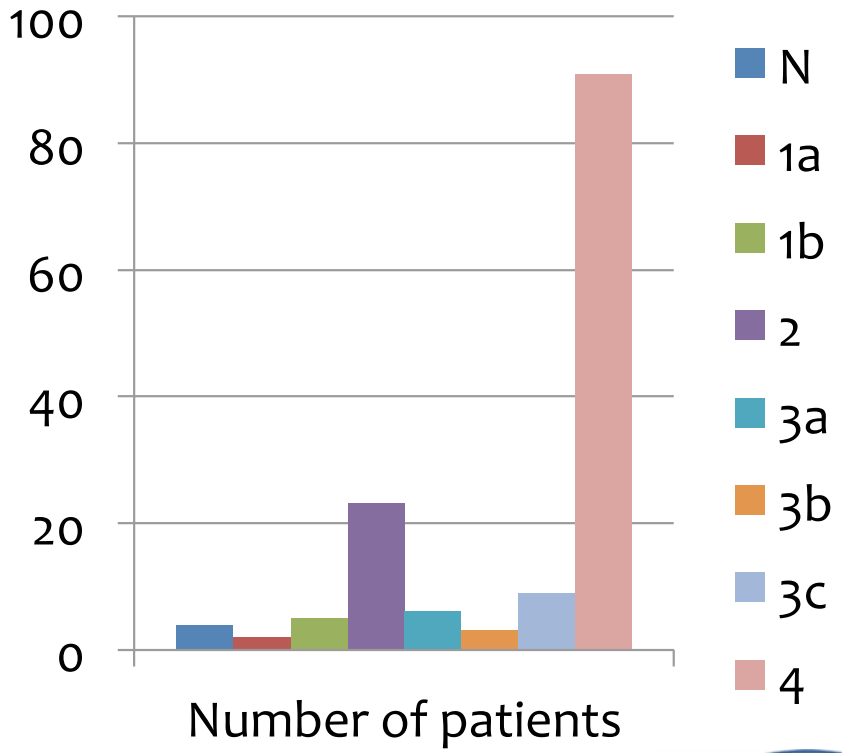
* Failure defined as conversion to Total Knee Replacement
* 19 lost to follow up
* National Joint Registry data was used to confirm any missed conversions
* Kaplan- Meier survivorship analysis

ICRS Medial Compartment

ICRS MFC N=143



ICRS MTP N=143



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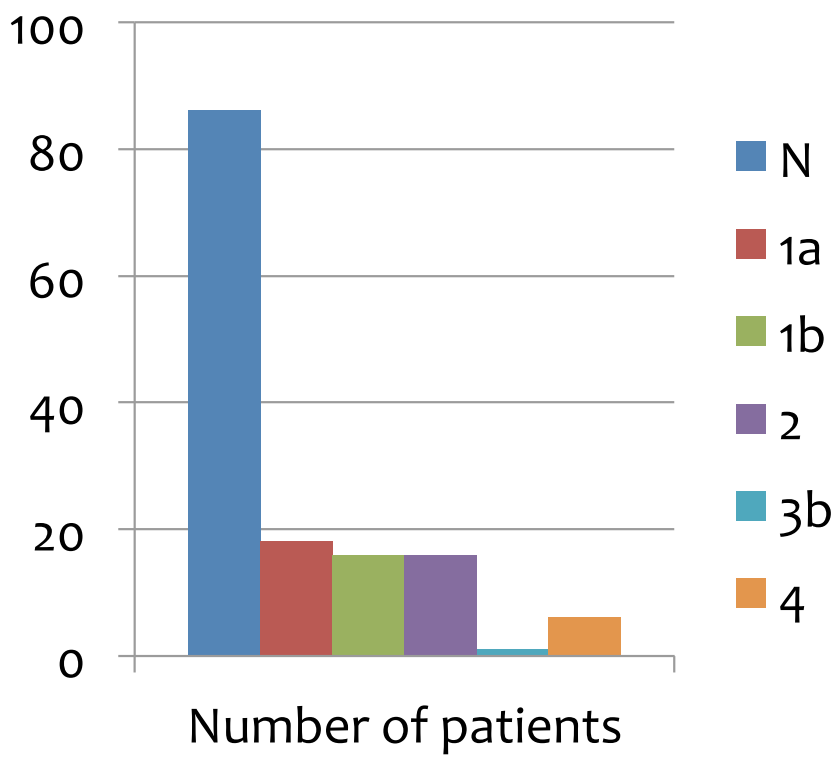
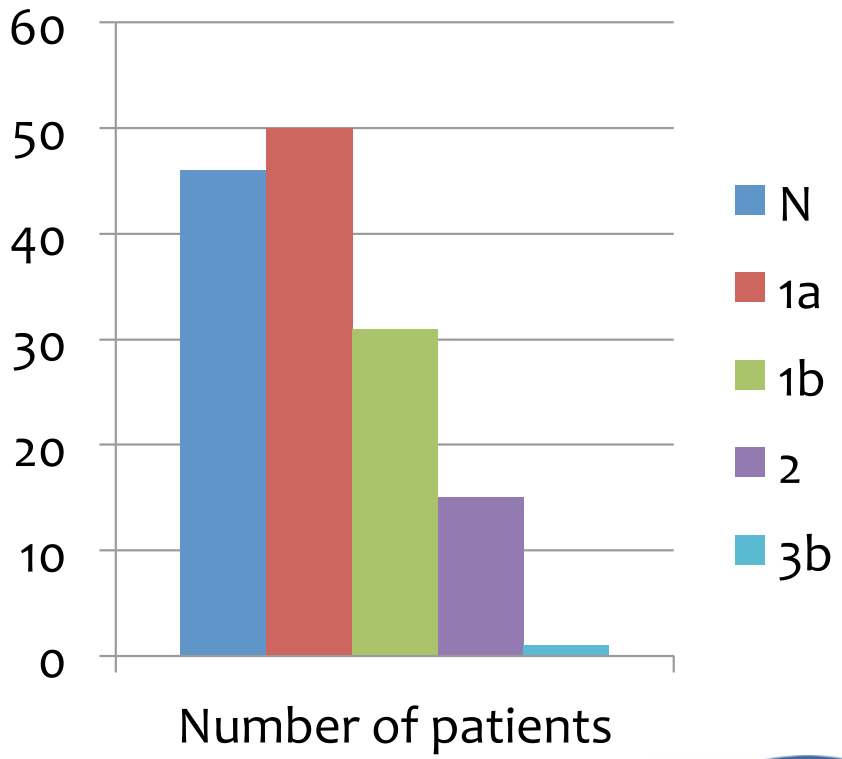
ICRS Lateral Compartment

ICRS LFC N=143



ICRS LTP N=143



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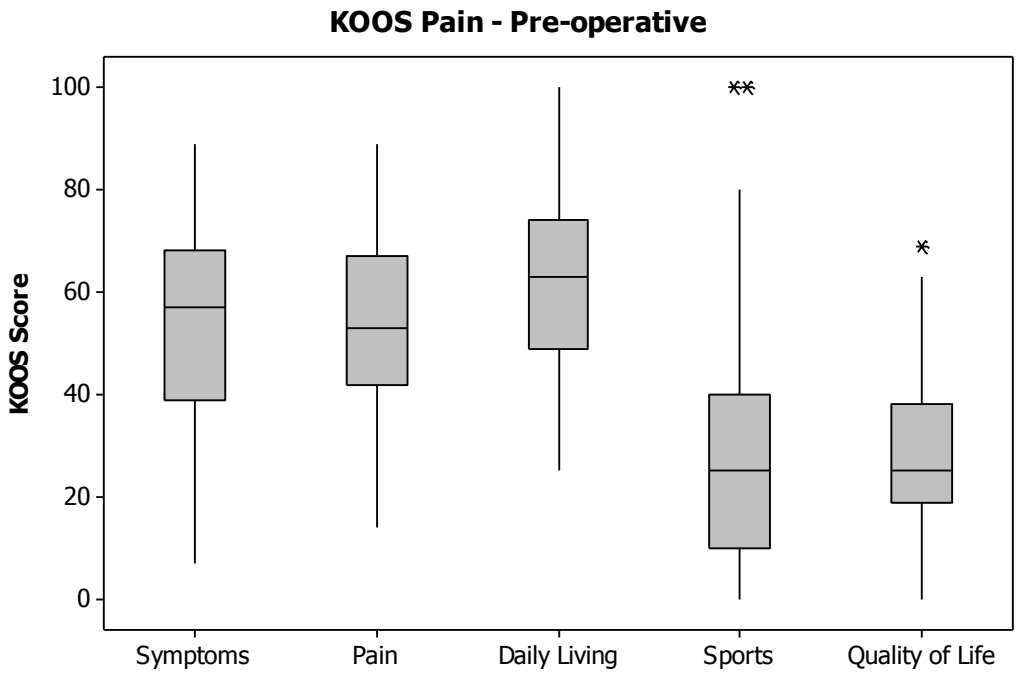
Patient Demographics

* Age 51
* Gender 86% male
* BMI 28 (26-32)
* Smoking-13% history
* Contra-lateral HTO 10%

* **KOOS Pre-op**



Results

* Post-op alignment

  3.5 (1.7-5.2)

* Converted to TKR

  14 - 6.8%

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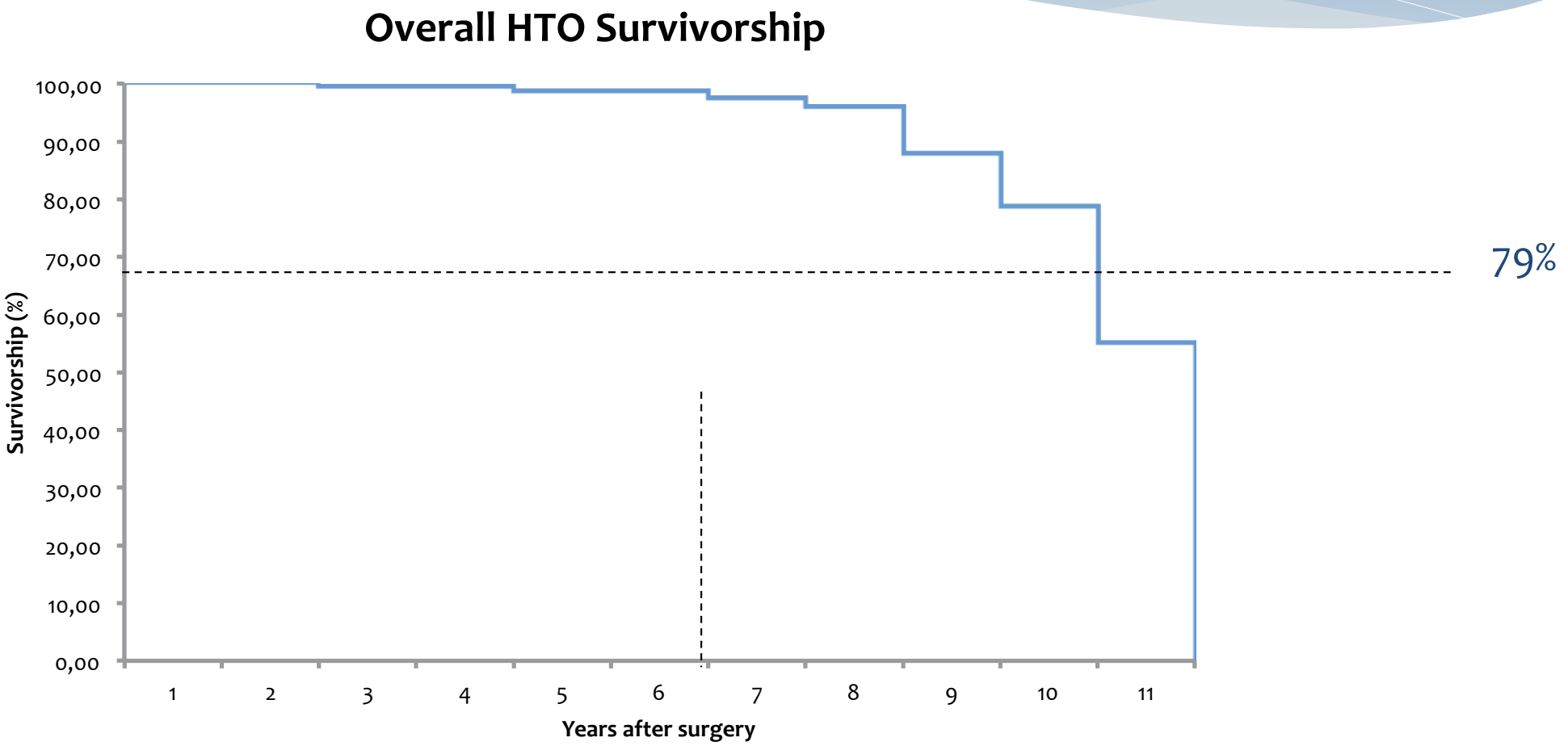
Procedure Survivorship



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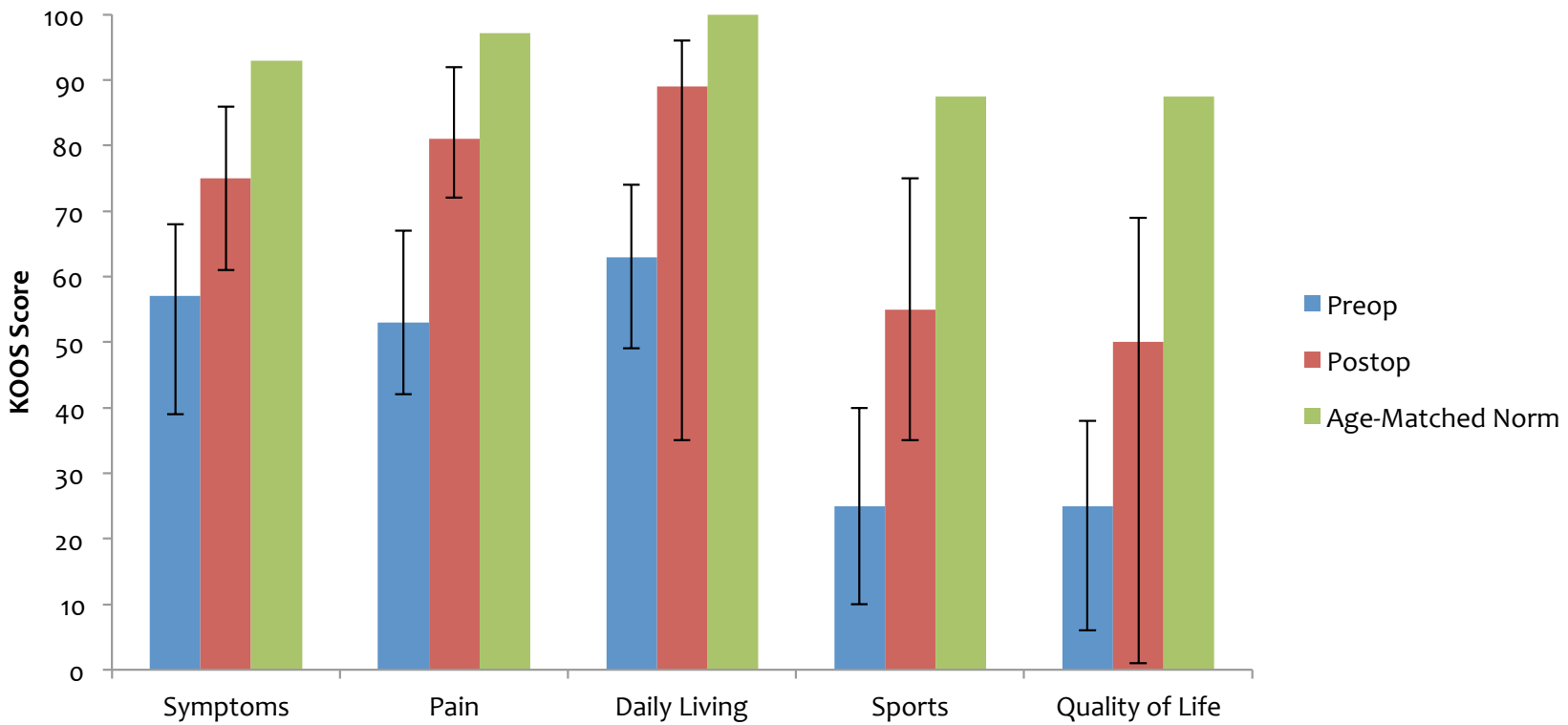
KOOS

* Average surgery to follow-up 2.1 years



Paradowski et al 2006
Males, 35-55yrs; N = 78

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Regression

Increased pain relief

* Increased postop valgus
* Increased BMI
* Worse pre-op pain

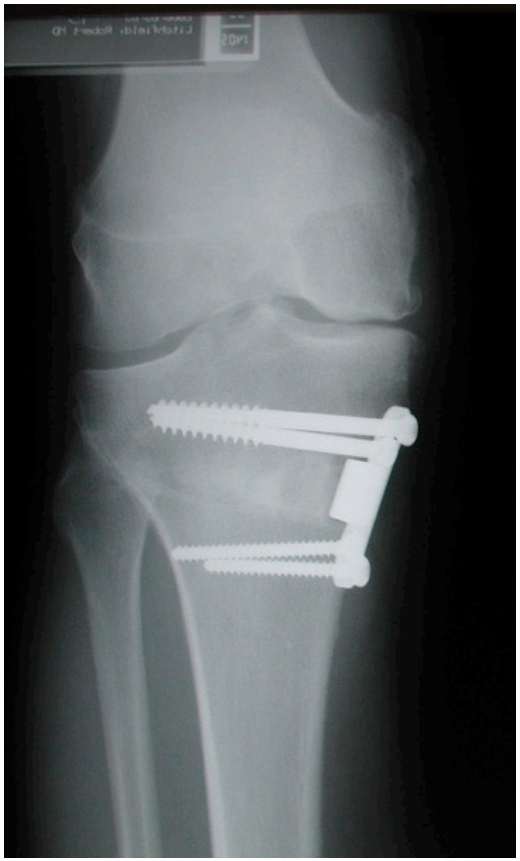
Decreased pain relief

* Male gender
* Increased surgery-follow-up time

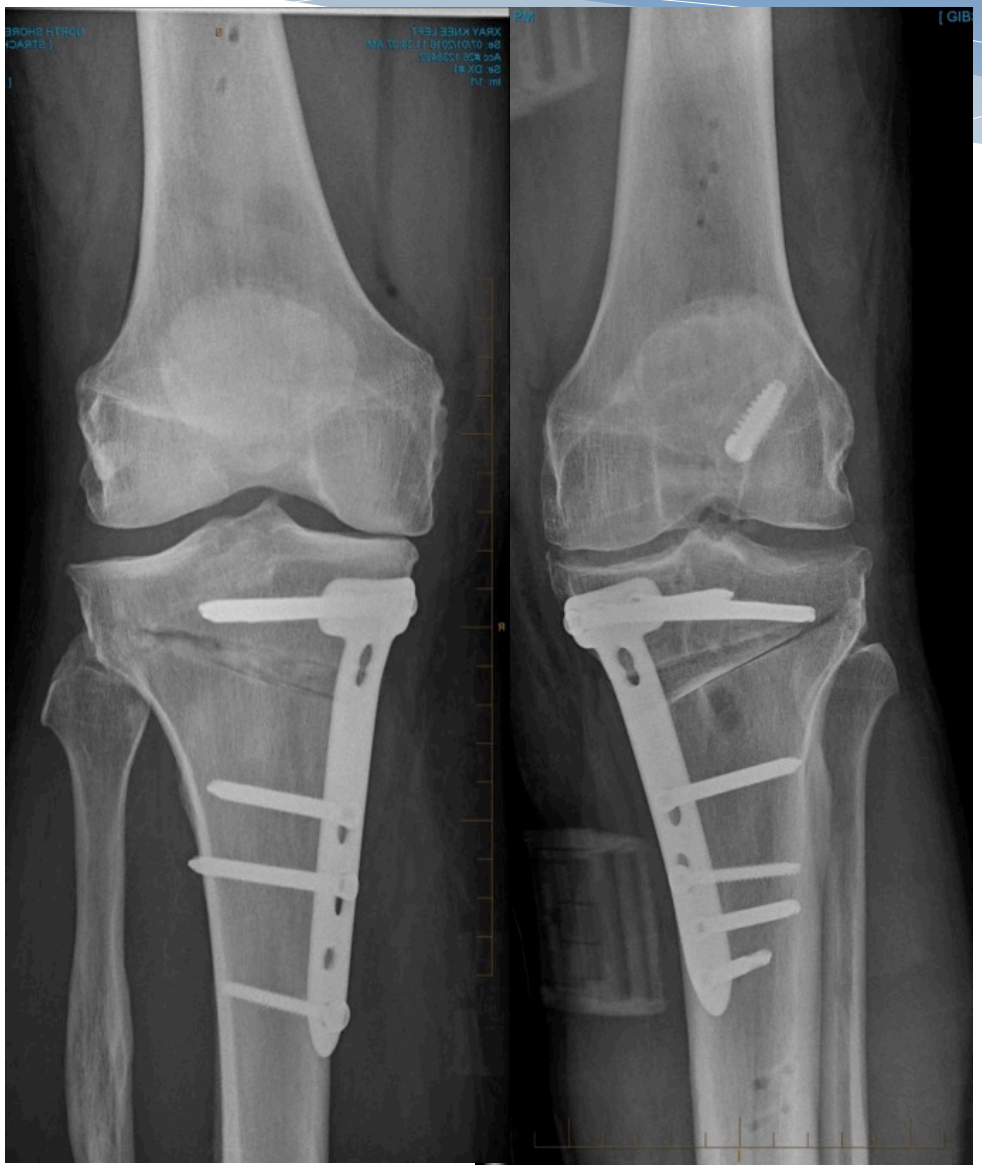
Conclusion

* HTO is a safe and effective procedure for relieving pain and improving function in "younger" patients with medial compartment OA
* Survival of 80% at 10.5 years
* Ongoing study will better direct indications and techniques
* Ongoing improvements in patient selection and surgical technique should further improve outcomes

→HTO should become an increasingly important option in surgical management of younger patients with OA



Thank You



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