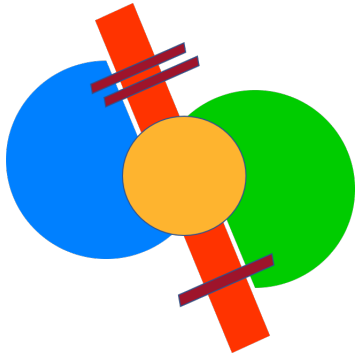
UNIVERSITÀ DEGLI STUDI DI BRESCIA



Centro R.I.T.M.O.
Ricerca e Innovazione in Traumatologia, chirurgia della Mano e Ortopedia
«Giorgio Brunelli»

Sistema Socio Sanitario
Regione Lombardia
ASST Spedali Civili

L'importanza del planning preoperatorio nella revisione protesica

Giuseppe Milano

Disclosures

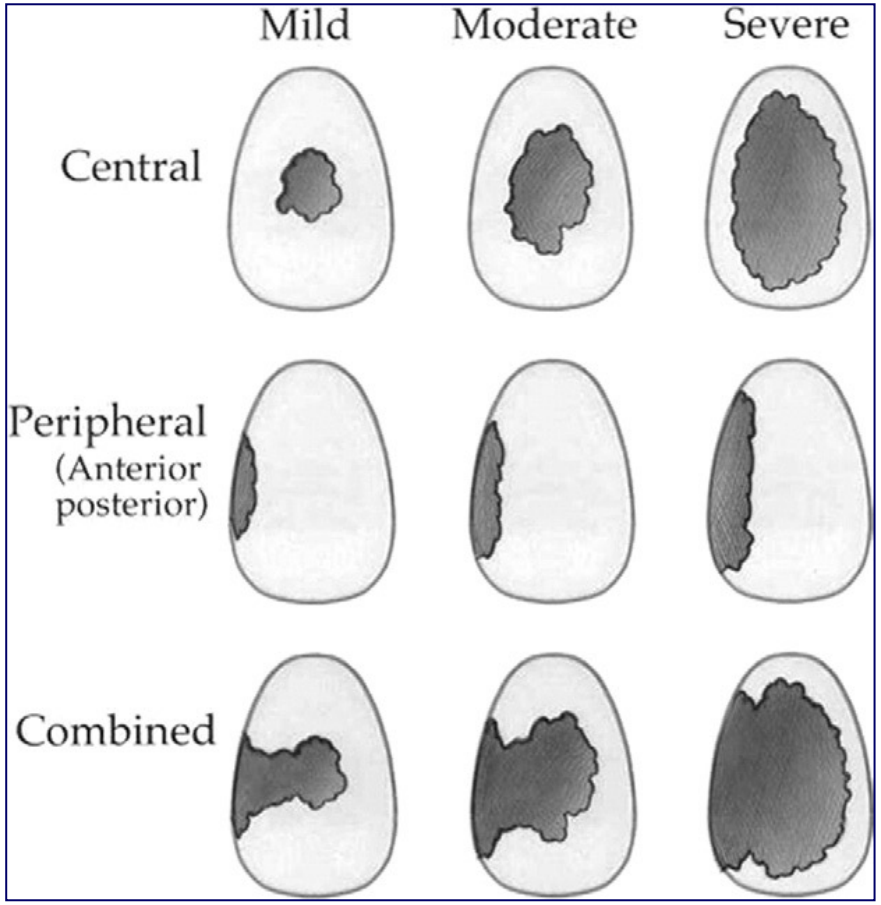
- *Arthrex: Paid consultant; paid presenter or speaker; research support; other financial or material support*
- *CONMED: Paid presenter*
- *FGP: Research support; other financial or material support*
- *Greenbone: Research support*
- *Medacta: Research support*
- *Medics: Research support*
- *Menarini: Paid presenter*

Revision: main factors

Patient Factors	Bony Anatomy	Implants	Soft Tissue Balancing
• Age • Comorbidities • Fragility of the patient • Bone quality • Presence of infection • Presence of neurogenic pain	• **Glenoid** ○ Bone loss ○ Residual bone stock for recon-struction ○ Joint line • **Humerus** ○ Bone loss ○ Residual bone stock for recon-struction ○ Humeral length	• **Existing implants** ○ Current positioning ▪ Correct ▪ Malpositioned ○ Baseplate and humeral stem fixation ▪ Stable ▪ Unstable ○ Extended glenosphere • **Revision implants** ○ Fixation options ▪ Long peg ▪ Screw ○ Augments ○ Humeral stems ▪ Design ▪ Sizing ○ Allografts ○ Tumor implants ○ Custom implants	• Excision of scar tissue • Axillary neurolysis • Cuff reattachment • Pectoralis major, teres major, and deltoid attachment • Tendon transfers

Italia 2022

Glenoid wear in revision



Antuna 2001

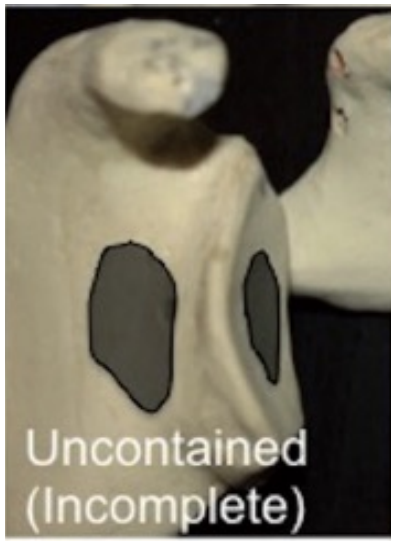
Modified:

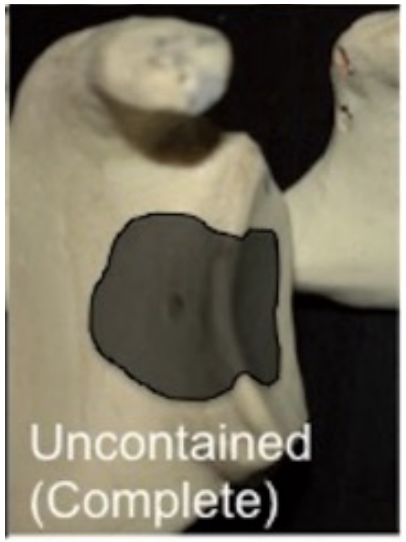
- **Type I**: central
  a) Contained (V+)
  b) Uncontained (V-)
- **Type II**: peripheral
  a) Symmetric
  b) Asymmetric
- **Type III**: combined
  a) Symmetric
  b) Asymmetric

Williams 2007

Glenoid wear in revision

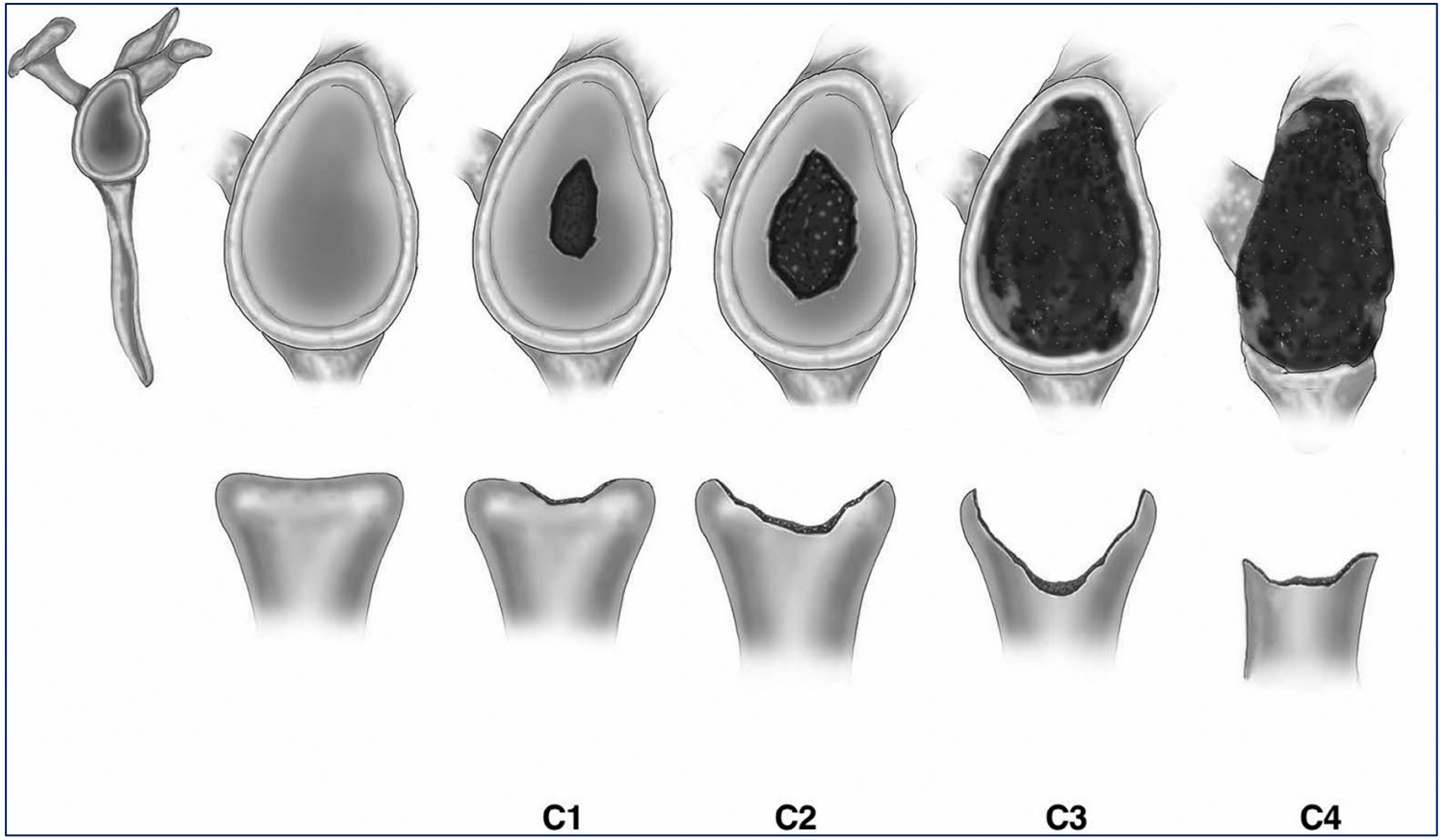
- **Type 1**: contained
  - ✓ an intact glenoid rim and vault wall
- **Type 2**: uncontained but can be converted to containable
  - ✓ an intact rim but a vault perforation
- **Type 3**: uncontainable
  - ✓ a deficient rim and vault





Page 2009

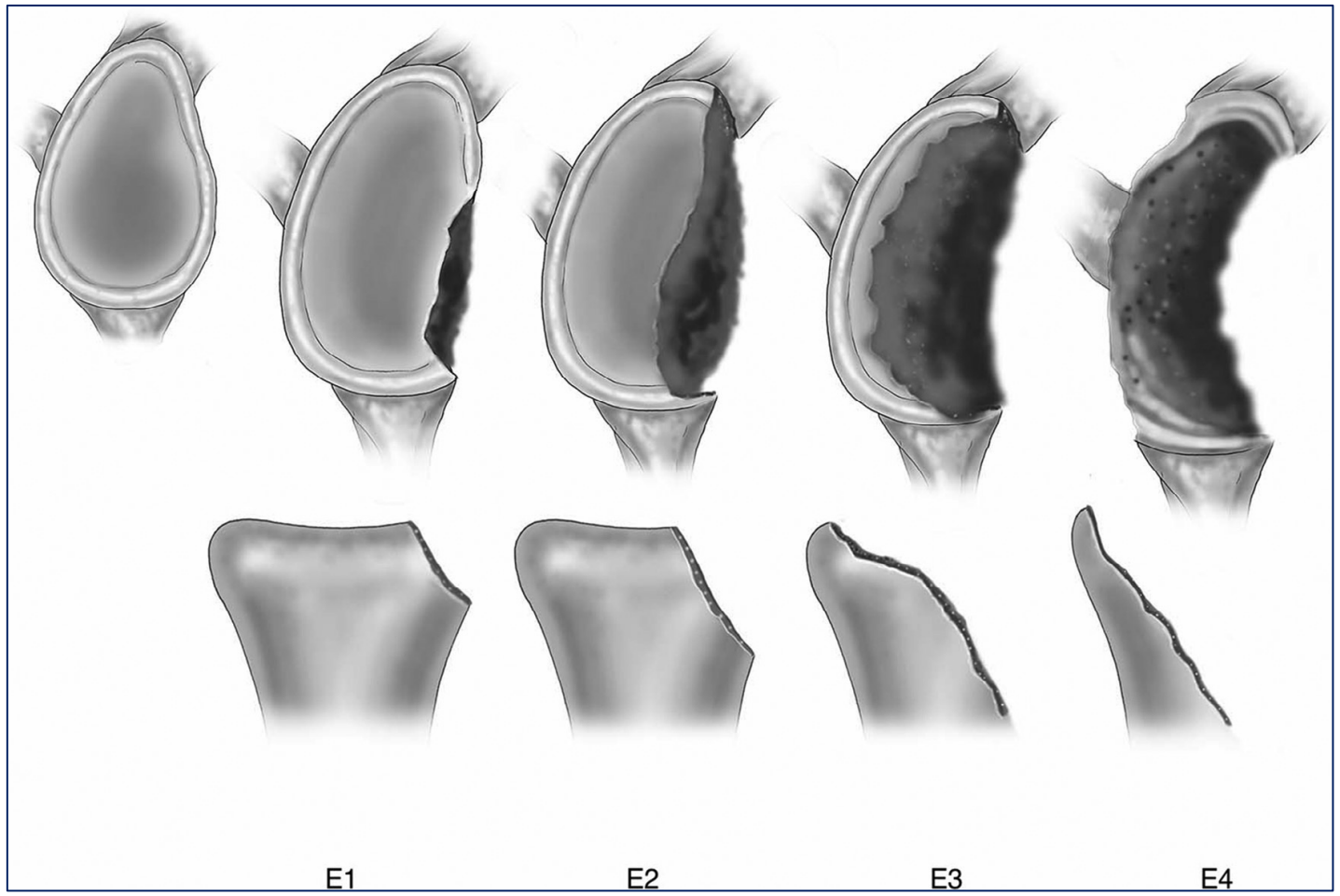
Glenoid wear in revision



- **Centric defect**
  - C1: Shallow (depth <50% of AP glenoid diameter)
  - C2: Deep (depth >50% of AP glenoid diameter + stable vault)
  - C3: Cavitary (C2 + unstable vault)
  - C4: Destructive

Gupta & Seebauer 2018

Glenoid wear in revision



- **Eccentric defect**

Based on size

- E1: small or shallow
- E2: medium (<30% of the glenoid bone stock)
- E3: large (30%-60% of the glenoid bone stock)
- E4: massive (>60% of the glenoid bone stock)

Based on location

- Anterior (A)
- Posterior (P)
- Inferior (I)
- Superior (S)

Gupta & Seebauer 2018

Hernandez-Ortiz EG, Christmas KN, Simon P, et al.
Improving preoperative planning of revision surgery after previous anatomic total shoulder arthroplasty.
J Shoulder Elbow Surg. 2019 Jun;28(6S):S168-S174

- 165 failed TSA
- 3 different evaluations
  - X-rays
  - Intraop videos
  - Explants analysis

X- Rays:

NOT ACCURATE!!!

Comparison of radiographic and videographic evaluations of glenoid component loosening

	Videographic evaluation		Total
	Loose	Not loose	
Radiographic evaluation			
Loose	30	17	47
Not loose	6	26	32
Total	36	43	79

- **40% false-positive**
- **17% false-negative**

Radiographic evaluation of glenoid loosening in patients undergoing revision of TSAs often differs from intraoperative findings

Single-stage revision: hemi

- Fracture sequelae

Preoperative assessment of glenoid wear

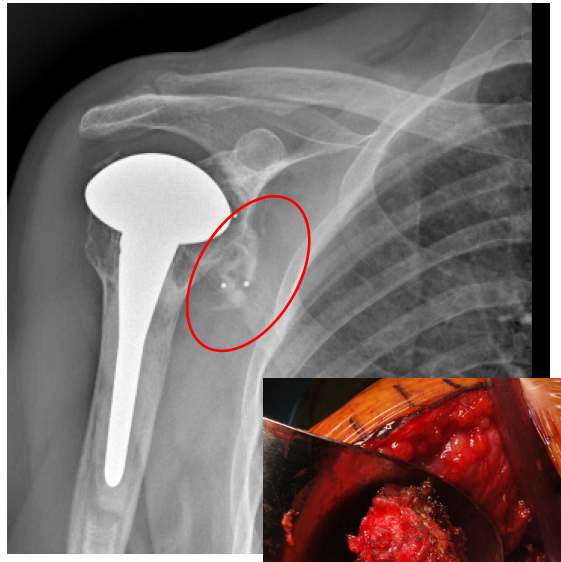
Conversion to RSA

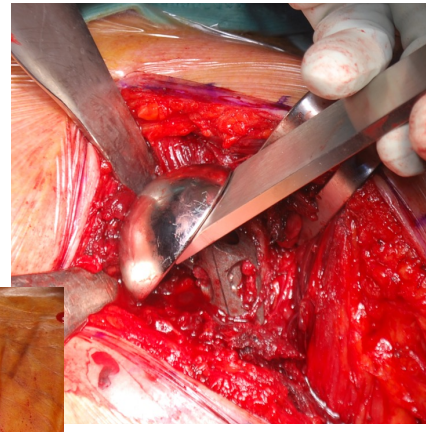
- w/wo bone graft

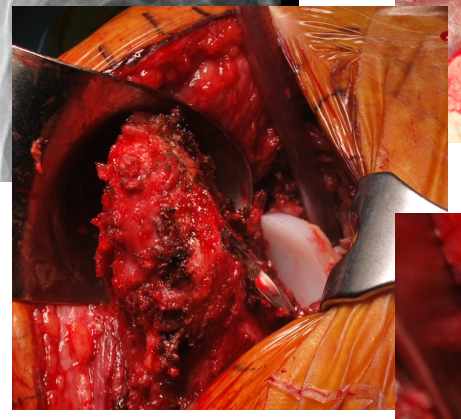
CT scan: reliable planning

Single-stage revision: TSA

- Rotator cuff failure
- Glenoid component loosening







Intraoperative assessment of glenoid wear

Conversion to RSA

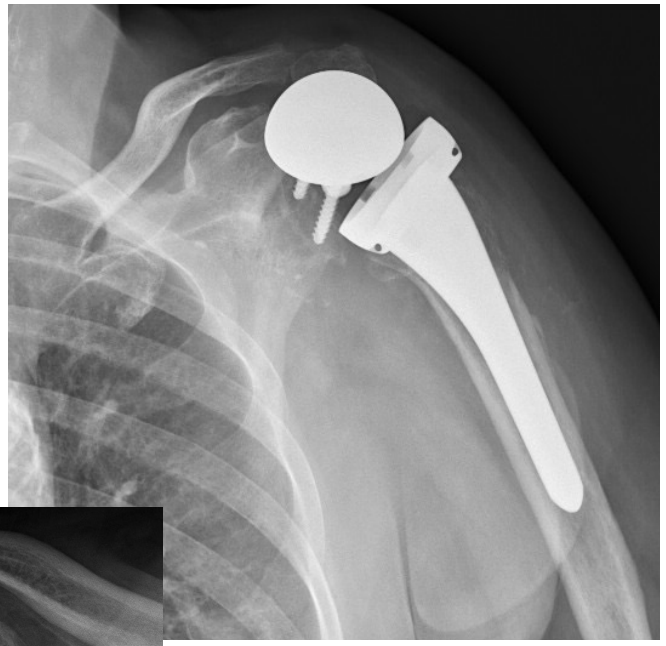
- w/wo bone graft

CT scan: unreliable planning for glenoid wear

Single-stage revision: RSA

Indications:

- Aseptic component loosening
- Fragile patients
  - Low grade infections



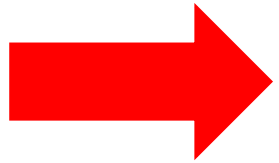
CT scan: unreliable planning due to metal artifacts

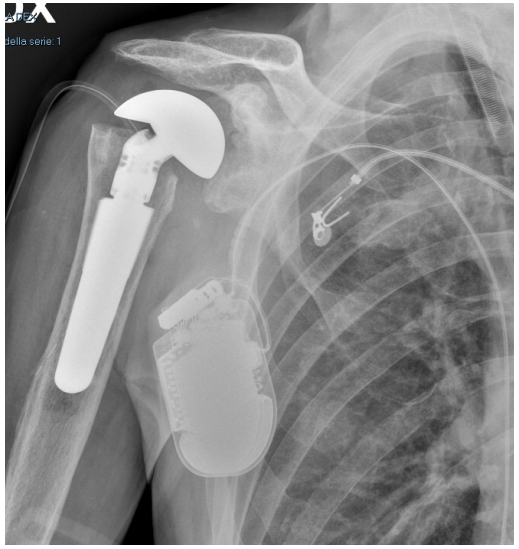
Single-stage revision: RSA

- **Instability**
  - ➢ Lateralization / Distalization
    - ✓ Larger glenosphere
    - ✓ Multiple liners: *“tower of terror”*
  - ➢ Humeral retroversion
    - ✓ Modular system (?)

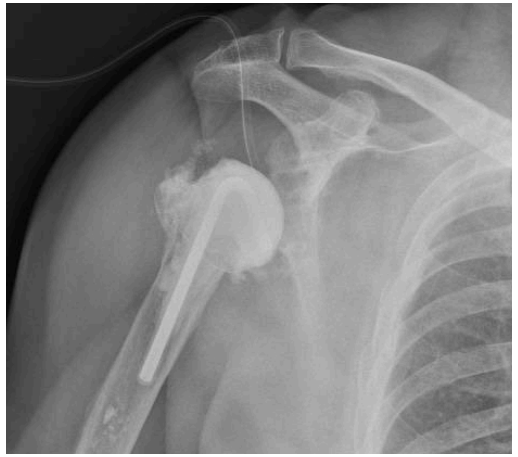
Single-stage revision: RSA

- **Insufficient bone stock after component removal**
  - Conversion to hemi



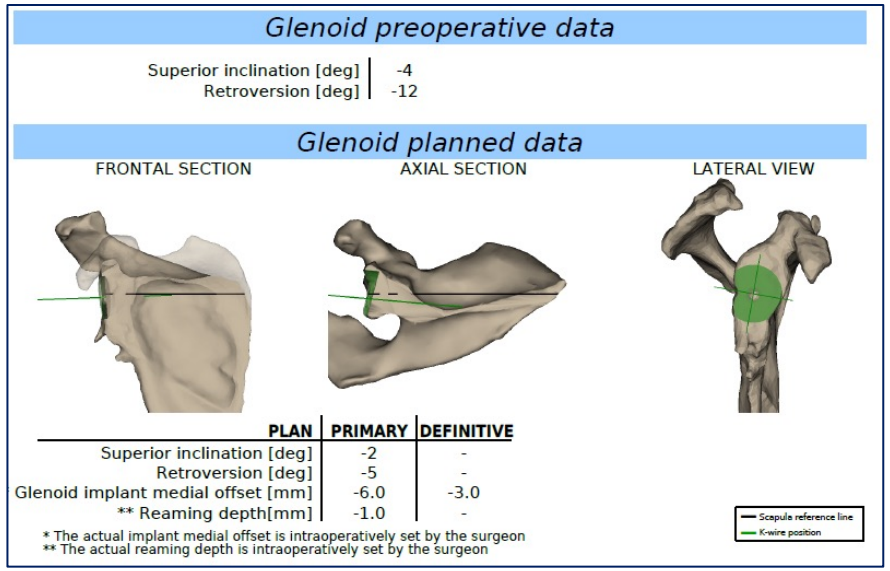


  - Conversion to two-stage



Two-stage revision

Mandatory CT scan planning before reimplantation!



Glenoid preoperative data

Superior inclination [deg]	-4
Retroversion [deg]	-12

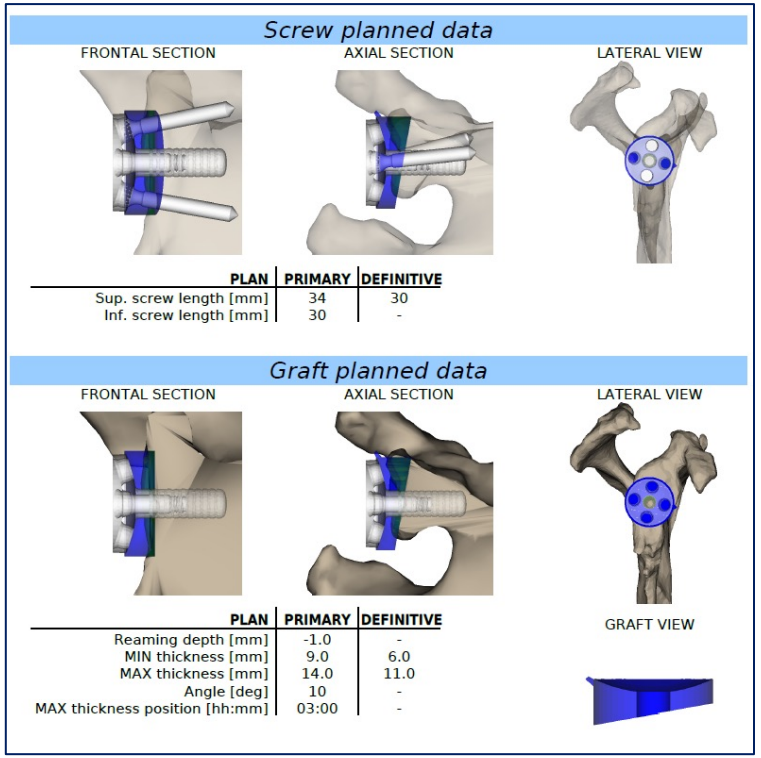
Glenoid planned data

FRONTAL SECTION AXIAL SECTION LATERAL VIEW

PLAN	PRIMARY	DEFINITIVE
Superior inclination [deg]	-2	-
Retroversion [deg]	-5	-
Glenoid implant medial offset [mm]	-6.0	-3.0
** Reaming depth[mm]	-1.0	-

Scapula reference line
K-wire position

* The actual implant medial offset is intraoperatively set by the surgeon
** The actual reaming depth is intraoperatively set by the surgeon



Screw planned data

FRONTAL SECTION AXIAL SECTION LATERAL VIEW

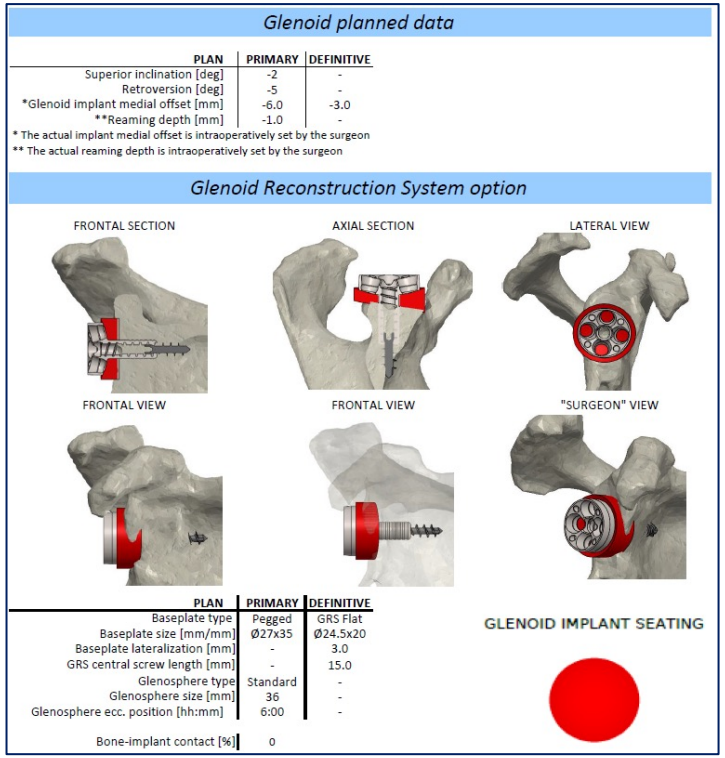
PLAN	PRIMARY	DEFINITIVE
Sup. screw length [mm]	34	30
Inf. screw length [mm]	30	-

Graft planned data

FRONTAL SECTION AXIAL SECTION LATERAL VIEW

PLAN	PRIMARY	DEFINITIVE
Reaming depth [mm]	-1.0	-
MIN thickness [mm]	9.0	6.0
MAX thickness [mm]	14.0	11.0
Angle [deg]	10	-
MAX thickness position [hh:mm]	03:00	-

GRAFT VIEW



Glenoid planned data

PLAN	PRIMARY	DEFINITIVE
Superior inclination [deg]	-2	-
Retroversion [deg]	-5	-
*Glenoid implant medial offset [mm]	-6.0	-3.0
**Reaming depth [mm]	-1.0	-

* The actual implant medial offset is intraoperatively set by the surgeon
** The actual reaming depth is intraoperatively set by the surgeon

Glenoid Reconstruction System option

FRONTAL SECTION AXIAL SECTION LATERAL VIEW

FRONTAL VIEW FRONTAL VIEW "SURGEON" VIEW

PLAN	PRIMARY	DEFINITIVE
Baseplate type	Pegged	GRS Flat
Baseplate size [mm/mm]	Ø27x35	Ø24.5x20
Baseplate lateralization [mm]	-	3.0
GRS central screw length [mm]	-	15.0
Glenosphere type	Standard	-
Glenosphere size [mm]	36	-
Glenosphere ecc. position [hh:mm]	6:00	-
Bone-implant contact [%]	0	

GLENOID IMPLANT SEATING

Pre-reimplantation CT scan

- **Main goals**
  - Glenoid
    - ✓ Stable baseplate fixation
    - ✓ Joint line restoration
  - Humerus
    - ✓ Humeral length
    - ✓ Tuberosities restoration

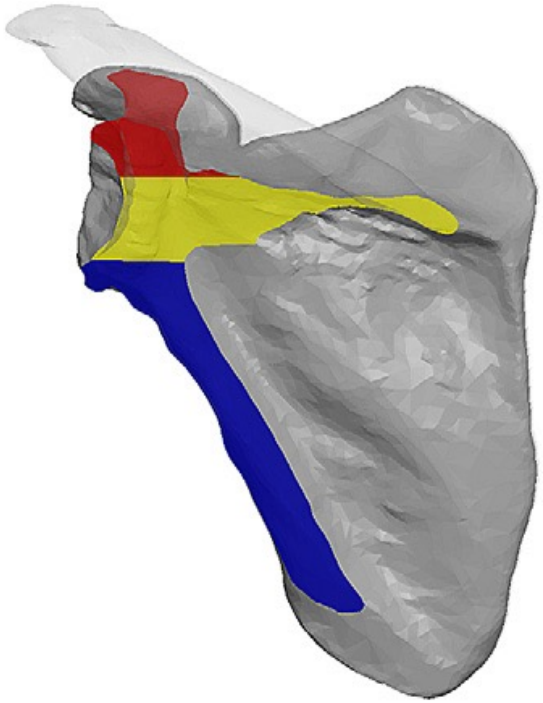
Glenoid planning

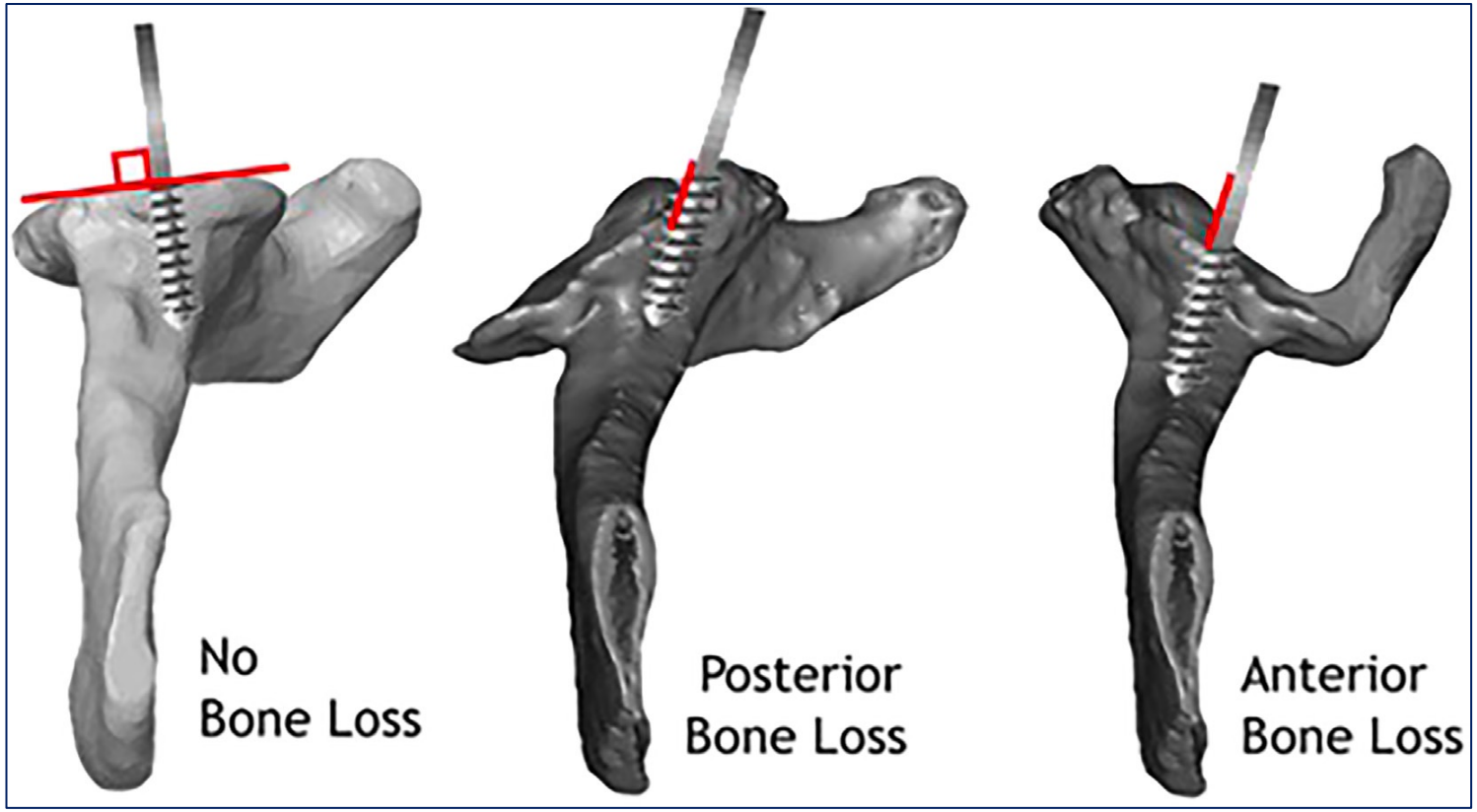
- **Stable baseplate fixation**
  - ***50% rule***
    - ✓ a minimum of 30%-50% of the baseplate or the baseplate bone graft composite should be resting on the native glenoid vault
    - ✓ 50% of central peg in native scapula
    - ✓ minimum of 2 opposite locking screws in native scapula

Gupta & Seebauer 2018

Glenoid planning

- **Stable baseplate fixation**
  - ***Alternate central line***



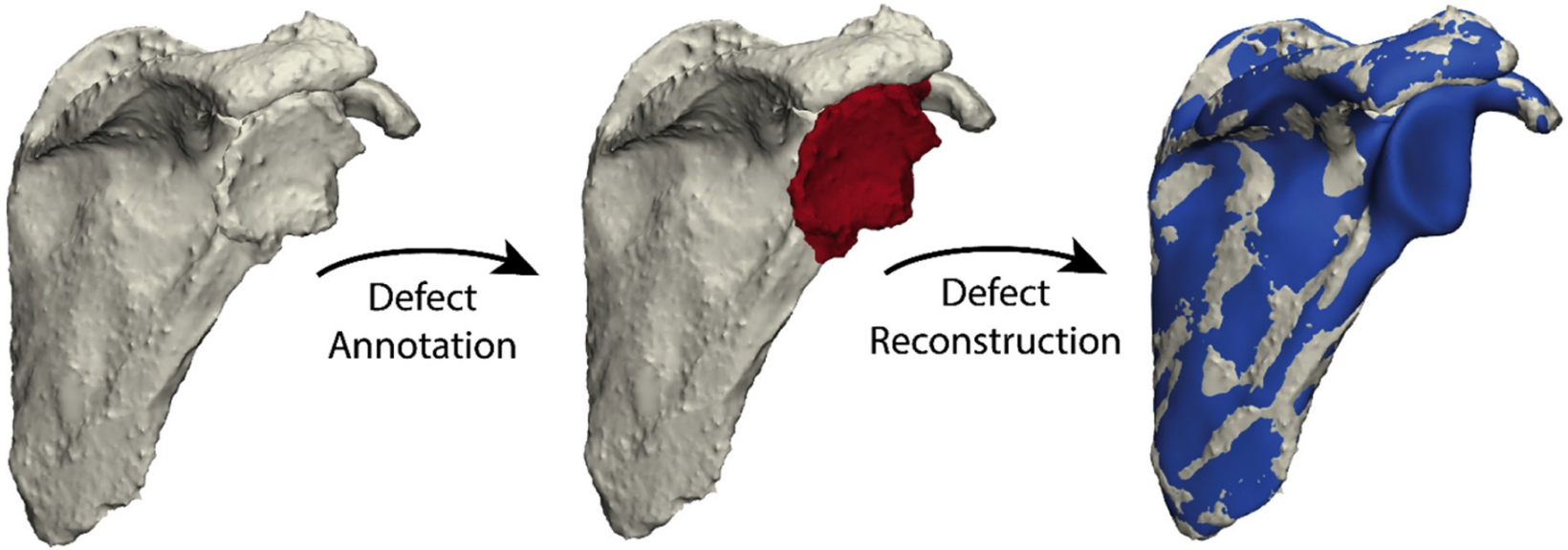


Frankle 2009, Smith 2024

Glenoid planning

- **Joint line restoration**
  - ***association between prearthropathy scapular anatomy and shoulder osteoarthritis***

- 110 healthy shoulder
- 117 osteoarthritis



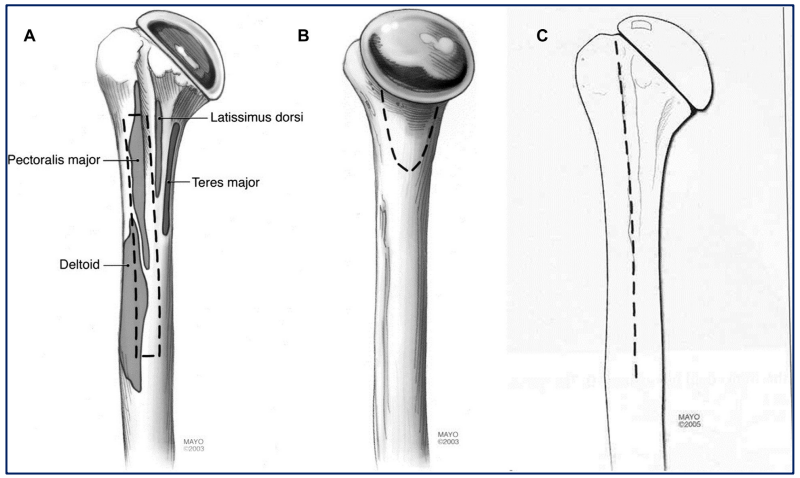
Statistical Shape Model (SSM) of the scapula

Verhaegen 2021

Humerus planning

- **1st implant features**
  - *Version*
  - *Inclination*
  - *Sizing*
  - *Cement*

- **Removal strategies**
  - Humeral window ***Sperling 2005***
  - Vertical osteotomy ***Van Thiel 2011***
  - Router bit extraction ***Kang 2019***



Humerus planning

Stem height

- Pectoralis major tendon
  - Average distance PEC ➡ top of the humeral stem (onlay): 4 cm
  - Average distance PEC ➡ top of the humeral stem (inlay): 5 cm

Boilaeu 2017

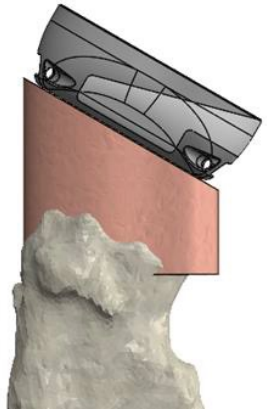
- X-rays/CT contralateral side

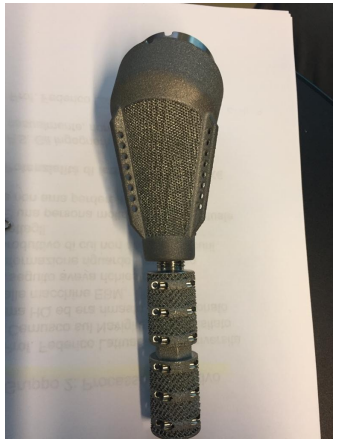
MacDonald 2023

Humerus planning

Stem height & tuberosities management

- *Bone deficiency proximal to the Pec Major insertion (<6 cm)*
  - APC
- *Bone deficiency below the Pec Major insertion but proximal to Deltoid insertion (6–14 cm)*
  - APC
  - Modular design
  - Custom implants





Goldman 2020

D

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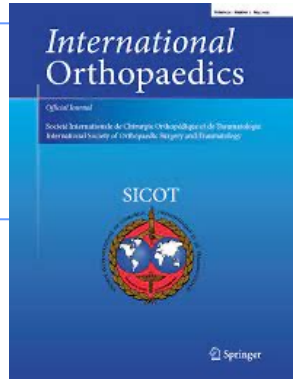
Werthel JD, Walch G, Vegehan E, et al.
Lateralization in reverse shoulder arthroplasty: a descriptive analysis of different implants in current practice.
Int Orthop. 2019 Oct;43(10):2349-2360.

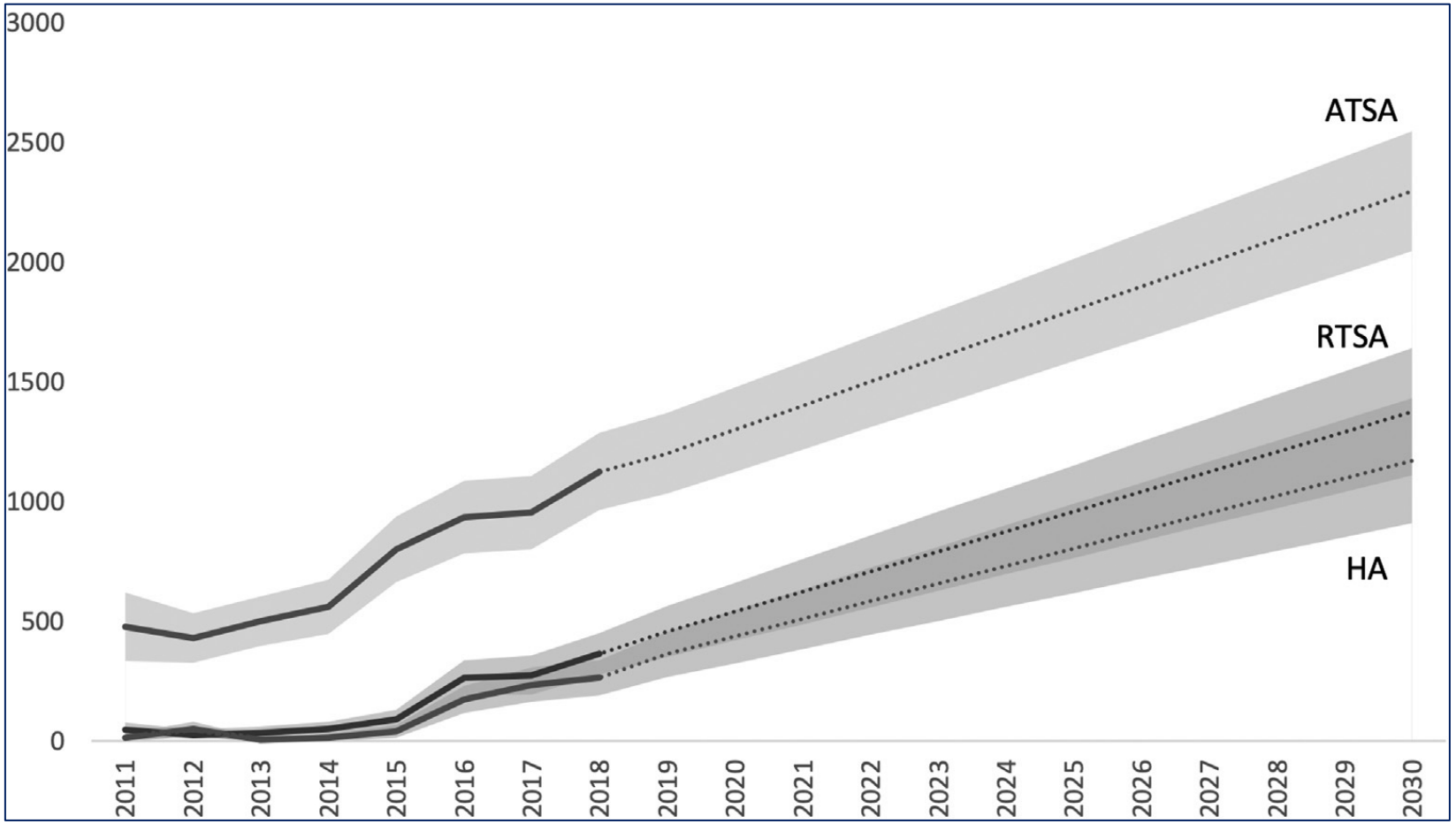


Manufacturer	Implant	Global LO	Global lateralization	Mean GT LO	Mean GT medialization	Global lateralization class	Gleno-humeral construct	Glenoid contribution	Humeral contribution
DePuy	Delta III	13.1	0	29.3	−16.9	M	MGMH		
Mathys	Affinis Reverse	13.2	+0.1	29.4	−16.8		MGMH		
Tornier	Aequalis	15.6	+2.5	31.8	−14.4		MGMH		
Tornier	Aequalis II	15.6	+2.5	31.8	−14.4		MGMH		
Lima	SMR	17	+3.9	33.2	−13	< 18.1	MGMH		
DePuy	DeltaXtend	18.5	+5.4	34.7	−11.5	ML	MGLH	0%	100%
Zimmer	Trabecular Metal	19	+5.9	35.2	−11		MGMH	32%	68%
Arthrex	Univers 155°	19.1	+6	35.3	−10.9		MGLH	−33%	133%
Arthrex	Univers 135°	20.7	+7.6	36.9	−9.3		MGMH	41%	59%
Medacta	Shoulder System 155°	21.7	+8.6	37.9	−8.3		MGLH	53%	47%
Tornier	Aequalis II + BioRSA	22.6	+9.5	38.8	−7.4	≤ 23.1	LGMH	57%	43%
DJO	Altivate	23.4	+10.3	39.6	−6.6	L	LGMH	69%	31%
Medacta	Shoulder System 145°	23.5	+10.4	39.7	−6.5		MGLH	61%	39%
Tornier	Ascend Flex 137.5°	23.8	+10.7	40	−6.2		MGLH+	7%	93%
Fx Solutions	Humelock Reverse	24.3	+11.2	40.5	−5.7		MGLH	37%	63%
Tornier	Ascend Flex 132.5°	24.5	+11.4	40.7	−5.5		MGLH+	6%	94%
Biomet	TESS	26	+12.9	42.2	−4	≤ 28.1	LGLH	50%	50%
Exactech	Equinoxe	26.4	+13.3	42.6	−3.6		MGLH+	25%	75%
Tornier	Ascend Flex 127.5°	26.7	+13.6	42.9	−3.3		MGLH+	5%	95%
Fx	Easytech	27.2	+14.1	43.4	−2.8		MGLH	51%	49%
Aston	Duocentric	28.2	+15.1	44.4	−1.8	HL	LGLH	26%	74%
Strkyer	ReUnion RSA	29.3	+16.2	45.5	−0.7		LGLH+	31%	69%
Biomet	Comprehensive	29.8	+16.7	46	−0.2		LGLH+	31%	69%
Zimmer	Inverse Reverse	31	+17.9	47.2	1		MGLH+	22%	78%
Tornier	Ascend Flex 132.5° + BioR-SA	31.5	+18.4	47.7	1.5	≤ 33.1	LGLH+	42%	58%
FH Ortho	Arrow II	31.7	+18.6	47.9	1.7		LGLH+	51%	41%
FH Ortho	Arrow	34.5	+21.4	50.7	4.5	VHL	LGLH+	31%	69%

- 22 implants
- Global lateral offset
  - 13.1 – 35.8 mm

Schick S, Elphingstone J, Murali S, et al.
The incidence of shoulder arthroplasty infection presents a substantial economic burden in the United States: a predictive model.
JSES Int. 2023 Apr 11;7(4):636-641.

1° cause of revision: periprosthetic joint infection!



- +176% in 2030
- 4844 cases
  (95% CI 4067-5621)

Matsen FA 3rd, Whitson A, Hsu JE. et al.
Preoperative Skin Cultures Predict Periprosthetic Infections in Revised Shoulder Arthroplasties: A Preliminary Report.
JB JS Open Access. 2020 Nov 25;5(4):e20.00095

- 18 revision RSA
- 3 different cultures
  - Clinic
  - Intraop before surgery
  - After skin incision

Prediction of a Culture-Positive Cutibacterium PJI*

	Clinic Skin Cutibacterium Value >1	Cutibacterium Percentage ≥75%
For all patients		
Sensitivity	71% (29% to 96%)	86% (42% to 100%)
Specificity	100% (72% to 100%)	100% (72% to 100%)
Positive predictive value	100%	100%
Negative predictive value	85% (63% to 95%)	92% (64% to 99%)
Accuracy	89% (65% to 99%)	94% (73% to 100%)
For male patients only		
Sensitivity	83% (36% to 100%)	100% (54% to 100%)
Specificity	100% (48% to 100%)	100% (48% to 100%)
Positive predictive value	100%	100%
Negative predictive value	83% (46% to 97%)	100%
Accuracy	91% (59% to 100%)	100% (72% to 100%)

*The values are given as the percentage, with or without the 95% confidence interval in parentheses.

A simple culture specimen of the unprepared skin surface obtained in a clinic may provide valuable assistance to surgeons planning a revision arthroplasty


BRESHOULDER 24
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Chairman
Giuseppe Milano
October 11-12, 2024
University of Brescia
Faculty of Medicine and Surgery
Brescia, Italy

Thank you!