

The Future Shoulder Arthroplasty

Where are we going?

How do we get there?

The future is now

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Disclosures; ZimmerBiomet Inc., Thieme, Wright Medical, ,AAOS



The Journey thru the Generations (1st→3rd)



More like an Odyssey!!!!



Even more Innovation

Stemless



Convertible



It Continues!!

Patient Specific Guides/3D Imaging
Augmented Glenoids
Patient Specific Implants

HOSPITAL FOR SPECIAL SURGERY WHERE THE WORLD COMES TO GET BACK IN THE GAME

Shoulder Arthroplasty 2018 ➔

- Shoulder Arthroplasty; TSA, RSA, HA increased exponentially over last decade ~20,000/yr→ 66,485/yr [Schairer et al JSES 2015 \(HSS\)](#)
- RSA increased at higher rate than TSA or HA [Williams et al JSES 2015](#)
- Increasingly More Activities after TSA. HA RSA. [Garcia et al JSES 2015/6 \(3\) \(HSS\)](#)
- By 2023- 745% increase in older pts/333% in < 55 yo. [Padegimas et al CORR 2105](#)

**More will be done in younger with more activity
? More revision!
Definitely more RSA!**

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More OPD-Shoulder Arthroplasty


- Limited
 - CO-MORBIDITIES
 - Less complicated
 - INSURANCE REIMBURSEMENTS (MEDICARE)
 - PT COMFORT
 - The business of Medicine will drive this trend

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What we can expect Even Newer Designs and Technical Improvements

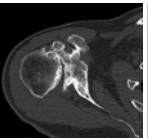

- Better recognition of disease characteristics and deformity
 - Indications
 - Best practice
- Better Implant design and biomaterials
- Convertible
- Imaging- CT/3D
- Patient Specific Planning Tools
- Patient Specific Guides
- Patient Specific Implants
- 3D Mapping- Pt "TSA set"

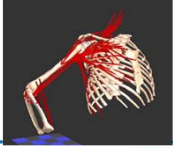







Better Imaging and Surgical Planning

- CT scan with 3D Reconstructions
 - Better recognition of bone deformity
 - Glenoid wear/ bone loss (Walch B2/3 +C)
 - Clinical Significance
 - **Dynamic Soft-tissue factors**
 - Virtual Simulator – Newcastle Shoulder Model










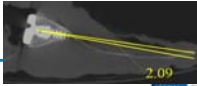



Better Imaging and Surgical Planning

- CT scan with 3D Reconstructions
 - Better recognition of bone deformity
 - Glenoid wear/ bone loss
 - **Patient specific Guides**









Better Imaging and Surgical Planning

- CT scan with 3D Reconstructions
 - Patient specific implants for severe deformity
 - Severe glenoid bone loss
 - Proximal Humeral Bone loss

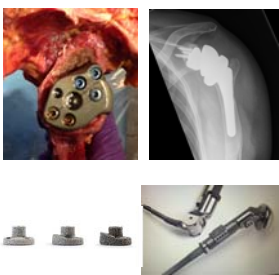


The Future???

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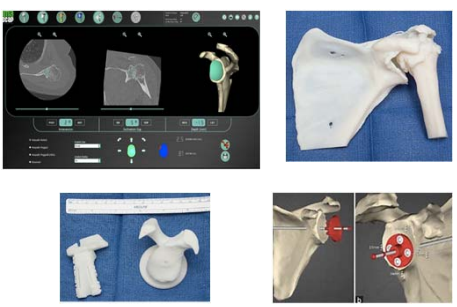
BONE DEFORMITY
"More is less?"

- REPLACE BONE WITH BONE??
- REPLACE BONE WITH METAL-works better~ TKR + THR
 - PATIENT-SPECIFIC IMPLANTS
 - AUGMENTED IMPLANT DESIGNS
 - CAD-CAM DESIGNS
 - **PATIENT-SPECIFIC "KITS"**



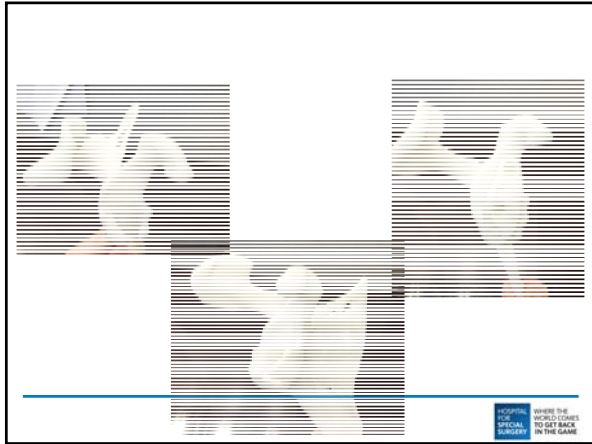
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The "Game Plan"



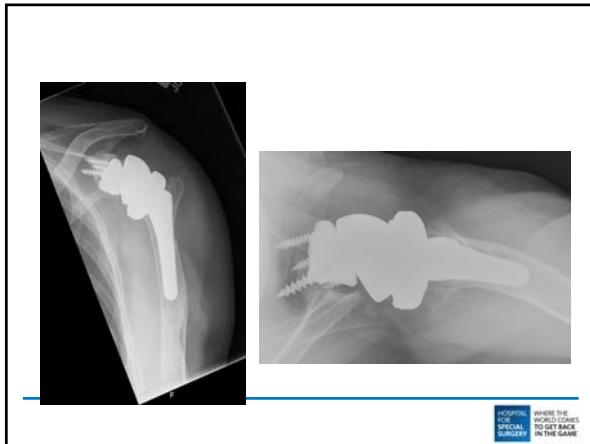
Planning Software → 3D Mapping → PS Guides +/- bone graft

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PATIENT-SPECIFIC "KITS"

- 3D Mapping software
- Patient planning software
- Patient specific guides
- **Intra-op GPS technology**
- **PS instruments – disposables**
- PS components

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Stemless to Short-stem Humeral Component Technology
Less is more!!!

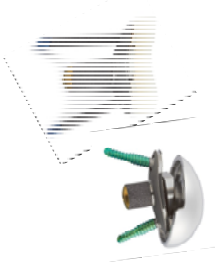
- Stemless (nano) Technology
- Micro-stem

Small and getting smaller

More sophisticated convertibility implants 2nd Generation Convertible Implant

ANAVERSE™ Glenoid-ZimmerBiomet
Christian Gerber MD

- **Metal-backed Anatomic Glenoid**
- **Allows to position Glenosphere in optimal position even if baseplate for TSA was placed with superior tilt**



In development



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BETTER MATERIALS

- Better Polyethylene
 - Vitamin E like
 - Stronger cross-links
 - Better resistance of oxidation
- Pyrocarbons/ceramics and new polymers
- ????
- Better fixation surfaces




Shoulder Arthroplasty

- Historically, we have used static design models based on estimated or assumed normal bone morphology.
- Recent advances in recognition of bone deformity have lead to "Patient-specific" Planning tools→guides and even PS implants.
- No real consideration of soft-tissue anatomy, physiology or mobility as it relates to deformity





It's not all about the "Bones"



How do you determine where to put the implant?


- Do you put it in the same place for everyone?
- How do you maximize ROM?
- Do you compromise fixation?






Future Directions

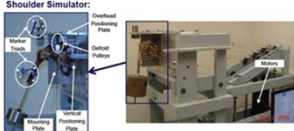

- - Patient specific planning based on function and fixation, not arbitrary positions





Basic Science Resources

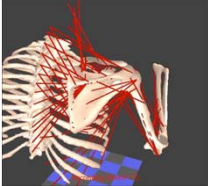
1. Physical Simulator




Courtesy of Xiang Chen, MSE

Basic Science Resources

1. Virtual Simulator – Newcastle Shoulder Model

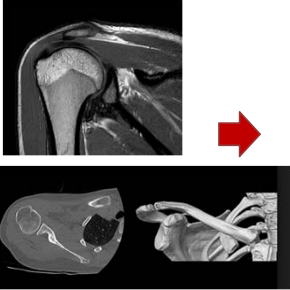


Courtesy of Andreas Kontaxis, PhD

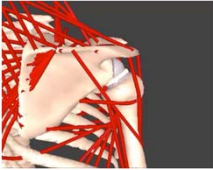


Functional Optimization

20 Cadavers




Custom Pre-Op plan model
Prediction of Motion



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Functional Optimization

Guided (PSI) RSA (n=10)



VS

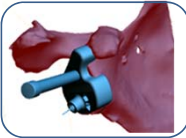
Traditional RSA (n=10)



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Functional Optimization

Guided (PSI) RSA (n=10)




VS

Traditional RSA (n=10)



Primary Outcome
Replication of Plan

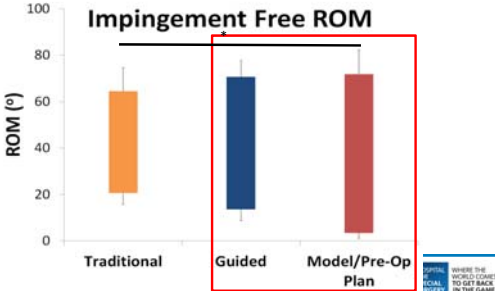


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Motion Analysis Validation

- ROM results on the 'Guided' (PSI) cadavers were better than the 'Traditional'

Impingement Free ROM

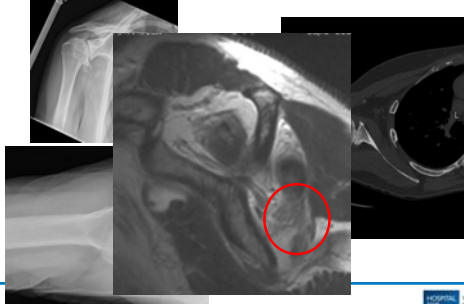


Group	ROM (°)
Traditional	~20 - 65
Guided	~15 - 70
Model/Pre-Op Plan	~5 - 70

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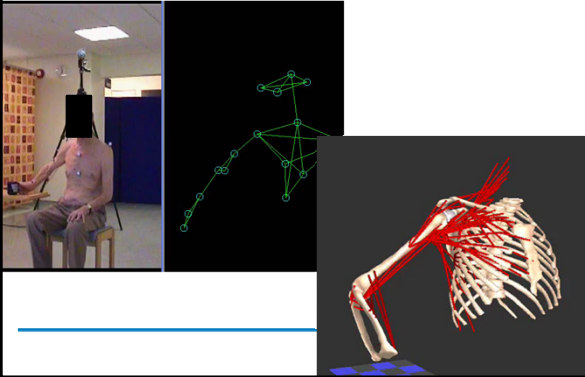
Future Directions

69 y/o man with shoulder OA



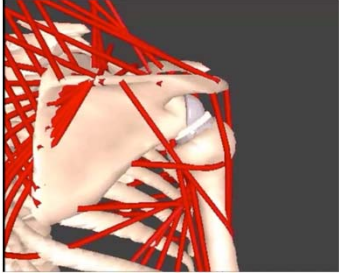
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Future Directions



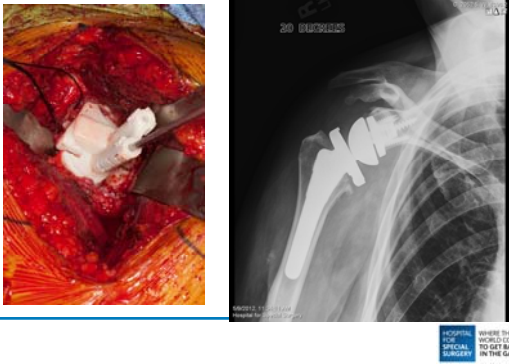
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Future Directions

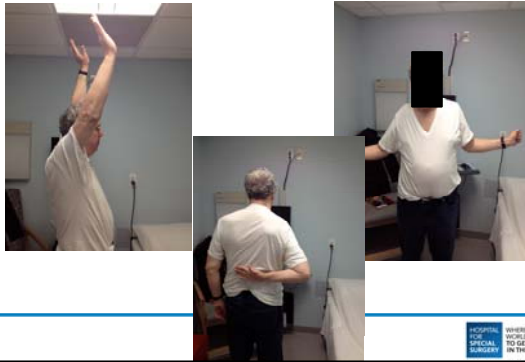


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Future Directions



Future Directions





Thank You



Future Directions

Load input from model to FEA fixation model

Best bone areas for fixation to share load

Translational Studies

- Significant variability in cadaver anatomy
- Need for Patient Specific Instrumentation

Translational Studies

Journal of Shoulder and Elbow Surgery

Journal of Shoulder and Elbow Surgery

Patient-specific targeting guides compared with traditional instrumentation for glenoid component placement in shoulder arthroplasty: a multi-surgeon study in 70 arthritic cadaver specimens

Thomas W. Throckmorton, MD^{1,2*}, Lawrence V. Gulotta, MD¹, Frank O. Bonnanens, MD¹, Stephen A. Wright, MD¹, Jeffrey L. Hartzell, MD¹, William B. Rozzi, MD¹, Jason M. Hurst, MD¹, Simon F. Frostick, MD¹, John W. Sperling, MD, MBA¹

PSI more Accurate

How do we Improve Our Results?

Basic Science Studies

J Shoulder Elbow Surg 2012;21:1121-1127

BASIC SCIENCE

Humeral component retroversion in reverse total shoulder arthroplasty: a biomechanical study

Lawrence V. Gulotta, MD^{1,*}, Dan Choi, BS, ME², Patrick Marinello, BS², Zakary Knutson, MD¹, Joseph Lipman, MS², Timothy Wright, PhD², Frank A. Cordasco, MD¹, Edward V. Craig, MD¹, Russell F. Warren, MD¹

¹Sports Medicine and Shoulder Service, Hospital for Special Surgery, New York, NY, USA
²Department of Biomechanics, Hospital for Special Surgery, New York, NY, USA

Less Retroversion can improve IR
 - 20 degrees may be sweet spot to maximize IR and still preserve stability

Basic Science Studies

Shoulder Elbow Surg 2013;22:407-413

Effects of glenosphere positioning on impingement-free internal and external rotation after reverse total shoulder arthroplasty

Xinming Li, MD¹, Zakary Knutson, MD, Daniel Choi, MEng, Daniel Lobatto, MSc, Joseph Lipman, MS, Edward V. Craig, MD, Russell F. Warren, MD, Lawrence V. Gulotta, MD

¹Hospital for Special Surgery, Division of Sports Medicine and Shoulder Surgery, New York, NY, USA

Lateralization and Inferior Placement Maximizes IR and ER

Basic Science Studies

J Shoulder Elbow Surg (2015) 24, 1120-1128



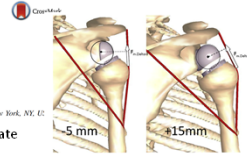
JOURNAL OF
SHOULDER AND
ELBOW
SURGERY
www.elsevier.com/locate/jse

The effects of progressive lateralization of the joint center of rotation of reverse total shoulder implants

Oren Costantini, MS, Daniel S. Choi, MEng, Andreas Kontaxis, PhD, Lawrence V. Gulotta, MD*

Department of Biomechanics, Sports Medicine and Shoulder Service, Hospital for Special Surgery, New York, NY, U.S.

- FE models needed to see if fixation can accommodate force



Translational Studies

- Significant variability in cadaver anatomy
- - High standard deviations in our models based on varying anatomy
- - Mimics what we see in patients

- Need for Patient Specific Planning and Instrumentation