SURGICAL APPROACH IN TOTAL HIP ARTHROPLASTY:

DOES IT REALLY MATTER?

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Cedars-Sinai Medical Center

Israel Orthopaedic Association
December, 2012

CEDARS-SINAI

DISCLOSURE

- **Consultant**
  - — **Zimmer**
  - — **Sanofi Biosurgical**
- **Research Support**
  - — **DePuy Orthopaedics**
  - — **Baxter**
- **Royalties**
  - — **DePuy Orthopaedics**

CEDARS-SINAI

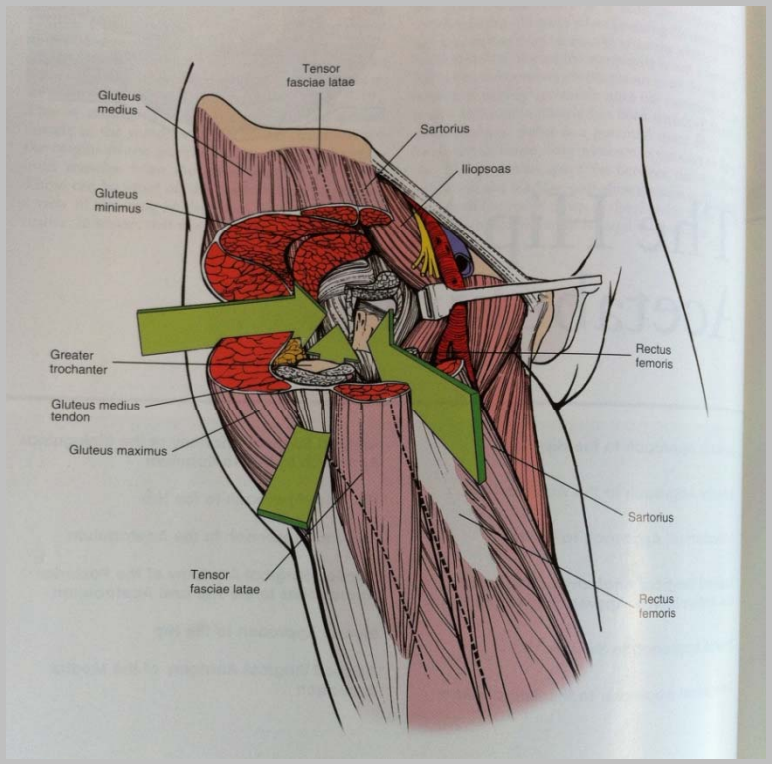
WHAT REALLY MATTERS IN THA?

What Really Matters in THA

- Component Position
- Stability
- Soft Tissue Balance
  - Limb Length
  - Offset
- Durable Fixation
- Minimal Complications
- Quality Outcomes
- Patient Satisfaction

Traditional Approaches to THA

- **Transtrochanteric Approach (Charnley)**
  - Trochanteric non-union
- **Direct Lateral (Hardinge)**
  - Postoperative Limp
- **Anterolateral (Watson-Jones)**
  - Postoperative Limp
- **Posterior Approach**
  - Dislocation

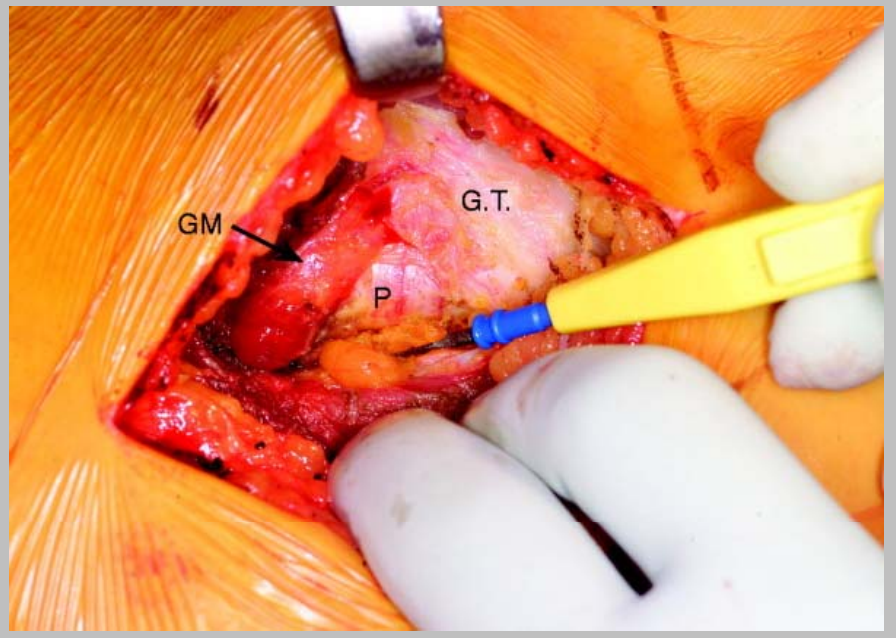


Minimally Invasive THA

- Shorter incisions
- Improved cosmesis
- Less Blood Loss
- Less muscle damage
- Less Pain
- Improved LOS
- Quicker recovery
- No compromises

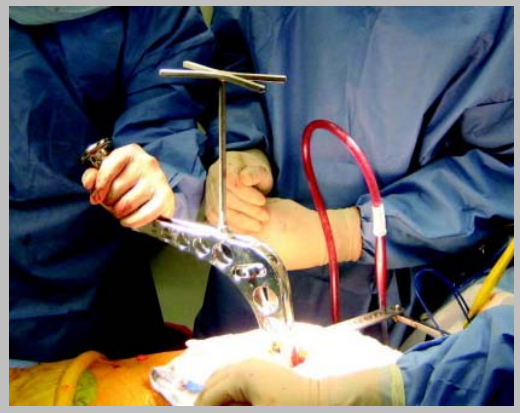
Minimally Invasive THA

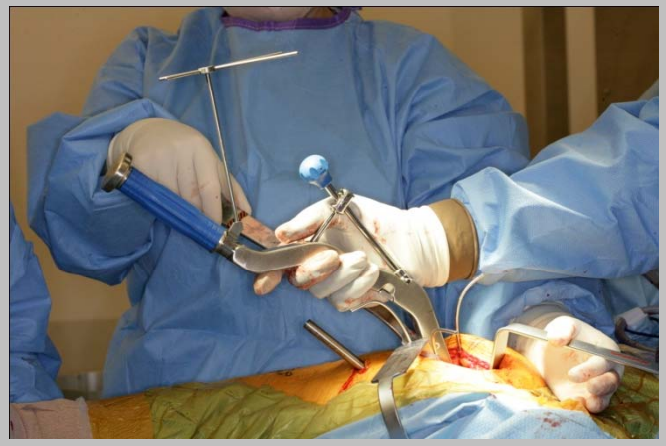
- Posterior
- Anterior
- Direct Lateral
- Anterolateral
- 2-Incision
- All Except 2-Incision can be adopted gradually, shortening the incision to comfort



Minimally Invasive THA

- **Prerequisites**
  - Patient Selection
  - Specialized Instruments
    - Retractors
    - Inserters
    - Lighting
    - Reamers
    - Broaches





Early Results of MIS THA

- **Larry Dorr—Mini Posterior**
  - **Improved Pain Relief**
    - Dorr, L. D., A. V. Maheshwari, et al. (2007). "Early pain relief and function after posterior minimally invasive and conventional total hip arthroplasty. A prospective, randomized, blinded study." J Bone Joint Surg Am 89(6): 1153-1160.
  - **Improved psychological satisfaction and body image**
    - Dorr, L. D., D. Thomas, et al. (2007). "Psychologic reasons for patients preferring minimally invasive total hip arthroplasty." Clin Orthop Relat Res 458: 94-100.
  - **Outpatient THA**
    - Dorr, L. D., D. J. Thomas, et al. (2010). "Outpatient total hip arthroplasty." J Arthroplasty 25(4): 501-506.

Early Results of MIS THA

- **Richard Berger—2-Incision Technique**
  - **Early rehabilitation, same-day discharge, no complications**
    - **Berger, R. A., J. J. Jacobs, et al. (2004). "Rapid rehabilitation and recovery with minimally invasive total hip arthroplasty." Clin Orthop Relat Res(429): 239-247.**
- **Joel Matta—Anterior Approach**
  - **Excellent results, low complications, rapid recovery**
    - **Matta, J. M., C. Shahrdar, et al. (2005). "Single-incision anterior approach for total hip arthroplasty on an orthopaedic table." Clin Orthop Relat Res 441: 115-124.**

CHALLENGES WITH MIS

MIS THA: Early Complications

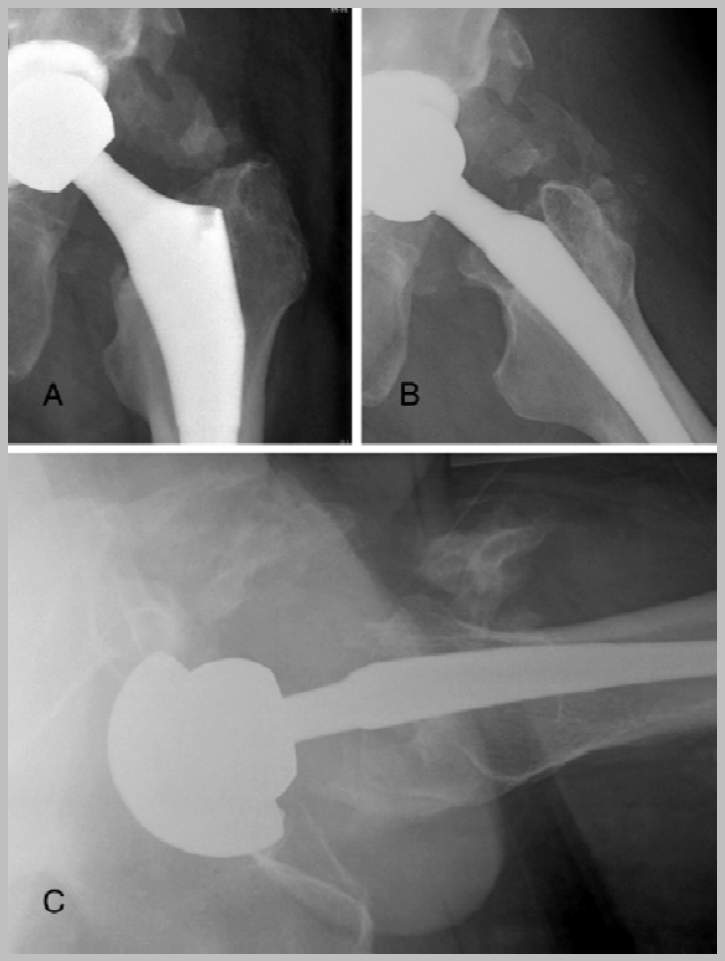
Catastrophic Complications of Minimally Invasive Hip Surgery

A Series of Three Cases

By Thomas K. Fehring, MD, and J. Bohannon Mason, MD

Investigation performed at the Charlotte Hip and Knee Center, Charlotte, North Carolina

MIS THA: Early Complications



Severe Symptomatic Heterotopic Ossification and Dislocation: A Complication After Two-Incision Minimally Invasive Total Hip Arthroplasty

Jeffrey S. Feinblatt, MD,* Keith R. Berend, MD,*†‡§ and
Adolph V. Lombardi Jr, MD, FACS*†‖¶

Heterotopic Ossification After 2-Incision Total Hip Arthroplasty

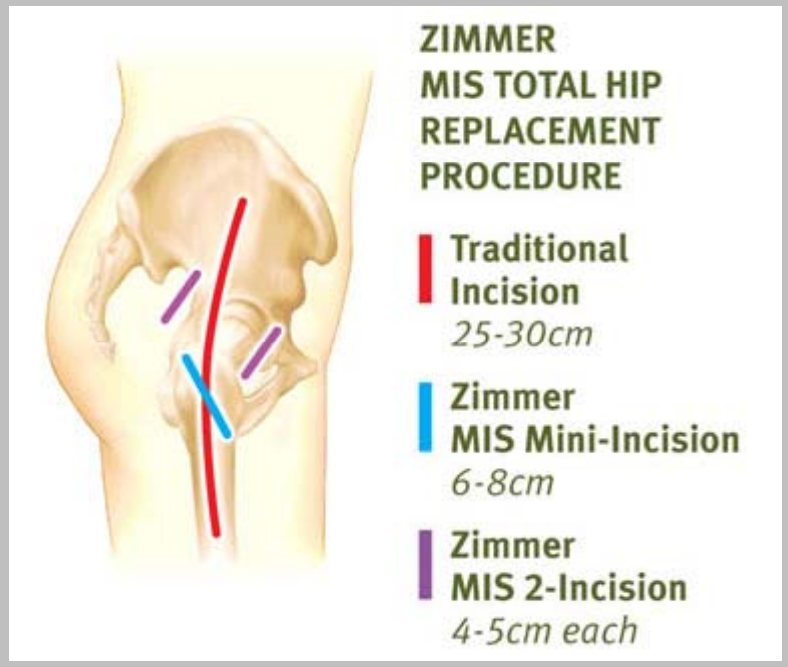
B. Sonny Bal, MD, Jason A. Lowe, MD,
Ann E. Gietler, MD, and Thomas J. Aleto, MD

MIS THA: Confounders

- Accelerated Rehabilitation
- Patient Education
- Multimodal Pain Management
- Improved Anesthesia
- Advanced Surgical Techniques
  - Navigation
  - Fluoroscopy
  - Robotics

Conflicts and MIS THA

- Proprietary Techniques
- Proprietary Instruments
- Required Prostheses
- Retain or Attract Cases
  - Advertising



Conflicts and MIS THA

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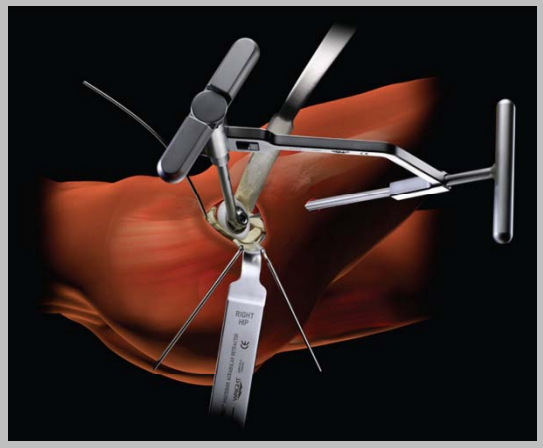
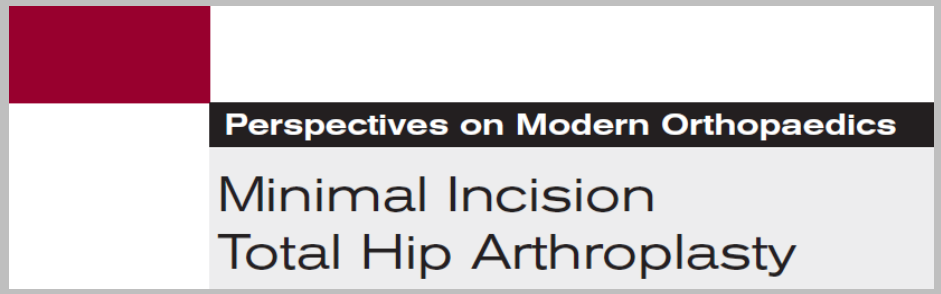


Minimal Incision THA



- **"With a few exceptions, the published literature on minimal incision hip arthroplasty is retrospective, lacking controls, statistically under-powered, and derived from proceedings, supplements, and invited articles rather than from unsolicited, independently peer-reviewed studies."**
- **"…the patient who has undergone THA through smaller incision is no better at ≥ 6 weeks…than the patient who has undergone THA through a standard incision."**

Vail, T. P. and J. J. Callaghan (2007). "Minimal incision total hip arthroplasty." J Am Acad Orthop Surg 15(12): 707-715.

Learning Curve

- **Wikipedia**

"A learning curve is a relationship of the duration or the degree of effort invested in learning and experience with the resulting progress, considered as an exploratory discovery process."

"experience curve", "improvement curve", "cost improvement curve", "progress curve", "progress function", "startup curve", and "efficiency curve"

CONTROVERSIES

Learning curves in surgical practice

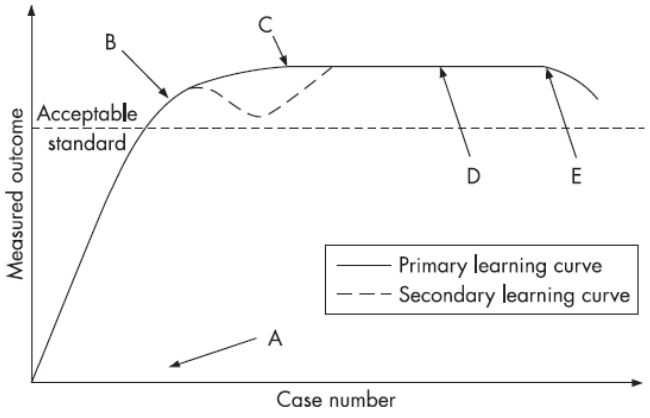


Figure 1 Idealised surgical learning curve.

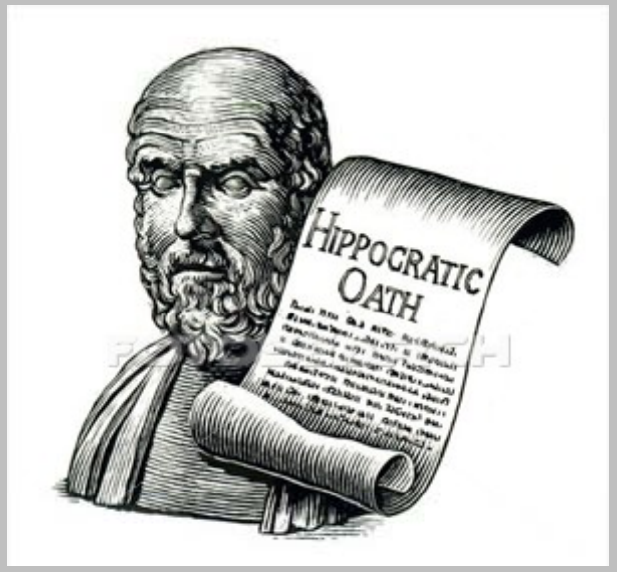
- A—Commencement of training
- B—Independent Competence
  - Temporary performance deterioration due to case mix, over-confidence, lapses in technique or judgment
- C—Small Incremental Improvements
- D—Plateau
- E—Declining performance from aging, negating benefits of experience

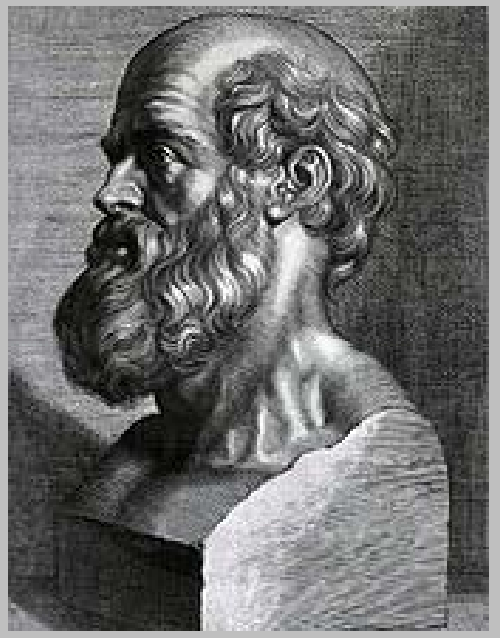
Hopper, A. N., M. H. Jamison, et al. (2007). "Learning curves in surgical practice." Postgrad Med J 83(986): 777-779.

Learning Curve

- **Primum non nocere (Above all do no harm)**


ΙΠΠΟΚΡΑΤΟΥΣ
ΟΡΚΟΣ
HIPPOCRATIS
IVSIVRANDVM





Learning Curve in MIS THA

- 46 DAA vs 46 Standard Posterolateral
  - No Improvement in functional outcome
  - Higher early complication rate
  - No learning benefit after 46 cases
- "…we recommend that hip surgeons should be very careful in changing their daily routine and performing THA through a technique whose benefit has not been proven in the long term and which could cause an increase in complications, especially during the learning-curve phase."

Spaans, A. J., J. A. Hout, et al. (2012). "High complication rate in the early experience of minimally invasive total hip arthroplasty by the direct anterior approach." Acta Orthop 83(4): 342-346.

Learning Curve in MIS THA

- Anterior Approach
- 81 patients
  - 3 groups of 20
  - 1 group of 21
- “Proficiency improved after 40 cases, and was more marked after 60 cases”
- No major complications
- “Surgeons considering this approach should expect a substantial learning period.”

Goytia, R. N., L. C. Jones, et al. (2012). "Learning curve for the anterior approach total hip arthroplasty." J Surg Orthop Adv 21(2): 78-83.

Learning Curve in MIS THA

- Anterior-supine intermuscullar approach
- “The authors found the learning curve to be around 40 cases and 6 months in a high-volume joint surgeon’s practice.”
- Cadaver dissections and one-on-on mentoring are recommended when implementing this approach in one’s practice.

Seng, B. E., K. R. Berend, et al. (2009). "Anterior-supine minimally invasive total hip arthroplasty: defining the learning curve." Orthop Clin North Am 40(3): 343-350.

Learning Curve in MIS THA

Comparison of Primary Total Hip Replacements Performed with a Standard Incision or a Mini-Incision

By Steven T. Woolson, MD, Christopher S. Mow, MD, Jose Fernando Syquia, MD, John V. Lannin, MD, and David J. Schurman, MD

Investigation performed at Stanford University Hospital, Stanford, California

Woolson, S. T., C. S. Mow, et al. (2004). "Comparison of primary total hip replacements performed with a standard incision or a mini-incision." J Bone Joint Surg Am 86-A(7): 1353-1358.

Learning Curve in MIS THA

	MIS	STANDARD	
HIPS	135	85	
WEIGHT (BMI)	25	28	P = 0.008
ASA	1.76	2.14	P = 0.006
WOUND COMPLICATION	3	0	P = 0.02
ACET MALPOSITION	15	13	P = 0.04
POOR FEMORAL FIT & FILL	13%	0%	P = 0.0036
SURGICAL TIME	97	105	P = 0.13
BLOOD LOSS	603	507	P = 0.12
TRANSFUSION	1.5	1.6	P = 0.49
LENGTH OF STAY	4	4	P = 0.44
DISPOSITION	48%	35%	P= 0.15

Woolson, S. T., C. S. Mow, et al. (2004). "Comparison of primary total hip replacements performed with a standard incision or a mini-incision." J Bone Joint Surg Am 86-A(7): 1353-1358.

Learning Curve in MIS THA

COMPARISON OF PRIMARY TOTAL HIP REPLACEMENTS PERFORMED WITH A STANDARD INCISION OR A MINI-INCISION

BY STEVEN T. WOOLSON, MD, CHRISTOPHER S. MOW, MD, JOSE FERNANDO SYQUIA, MD, JOHN V. LANNIN, MD, AND DAVID J. SCHURMAN, MD

Investigation performed at Stanford University Hospital, Stanford, California

- **Based on authors' initial experience**
- **Failed to confirm positive clinical outcomes**
- **Further analysis of technique needed before it can be recommmended for general use**

Woolson, S. T., C. S. Mow, et al. (2004). "Comparison of primary total hip replacements performed with a standard incision or a mini-incision." J Bone Joint Surg Am 86-A(7): 1353-1358.

Learning Curve in MIS THA

Primary Total Hip Arthroplasty Using an Anterior Approach and a Fracture Table

Short-term Results From a Community Hospital

Steven T. Woolson, MD,* Michael A. Pouliot, BA,† and James I. Huddleston, MD*

- 247 hips, 5 community surgeons
- Double that of innovator
  - Surgical time =164
  - EBL = 858
- 6 times rate of innovator
  - Major complications (9%)
- "Adequate training is critical to reduce the risk of complications during the learning experience of minimally invasive hip arthroplasty procedures by community practice surgeons."

Woolson, S. T., M. A. Pouliot, et al. (2009). "Primary total hip arthroplasty using an anterior approach and a fracture table: short-term results from a community hospital." J Arthroplasty 24(7): 999-1005.

Learning Curve in MIS THA

- Zimmer MIS 2-Incision Training
- 159 Surgeons
  - 10 cases each
    - Significant decrease in OR/Fluoro time
    - NO decrease complications
- Learning curve is longer than 10 cases
  - Patient characteristics
  - Surgeon experience

Archibeck, M. J. and R. E. White, Jr. (2004). "Learning curve for the two-incision total hip replacement." Clin Orthop Relat Res(429): 232-238.

WHAT HAPPENS AFTER THE LEARNING CURVE?

Complication in MIS Surgery

High Complication Rate With Anterior Total Hip Arthroplasties on a Fracture Table

Brian A. Jewett MD, Dennis K. Collis MD

Series of 800 THAs

Table 1. Intraoperative complications

Complication	Number
Trochanteric fracture	19 (2.3%)
Femoral perforation	3 (0.37%)
Femur fracture	1 (0.12%)
Acetabular fracture	1 (0.12%)
Bleeding	1 (0.12%)
Cardiovascular	1 (0.12%)
Ankle fracture	0
Total	26

Table 2. Postoperative complications

Complication	Number
Infection	7 (0.88%)
Dislocation	7 (0.88%)
Wound healing	37 (4.6%)
Femur fracture	1 (0.12%)
Superficial nerve injury	1 (0.12%)
DVT/PE	14 (1.75%)/2 (0.25%)
Other medical	24 (3.1%)
UTI	4
A-Fib	2
Delirium	10
Ileus	2
Pneumonia	2
MI	1
CVA	1
Other CV	2
Total	91

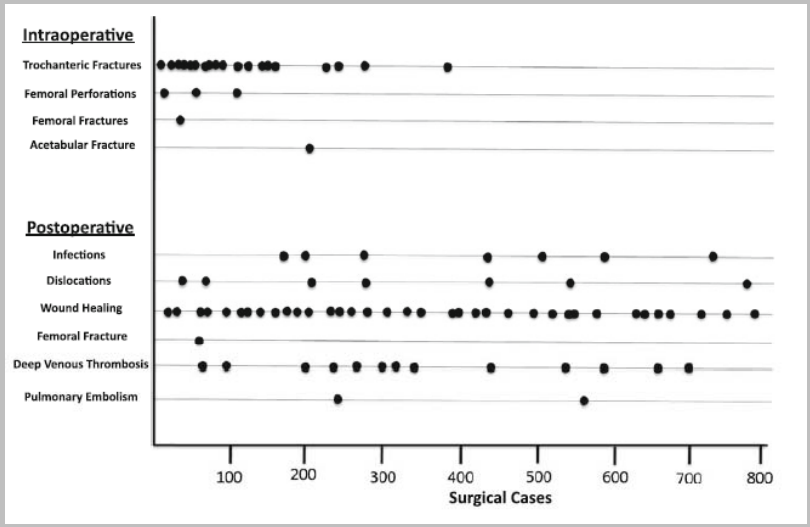
DVT = deep venous thrombosis; PE = pulmonary embolism; UTI = urinary tract infection; A-Fib = atrial fibrillation; MI = myocardial infarction; CVA = cerebrovascular accident; CV = cerebrovascular.

Jewett, B. A. and D. K. Collis (2011). "High complication rate with anterior total hip arthroplasties on a fracture table." Clin Orthop Relat Res 469(2): 503-507.

Complication in MIS Surgery

High Complication Rate With Anterior Total Hip Arthroplasties on a Fracture Table

Brian A. Jewett MD, Dennis K. Collis MD



"Despite potential advantages…surgeons whould be aware of the potential complications…associated with this technique."

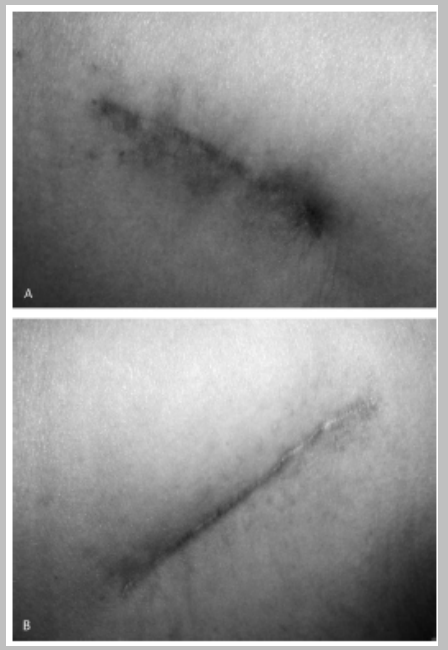
Jewett, B. A. and D. K. Collis (2011). "High complication rate with anterior total hip arthroplasties on a fracture table." Clin Orthop Relat Res 469(2): 503-507.

Scars in MIS THA

Comparison of Scars from Total Hip Replacements Done with a Standard or a Mini-incision

Christopher S. Mow, MD; Steven T. Woolson, MD*; Srihatach G. Ngarmukos, MD*; Edward H. Park, MD†; and H. Peter Lorenz, MD†*

- **Mini Incision Wounds**
  - **More rated poor by plastic surgeons**
  - **More wound healing problems**
- **30/31 patients rated pain relief and longevity higher priorities than cosmesis**
- **Cosmesis may be inferior to standard incision scars due to retraction**



Mow, C. S., S. T. Woolson, et al. (2005). "Comparison of scars from total hip replacements done with a standard or a mini-incision." Clin Orthop Relat Res 441: 80-85.

Early Failure in MIS THA

Minimal Incision Surgery as a Risk Factor for Early Failure of Total Hip Arthroplasty

Bradley P. Graw MD, Steven T. Woolson MD,
Heather G. Huddleston MD, Stuart B. Goodman MD, PhD,
James I. Huddleston MD

- Retrospective review
- 46 revision THAs
  - Excluded re-revisions and infections
  - No differences in age, gender, BMI
- Most common reasons for revision in MIS THA
  - Intraoperative fracture
  - Femoral loosening
- MIS THA may be risk factor for early revision

	MIS	NON-MIS
N	15 (33%)	31 (67%)
MEAN TIME TO REVISION (YRS)	1.4	14.7
REVISION WITHIN 2 YEARS	12	4

Graw, B. P., S. T. Woolson, et al. (2010). "Minimal incision surgery as a risk factor for early failure of total hip arthroplasty." Clin Orthop Relat Res 468(9): 2372-2376.

MIS vs Standard Posterior THA

Mini-Incision for Total Hip Arthroplasty

A Prospective, Controlled Investigation With 5-Year Follow-Up Evaluation

John M. Wright, MD,* Heber C. Crockett, MD,* Sam Delgado, SA-C,†
Stephen Lyman, PhD,† Mike Madsen, MD,† and Thomas P. Sculco, MD†

- MIS vs Convetional THA
- No difference in outcomes
  - Infection
  - Nerve Palsy
  - Component malposition
  - Aseptic loosening
  - Dislocation
- MIS patients preferred cosmetic result
- No clinical benefit other than COSMETIC APPEAL

Wright, J. M., H. C. Crockett, et al. (2004). "Mini-incision for total hip arthroplasty: a prospective, controlled investigation with 5-year follow-up evaluation." J Arthroplasty 19(5): 538-545.

MIS vs Standard Posterior THA

A Minimal-Incision Technique in Total Hip Arthroplasty Does Not Improve Early Postoperative Outcomes

A Prospective, Randomized, Controlled Trial

By Luke Ogonda, MRCS, Roger Wilson, MRCS, Pooler Archbold, MRCS, Marie Lawlor, BSc(Hons), MCSP, Patricia Humphreys, BSc(Hons), MCSP, Seamus O'Brien, PhD, and David Beverland, MD, FRCS

Investigation performed at Musgrave Park Hospital, Belfast, Northern Ireland, United Kingdom

- 219 hips randomized
- Single incision posterior approach
- Blinded during hospital stay
- Standardized protocol
  - Anesthesia
  - Analgesia
  - Postoperative PT

- No benefit in early postop period
  - Transfusion
  - Pain
  - Walking ability
  - LOS
  - Component position
  - Component fixation
  - Functional scores
    - 6 weeks

Ogonda, L., R. Wilson, et al. (2005). "A minimal-incision technique in total hip arthroplasty does not improve early postoperative outcomes. A prospective, randomized, controlled trial." J Bone Joint Surg Am 87(4): 701-710.

MIS vs Standard Anterolateral THA

Minimally Invasive Compared with Traditional Transgluteal Approach for Total Hip Arthroplasty

A Comparative Gait Analysis

By M. Pospischill, MD, A. Kranzl, Mag, B. Attwenger, and K. Knahr, MD

Investigation performed at the Orthopedic Hospital Vienna—Speising, Vienna, Austria

- **"With regard to gait kinematics in the early postoperative period (three months), the present study showed no significant benefits for…minimally invasive…approach in comparison with…a standard…approach."**

Pospischill, M., A. Kranzl, et al. (2010). "Minimally invasive compared with traditional transgluteal approach for total hip arthroplasty: a comparative gait analysis." J Bone Joint Surg Am 92(2): 328-337.

Functional Outcome after MIS THA

A Randomized, Prospective Study of 3 Minimally Invasive Surgical Approaches in Total Hip Arthroplasty

Comprehensive Gait Analysis

- 24 hips randomized
  - Mini posterior approach
  - Mini anterolateral approach
  - 2-incision approach
- No difference at 6 weeks and 1 year in gait analysis parameters

Meneghini, R. M. and S. A. Smits (2009). "Early discharge and recovery with three minimally invasive total hip arthroplasty approaches: a preliminary study." Clin Orthop Relat Res 467(6): 1431-1437.

MIS THA: Incision or Other Factors

Minimally Invasive Hip Arthroplasty:
What Role Does Patient Preconditioning Play?

By Aidin Eslam Pour, MD, Javad Parvizi, MD, FRCS, Peter F. Sharkey, MD, William J. Hozack, MD, and Richard H. Rothman, MD, PhD

- **Most important factors influencing outcomes**
  - **Family education**
  - **Patient preconditioning**
  - **Pre-emptive analgesia**
  - **Preop and Postop Rehab acceleration**
- **Surgical technique may not matter**

Pour, A. E., J. Parvizi, et al. (2007). "Minimally invasive hip arthroplasty: what role does patient preconditioning play?" J Bone Joint Surg Am 89(9): 1920-1927.

MIS vs Standard THA

Single Mini-Incision Total Hip Replacement for the Management of Arthritic Disease of the Hip

A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Mari Imamura, PhD, Niall A. Munro, MD, FRCS(Tr&Orth), Shihua Zhu, PhD, Cathryn Glazener, PhD, Cynthia Fraser, MA, James Hutchison, FRCSEd, PhD, and Luke Vale, PhD

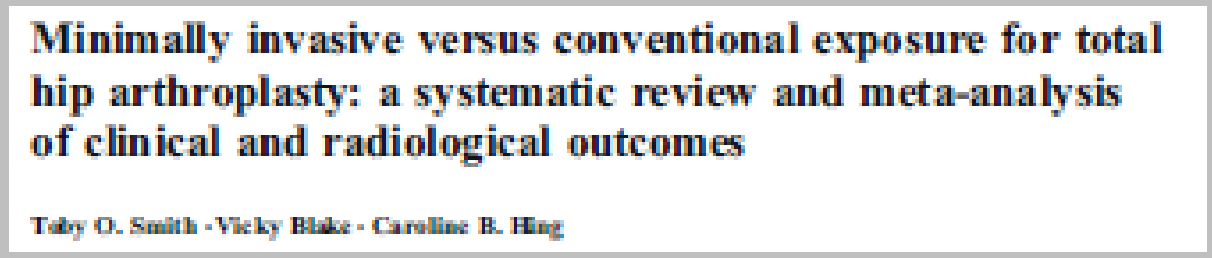
Investigation performed at the Health Services Research Unit, University of Aberdeen, Aberdeen, United Kingdom

- **Meta Analysis through 3/10**
  - **RCT and quasi RCT**
  - **1857 hips**
  - **F/u 6 weeks to 3 years**
- **Small, non-clinically important advantages**
  - **Less blood loss**
  - **Shorter OR times**
  - **Shorter LOS**

"...no strong evidence either for or against mini-incision compared with standard incision total hip replacement."

Imamura, M., N. A. Munro, et al. (2012). "Single mini-incision total hip replacement for the management of arthritic disease of the hip: a systematic review and meta-analysis of randomized controlled trials." J Bone Joint Surg Am 94(20): 1897-1905.

MIS vs Standard THA


Minimally invasive versus conventional exposure for total hip arthroplasty: a systematic review and meta-analysis of clinical and radiological outcomes

Toby O. Smith · Vicky Blake · Caroline B. Hing

- Systematic review
  - Published and unpublished literature
  - Randomized and non-randomized controlled trials
  - Clinical and radiologic outcomes
- 28 studies
  - 1428 MIS THA
  - 1421 Conventional THA
- Conclusions
  - Significantly increased risk of LFCN palsy (p=0.006)
  - No improvement in any other outcomes

Smith, T. O., V. Blake, et al. (2011). "Minimally invasive versus conventional exposure for total hip arthroplasty: a systematic review and meta-analysis of clinical and radiological outcomes." Int Orthop 35(2): 173-184.

Minimally Invasive THA

• Shorter incisions	• YES
• Improved cosmesis	• MAYBE NOT
• Less Blood Loss	• MAYBE NOT
• Less muscle damage	• MAYBE NOT
• Less Pain	• MAYBE NOT
• Improved LOS	• MAYBE
• Quicker recovery	• MAYBE NOT
• No compromises	• MANY

BRAD PENENBERG

Percutaneously

Assisted

Total

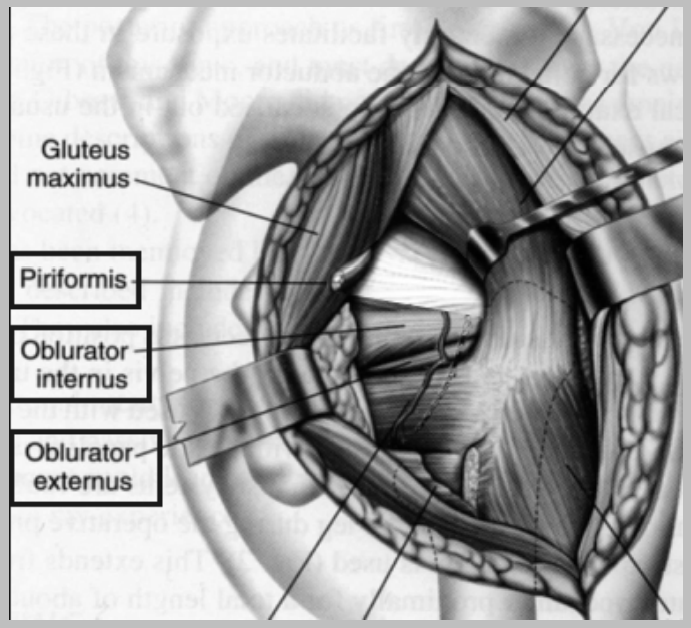
Hip arthroplasty

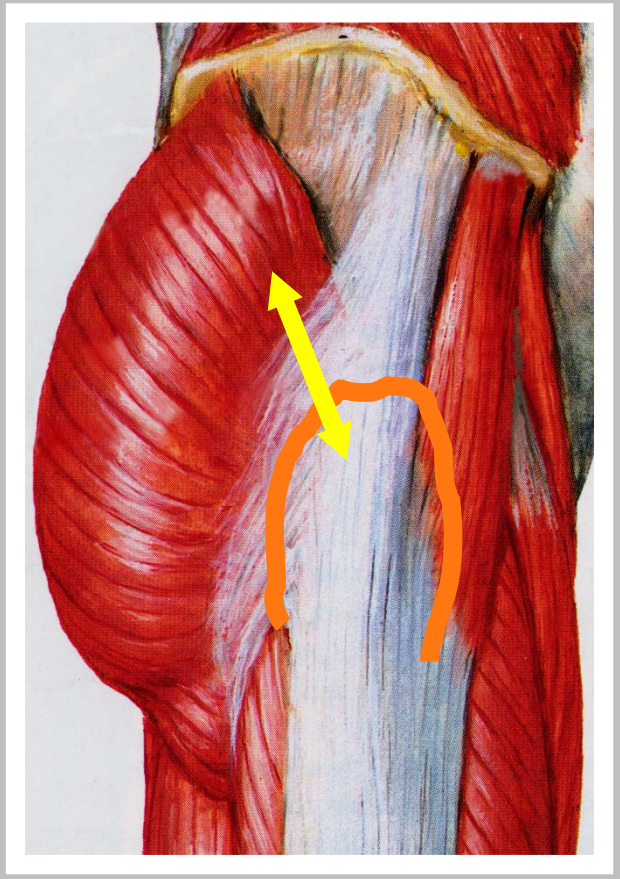
Minimally Invasive THA

- Mini Incision THA
  - –NOT MINIMALLY INVASIVE!!!
- True minimally invasive THA spares:
  - Skin
  - Muscle
  - Tendon
  - Fascia
  - Joint Capsule

PATH THA

- **Direct Posterior Approach**
  - **Incision over Pyriformis**
  - **Pyriformis release only**





PATH THA

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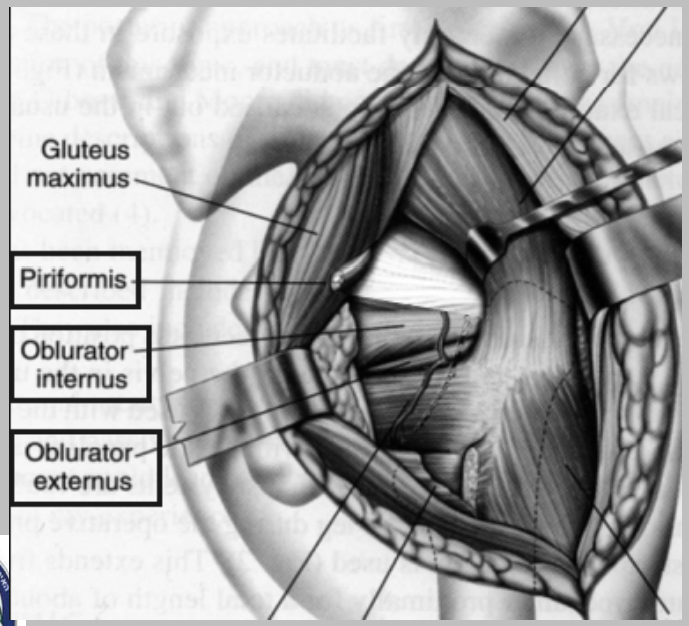
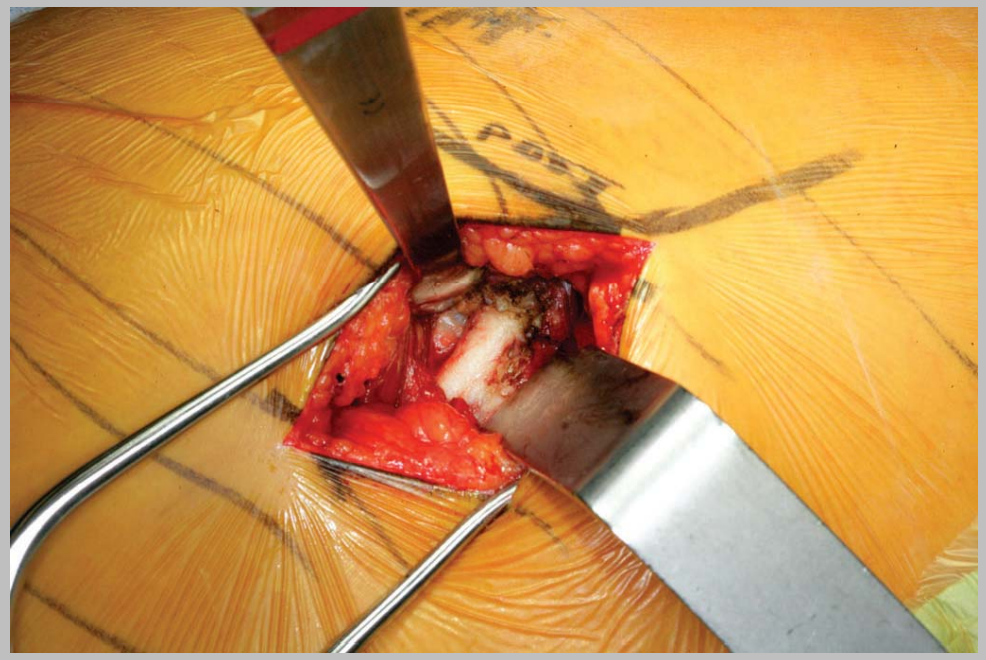
  - **Pyriformis release only**



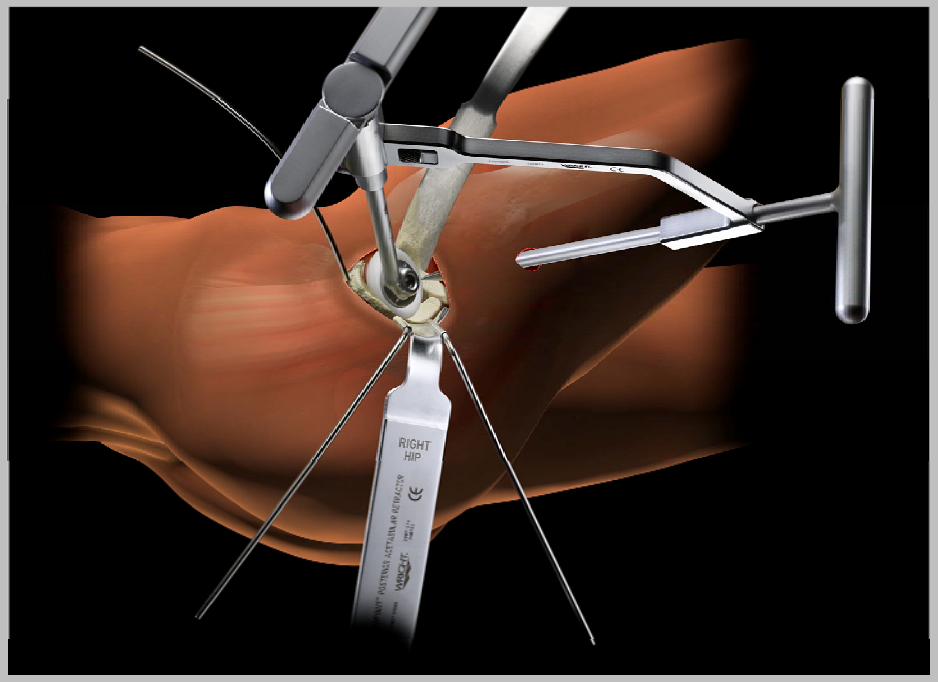


PATH THA

- Visualization
  - Headlight

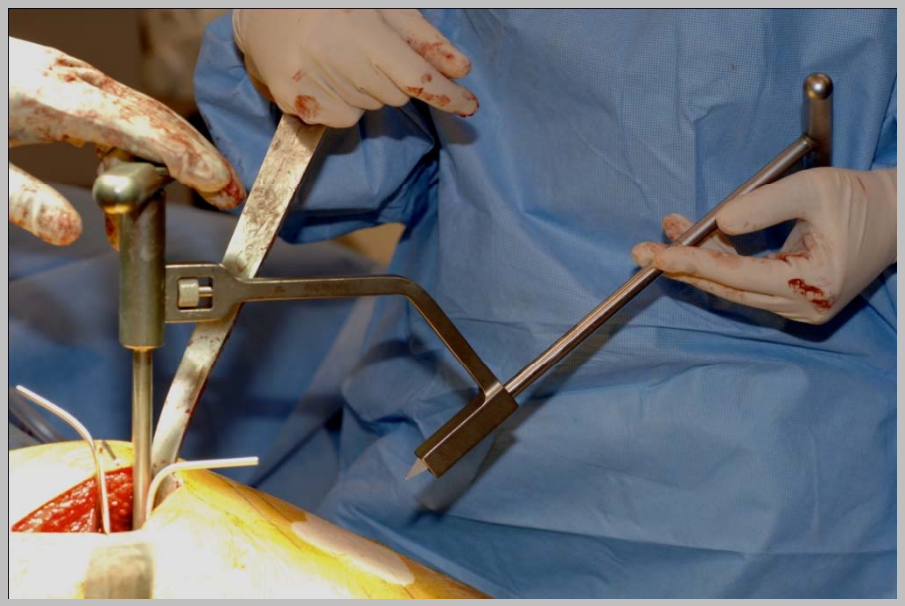
- Access
  - Special retractors
  - Special preparation instruments
  - Special implantation instruments

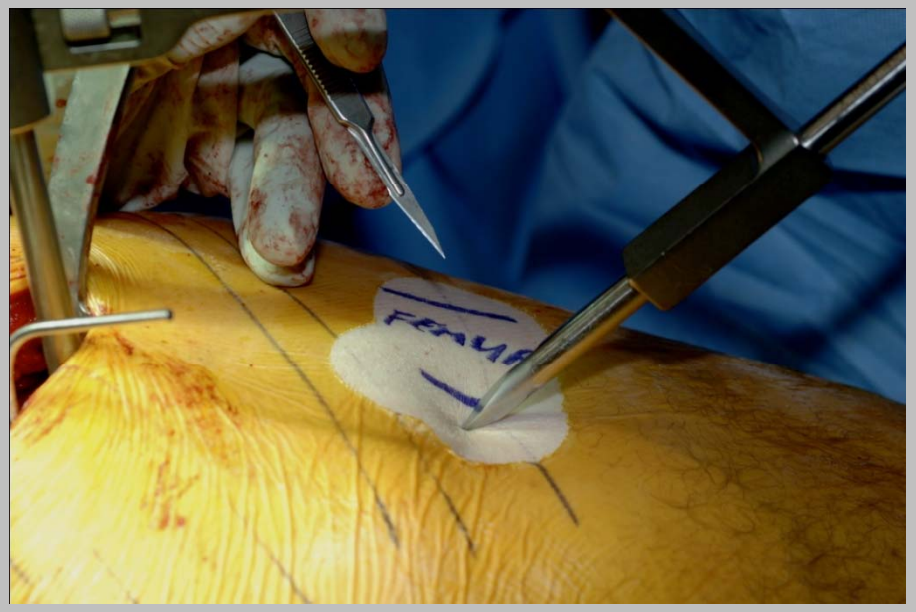
Portal Guide



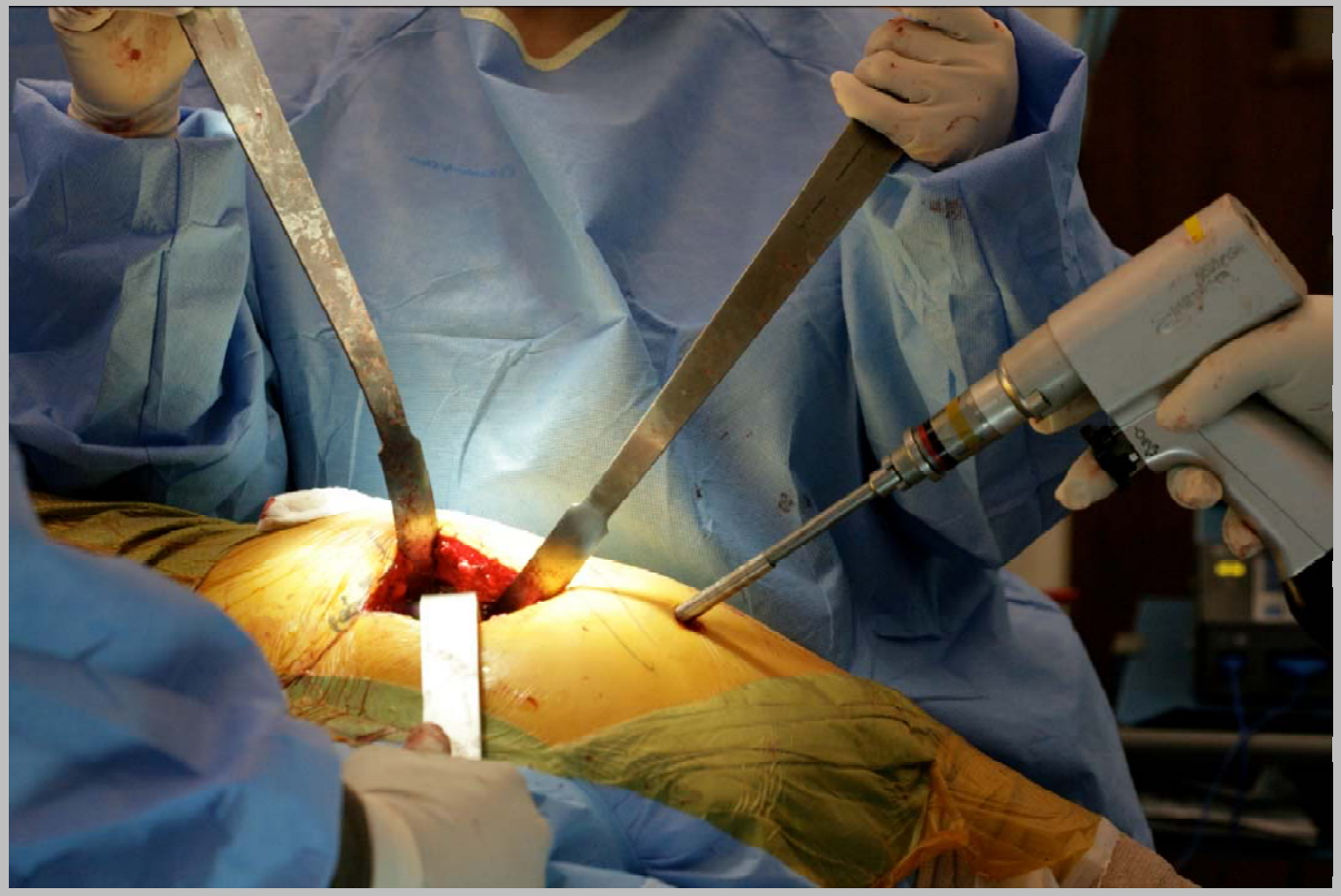
Portal Guide

- **Portal posterior to Femur**





PATH THA



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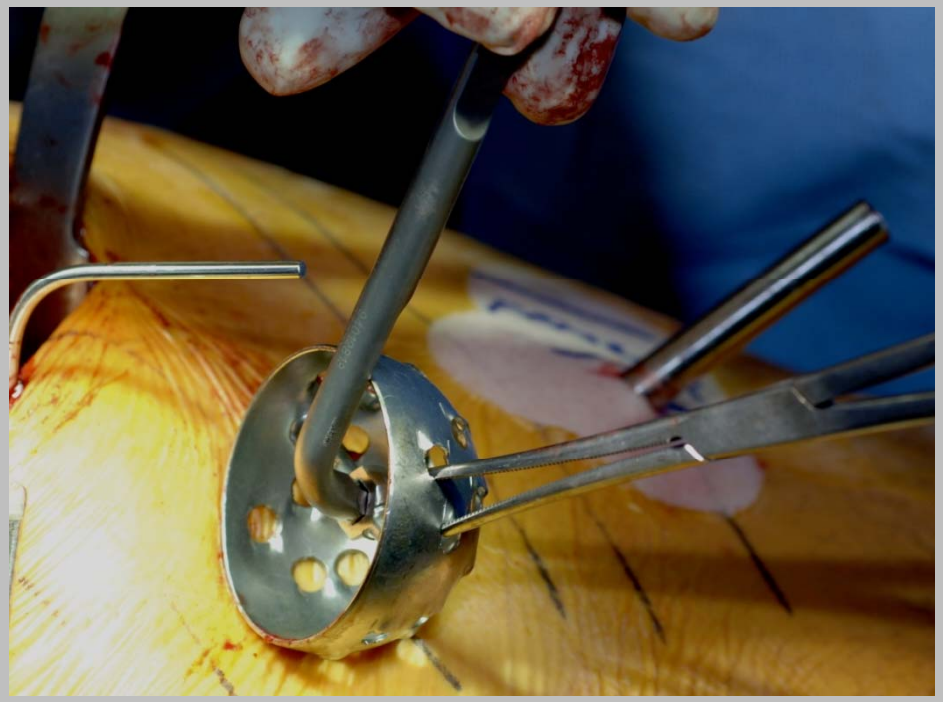
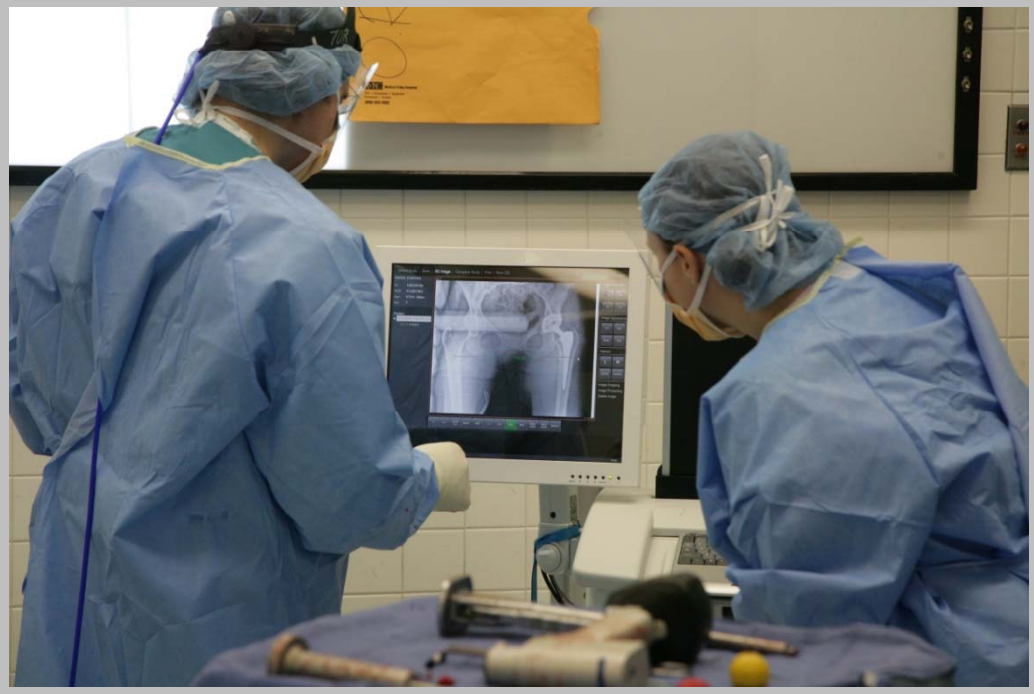


PATH THA

- **Femoral Preparation**

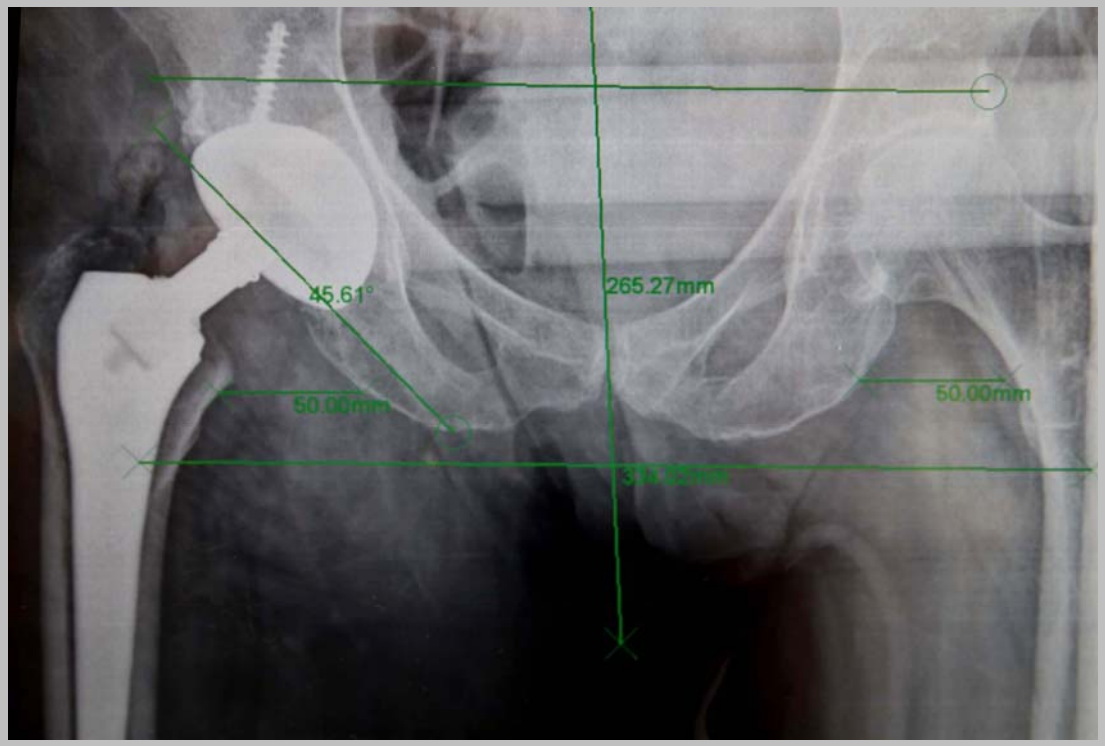
PATH THA

- **Intraoperative radiographic evaluation**



PATH THA

- **Intraoperative radiographic evaluation**



PATH THA

THE JOURNAL OF BONE & JOINT SURGERY
JB&JS
This is an enhanced PDF from The Journal of Bone and Joint Surgery
The PDF of the article you requested follows this cover page.

Percutaneously Assisted Total Hip Arthroplasty (PATH): A Preliminary Report

By Brad L. Penenberg, MD, W. Seth Bolling, MD, and Michelle Riley, PAC

Penenberg, B. L., W. S. Bolling, et al. (2008). "Percutaneously assisted total hip arthroplasty (PATH): a preliminary report." J Bone Joint Surg Am 90 Suppl 4: 209-220.

Economic Impact of MIS THA

The Economic Impact of Minimally Invasive Total Hip Arthroplasty

Paul J. Duwelius, MD,* Hans S. Moller, MD,* Robert L. Burkhart, PA,* Frederick Waller, MD,† YingXing Wu, MD,‡ and Gary L. Grunkemeier, PhD‡

- **MIS/ACTIVE PATHWAY**
  - LOS: 1.5 Days*
  - Costs: $12.8 K*
  - Complications =
- **LIS/PASSIVE PATHWAY**
  - LOS: 3.8 Days
  - Costs: $16.7 K
  - Complications =

COST SAVINGS: 3.9K

* $p < 0.001$

Duwelius, P. J., H. S. Moller, et al. (2011). "The economic impact of minimally invasive total hip arthroplasty." J Arthroplasty 26(6): 883-885.

MIS THA: Additional Costs

SURGICAL APPROACH IN TOTAL HIP ARTHROPLASTY:

DOES IT REALLY MATTER?

Andrew I. Spitzer, MD
Director
Joint Replacement Center of Excellence
Cedars-Sinai Medical Center

Israel Orthopaedic Association
December, 2012

CEDARS-SINAI

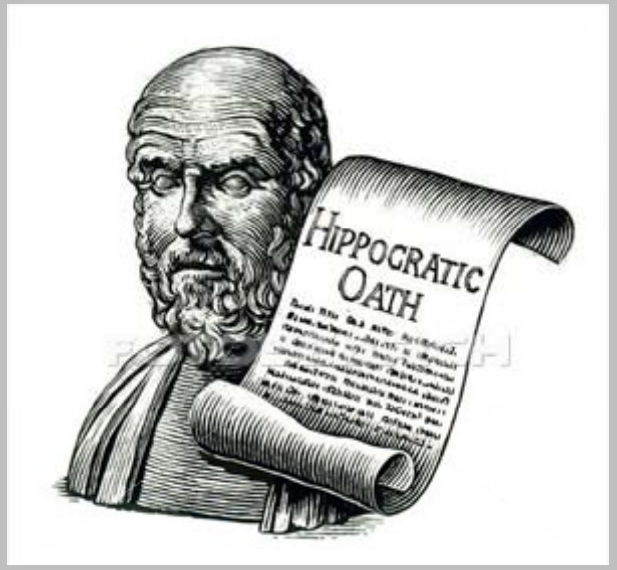
MIS THA

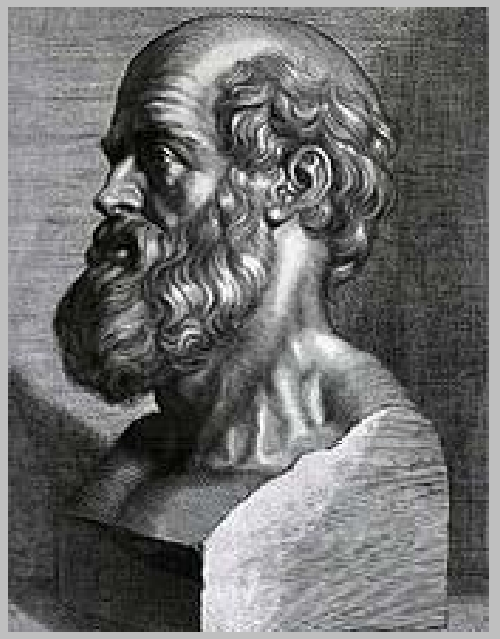
- Does not improve long term results
- Limited and poor data
- May impact short term results
  - Cosmesis
  - LOS
  - Speed of rehabilitation
- May significantly increase complications (“Learning Curve”)
- Careful adoption
  - Progressive shortening of incision
  - Consider adjunctive imaging
  - Consider truly innovative approaches
  - WAIT FOR DATA

What Really Matters in THA

- Component Position
- Stability
- Soft Tissue Balance
  - Limb Length
  - Offset
- Durable Fixation
- Minimal Complications
- Quality Outcomes
- Patient Satisfaction

Primum Non Nocere





MAIMONIDES

- **May I never see in the patient anything other than a fellow creature in pain.**

THANK YOU תודה רבה!!

Patient Outcomes vs Surgical Approach

- Outcomes Measures
  - WOMAC Pain and Function
  - Self Administered Patient Satisfaction Scale for Primary Hip and Knee Arthroplasty
- Posterior approach superior to anterolateral
  - 3.5-7.2%

Smith, A. J., V. Wylde, et al. (2012). "Surgical approach and patient-reported outcomes after total hip replacement." Hip Int 22(4): 355-361.

TJA: Fatal and Near Fatal Events

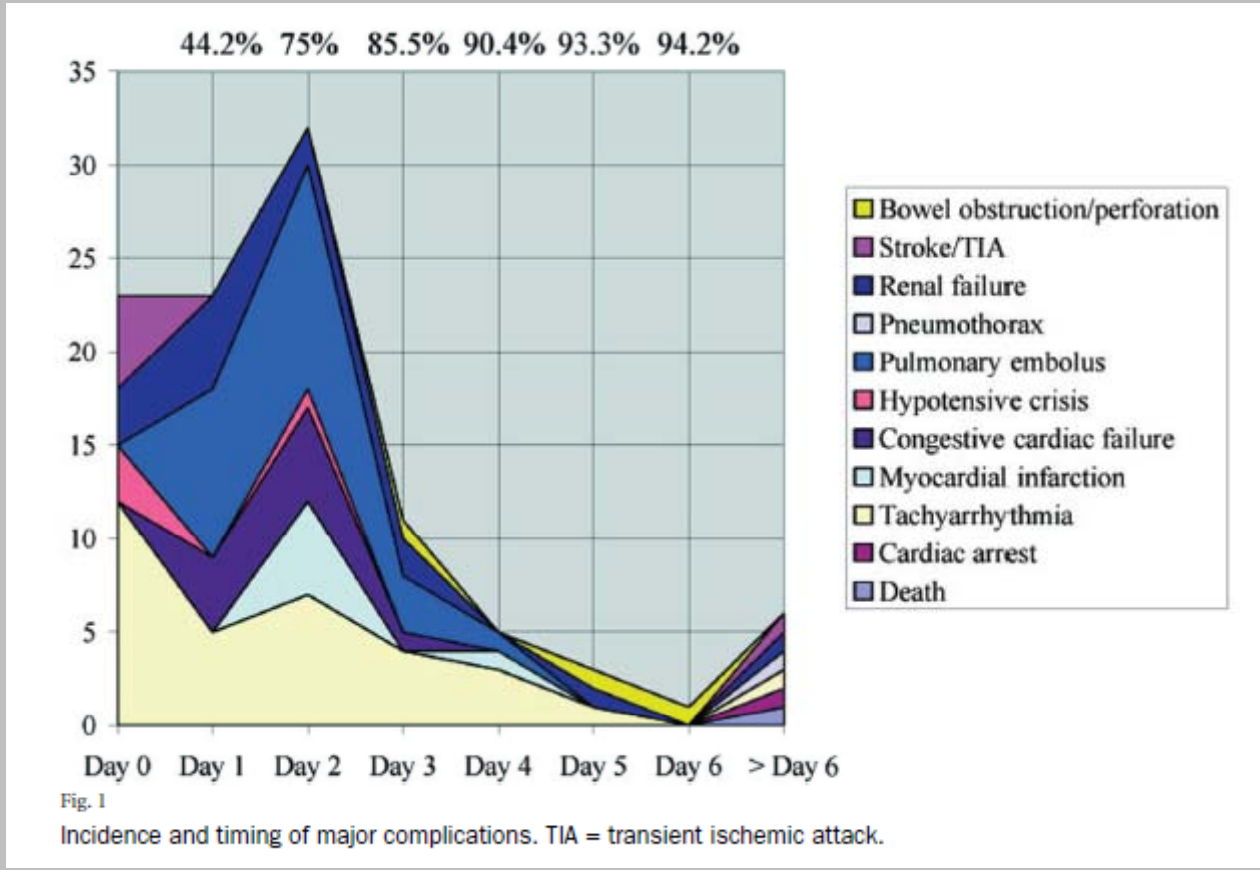


Fig. 1

Incidence and timing of major complications. TIA = transient ischemic attack.

Parvizi, J., A. Mui, et al. (2007). "Total joint arthroplasty: When do fatal or near-fatal complications occur?" J Bone Joint Surg Am 89(1): 27-32.