Baseplate Design: Screw in/Threaded Post

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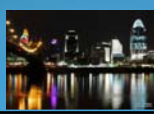

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- Committees: JBJS Knowledge Plus, ASES Program, AAOS Shoulder/Elbow Content Pilot, MercyHealth/Orthopaedics

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My formidable debate opponent

Dr. Joseph Zuckerman

- Chairman of the Department of Orthopaedic Surgery at NYU Hospital for Joint Diseases and the Walter A.L. Thompson professor of orthopaedic surgery at the NYU School of Medicine
- Past-president of the AAOS (2009)
- Portrait from the Clinical Educator Hall of Fame!

Fortunately, I like my topic!

- Threaded (screw-in) baseplate design

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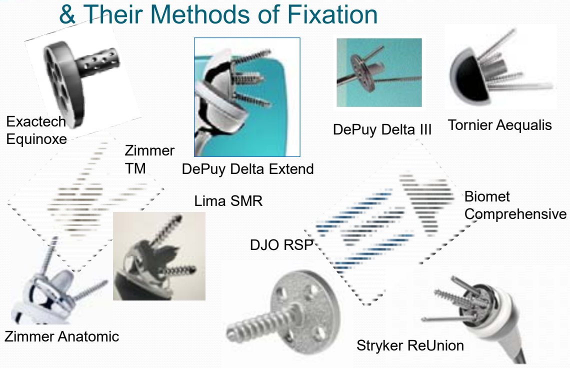
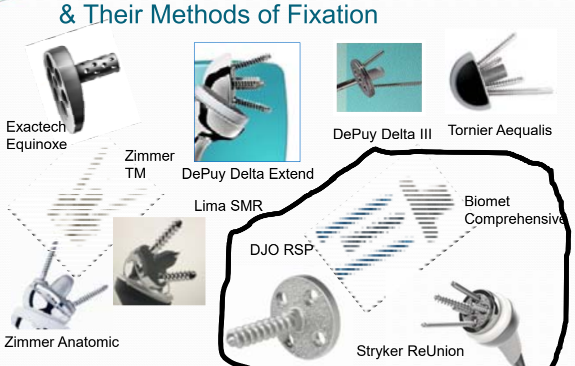
Glenoid Baseplates & Their Methods of Fixation



Glenoid Baseplates & Their Methods of Fixation



Threaded (screw-in) baseplate design

- DJO RSP
- Designed by Frankle
- 1st custom RSP in 1998 featured this design
- > 20 year history
  - My first RSP was in 2004 (Original IDE)
  - Personal history 14 years

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Threaded (screw-in) baseplate design

Base Plate Fixation:

- Fixed angle central compression 6.5mm lag screw fixation
- Backside coating
  - Hydroxyapatite coating for ingrowth (2004+)
  - P^2 coating

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Threaded (screw-in) baseplate design

Base Plate Fixation:

- Fixed angle central compression 6.5mm lag screw fixation
- 4 fixed angle 5.0mm locked peripheral screws
  - De-rotation screws
  - No advantage for polyaxial insertion
  - Adjunctive screw fixation must be strong enough

Threaded (screw-in) baseplate design

Original Base Plate Fixation:

- Frankle et al., JBJS 2005
- 11% incidence of baseplate failure
- Fixed angle central compression 6.5mm lag screw fixation
- 4 3.5mm non-locking peripheral screws
- NO backside coating

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Threaded (screw-in) baseplate design

Subsequent studies have revealed much lower baseplate failure rates:

- Frankle et al., JBJS 2008
  - 0/114 shoulders beginning 2/2004
- Multi-center study (2 year data)
  - 0/173 shoulders (enrolled 2010-12)
- Personal experience
  - 3/400+; less than 1%
  - 2 with PJI ; 1 in a patient with movement disorder

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Biomechanics of Baseplate Fixation

- Compressive force of baseplate fixation
- Strength of fixation (load to failure testing)
- Micromotion at baseplate-glenoid interface
- Finite element modeling of the interface

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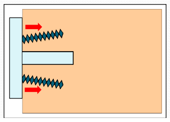
Compressive Force of Baseplate Fixation

Grammont

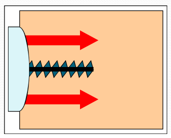


200N

Small Compressive Force

Screw in Baseplate Provides Greater Compressive Forces

RSP



2000N

Large Compressive Force

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Load to Failure Testing

2.3X >

RSP 632N

Grammont 269N

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Micro-motion Testing

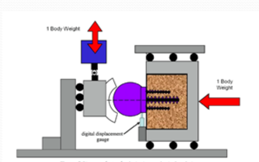
In vitro and finite element analysis of glenoid bone/baseplate interaction in the reverse shoulder design

Nazeem A. Virani, MD,[a] Melinda Harman, MSc,[b] Ke Li, PhD,[c] Jonathan Levy, MD,[d] Derek R. Pupello, MBA,[a] and Mark A. Frankle, MD,[a] Tampa, West Palm Beach, and Ft. Lauderdale, FL

- 7 baseplate-glenosphere combinations tested in polyurethane foam blocks
- 1000 cycles of shear
- Trend to increasing micro-motion(90-120µm) with increased lateralization but no significant differences

Table II Differences in dimensions for the various reverse glenospheres used in this study (diagram below is not to scale)

Reverse Shoulder Prosthesis (RSP)	r (mm)	h0 (mm)	h1 (mm)	h2 (mm)	h3 (mm)
RSP (40-4 mm)	20	20	3	0	–3
Delta-III	18	19	3	1	–2
RSP (36-4 mm)	18	20	3	2	–1
RSP (40 mm neutral)	20	24	3	4	1
RSP (36 mm neutral)	18	24	3	6	3
RSP (32-4 mm)	16	22	3	6	3
RSP (32 mm neutral)	16	26	3	10	7



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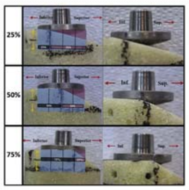
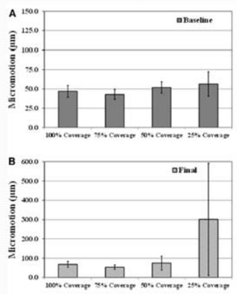
Micro-motion Testing

- No significant baseplate micro-motion unless less than 50% of the baseplate is supported by bone (Formaini, JSES, 2015)
- Central compression screw also helps hold bone graft in place under compression if needed
- Peripheral screws important only for de-rotation





Finite element modeling of glenoid bone/baseplate interface

In vitro and finite element analysis of glenoid bone/baseplate interaction in the reverse shoulder design

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- Same 7 baseplate-glenosphere combinations modeled in ABAQUS (36-45K 3D solid elements)
- Results: Great correlation with in vitro testing. Micromotion < 100µm for all combinations

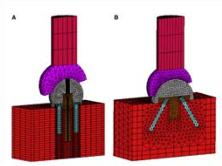
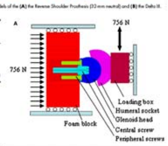


Table V Comparison of finite element simulation and the mechanical test results

		Baseplate motion			Baseplate motion from mechanical testing	
Prosthesis	Distance between simulated glenoid and center of rotation (mm)	at $\mu = 0$ from FE analysis (µm)	at $\mu = 0.1$ from FE analysis (µm)	at $\mu = 0.22$ from FE analysis (µm)	1 cycle of loading (µm)	1000 cycles of repetitive shear load (µm)
RSP (40-4 mm)	0	59	66	74	100 ± 10	100 ± 10
Delta-III	1	57	63	69	90 ± 27	90 ± 24
RSP (36-4 mm)	2	64	70	77	107 ± 6	107 ± 15
RSP (40 mm neutral)	4	69	75	84	110 ± 17	97 ± 12
RSP (36 mm neutral)	6	74	81	87	110 ± 10	120 ± 10
RSP (32-4mm)	6	74	80	86	110 ± 10	113 ± 12
RSP (32 mm neutral)	10	84	90	96	113 ± 12	113 ± 6

FE, Forward elevation; *RSP*, Reverse Shoulder Prosthesis.



Threaded (screw-in) baseplate design

Bone Conserving Fixation:

- Fixed angle central compression 6.5mm lag screw fixation
- Shank has a diameter of 3.2mm

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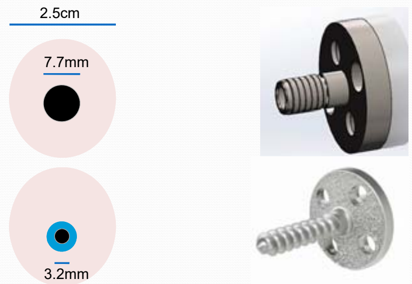
Threaded (screw-in) baseplate design

Bone Conserving Fixation:



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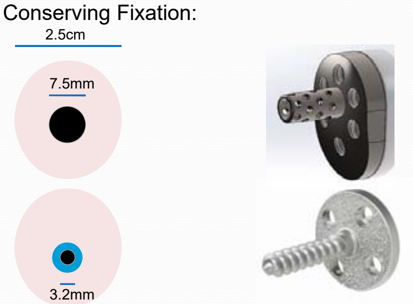

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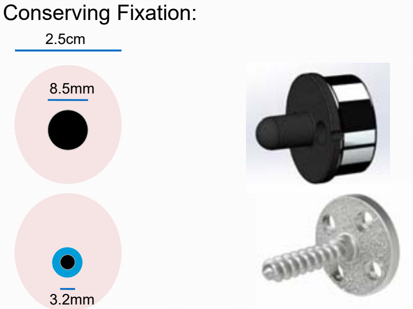

Threaded (screw-in) baseplate design

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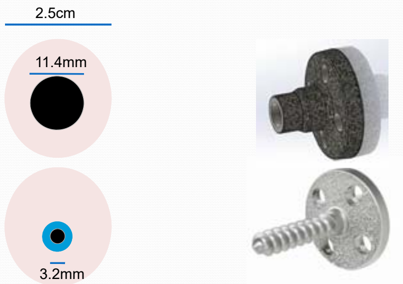

Threaded (screw-in) baseplate design

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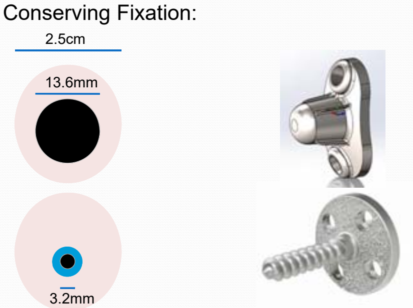

Threaded (screw-in) baseplate design

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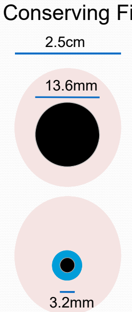

- Most posts/cages are larger with diameters from 7.5-14mm
  - An 11.5mm post removes 13 X as much bone compared with a threaded screw with a 3.2mm shank
- Small glenoids are commonly encountered (small stature, post-traumatic bone loss)
- So what would you rather work with?
  - A device that will violates 20-25% of the glenoid surface or a device that conserves 98%
  - A device that permits intra-op changes or that facilitates single stage revision, or a device that does not

Bone Conservation Matters

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Bone Conservation Matters

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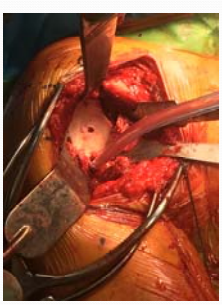
Bone Conservation Matters



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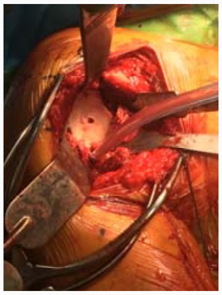
Bone Conservation Matters



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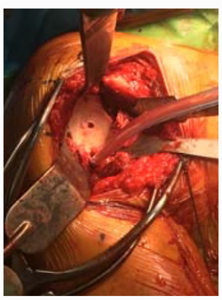
Bone Conservation Matters



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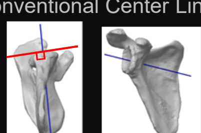
Threaded (screw-in) baseplate design

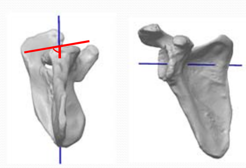
Alternative Center Line:

- Any center line that bisects the available native bone
- Very helpful concept in cases of (severe) glenoid bone loss

- Starts at glenoid surface
- Parallels scapular spine
  - Through junction of scapular spine and body
- Anteverted

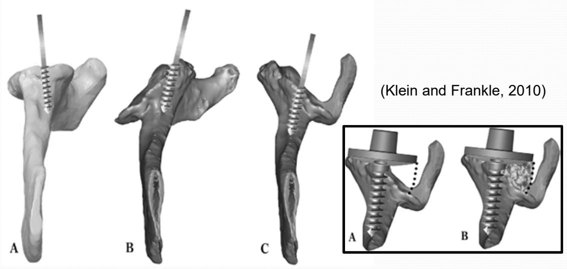
Conventional Center Line:





Alternate Centerline

Works for retroversion and for anteversion



(Klein and Frankle, 2010)

Applications of the Alternate Center Line

Normal Morphology	Posterior Bone loss	Anterior Bone Loss
Standard Center Line	Spine Center Line	Spine Center Line
32 Neutral Glenosphere	Hooded Glenosphere	Hooded Glenosphere

You just can't do this without a screw-in baseplate!

Summary

- Threaded baseplates offer several advantages including:
  - Superior time 0 fixation
  - Bone conservation that may facilitate revision
  - Ability to reorient baseplate along alternate centerline
- Threaded baseplates have a 20 year-track record
- Several implant systems currently offer baseplate designs employing screw fixation
  - Single piece design acts as a large compression screw
  - Other similar implants are two piece designs

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Let's face it…

- Who doesn't like a good *screw*

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