
AIR
2024

UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Ospedale di Sassuolo s.p.a.

Shoulder Elbow Team
Chirurgia della Spalla e del Gomito

IX Congresso Nazionale
Il recupero delle geometrie articolari nelle revisioni protesiche
Verona | Gran Guardia | 7-8 Marzo 2024

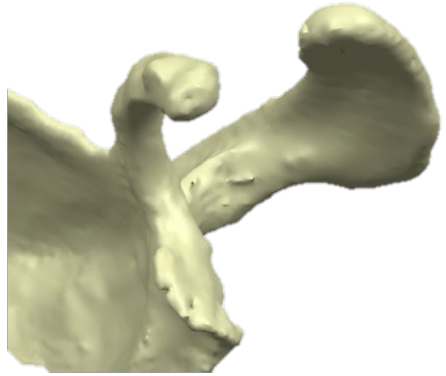
AIR
Associazione Italiana Riprotesizzazione

LE PROTESI CUSTOM MADE NELLE REVISIONI

Prof. Giuseppe Porcellini

Dott. Rocco Bonfatti, Dott. Alessandro Donà
Dott. Andrea Giorgini, Dott. Gian Mario Micheloni

INDICATIONS



"where there is such **destruction of the glenoid vault** that secure **fixation** of a reverse-type prosthesis **is impossible** as a result of a **lack of bone** to accommodate the **central peg** and predefined screw placement"

= BONE LOSS

Points of **fixation**

- **SCAPULAR NECK**
- **SCAPULAR SPINE**
- **CORACOID**

Malhas A, Shoulder Elbow - 2016

GLENOID BONE LOSS

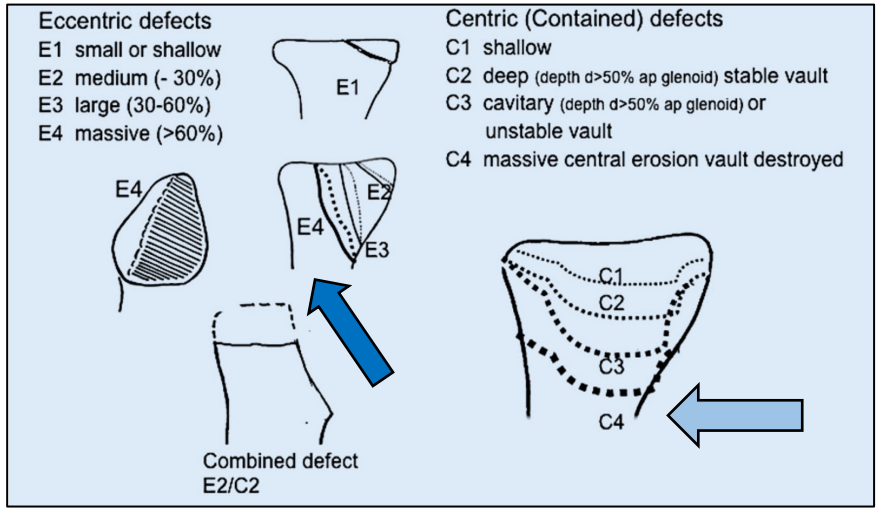
BONE QUALITY

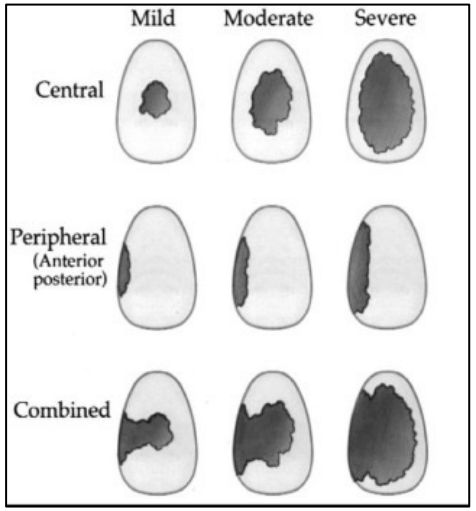
EROSION MORPHOLOGY

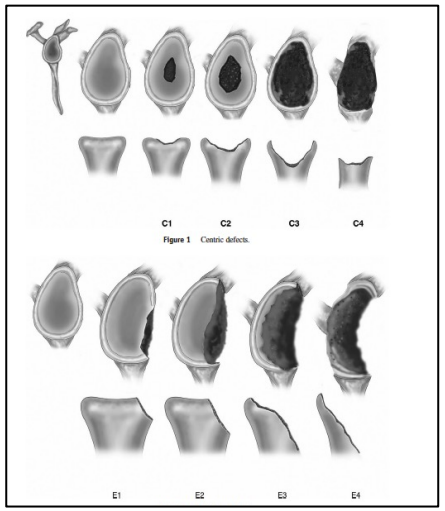
VAULT AREA

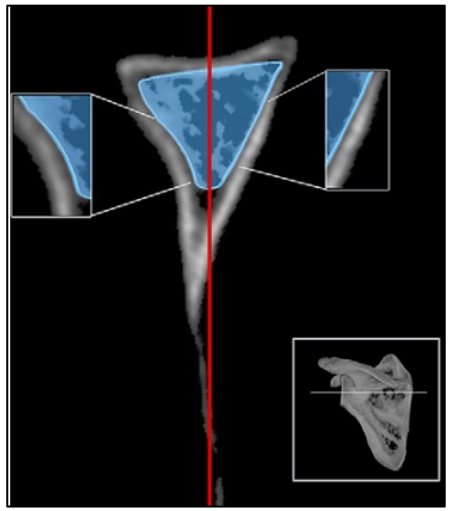
STOCK AFTER REMOVAL

What does it mean ?









GLENOID BONE LOSS

FAILED HEMI

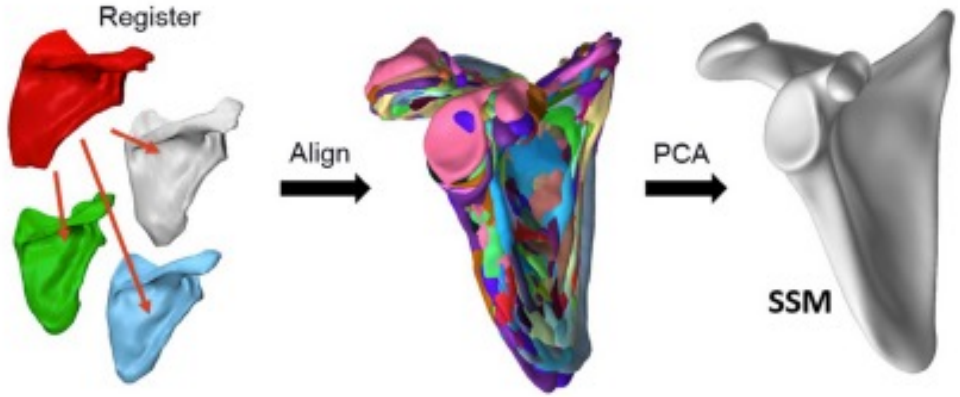
FAILED TSA

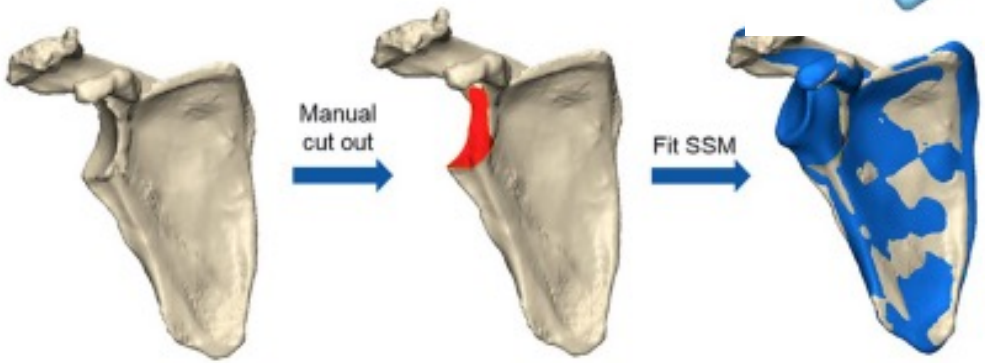
REVISION RSA

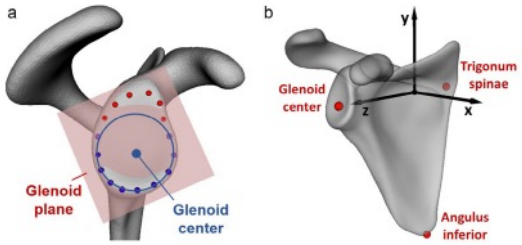
FRACTURES…

9% up to 38%
of glenoid bone loss

GLENOID WEAR
→ First problem





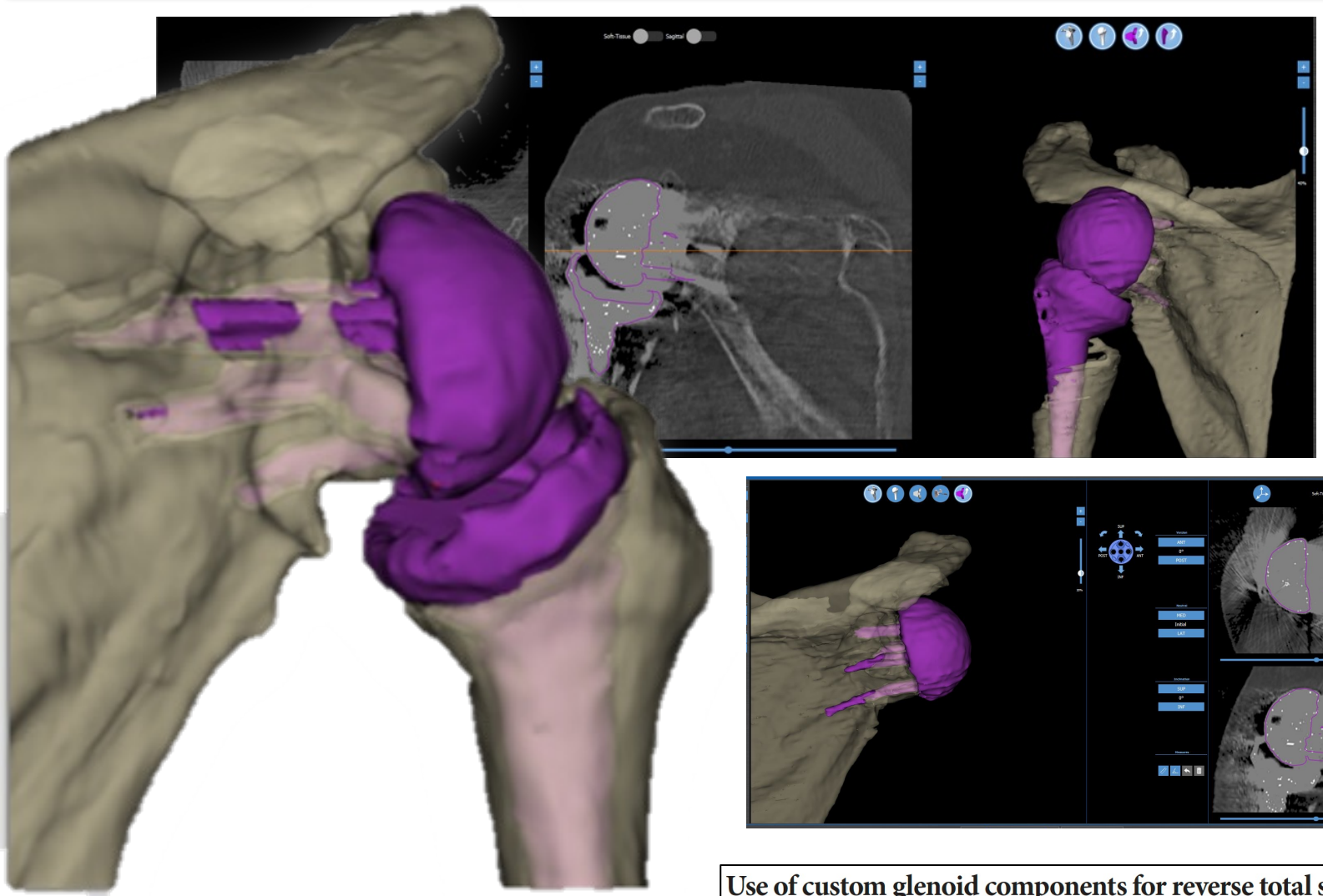


Virtual reconstruction of glenoid bone defects using a statistical shape model

Katrien Plessers, MSc[a,b,*], Peter Vanden Berghe, MSc[a,b], Christophe Van Dijck, MSc[a,b], Roel Wirix-Speetjens, PhD[b], Philippe Debeer, MD, PhD[c,d,e], Ilse Jonkers, PhD[f], Jos Vander Sloten, PhD[a]

JSES - 2016

BONE LOSS



> 6 months CT scan/implantation
→ bone loss: implants unusable

Use of custom glenoid components for reverse total shoulder arthroplasty

Punyawat Apiwatanakul, Prashant Meshram, Andrew B. Harris, Joel Bervell, Piotr Łukasiewicz, Ridge Maxson, Matthew J. Best, Edward G. McFarland

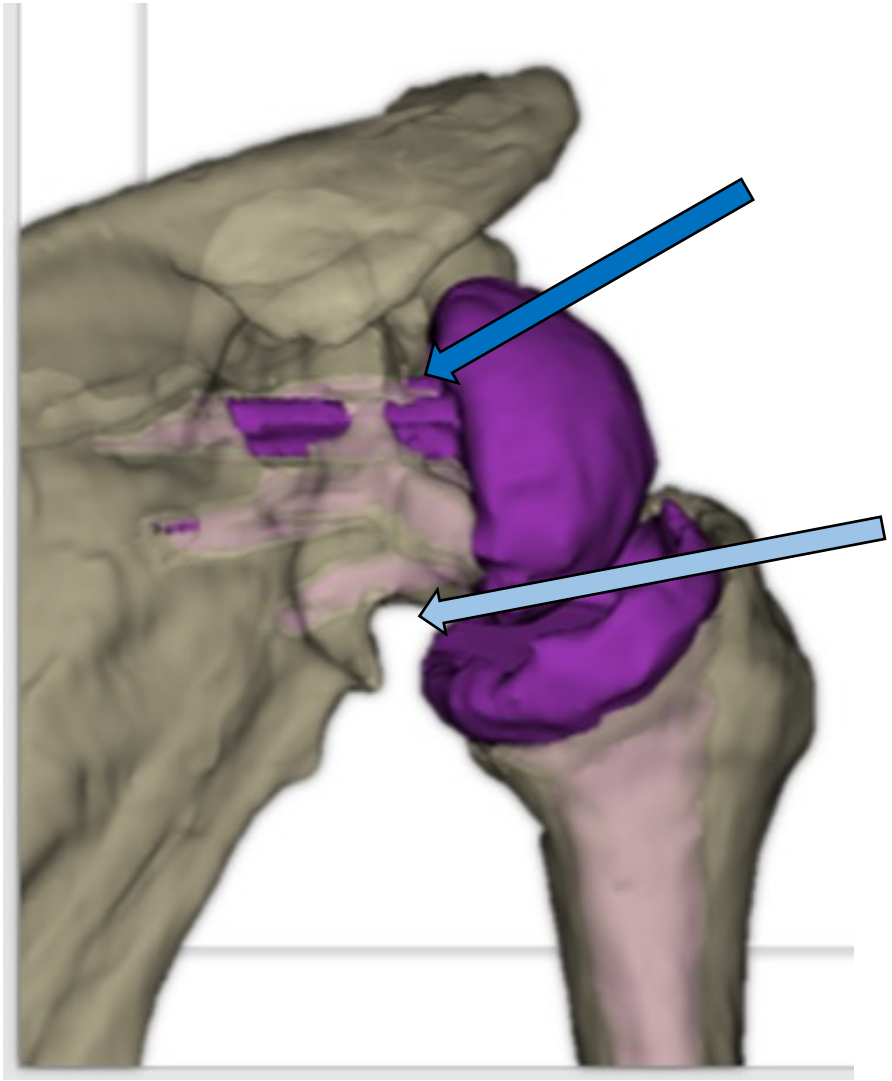
What can we foresee ?

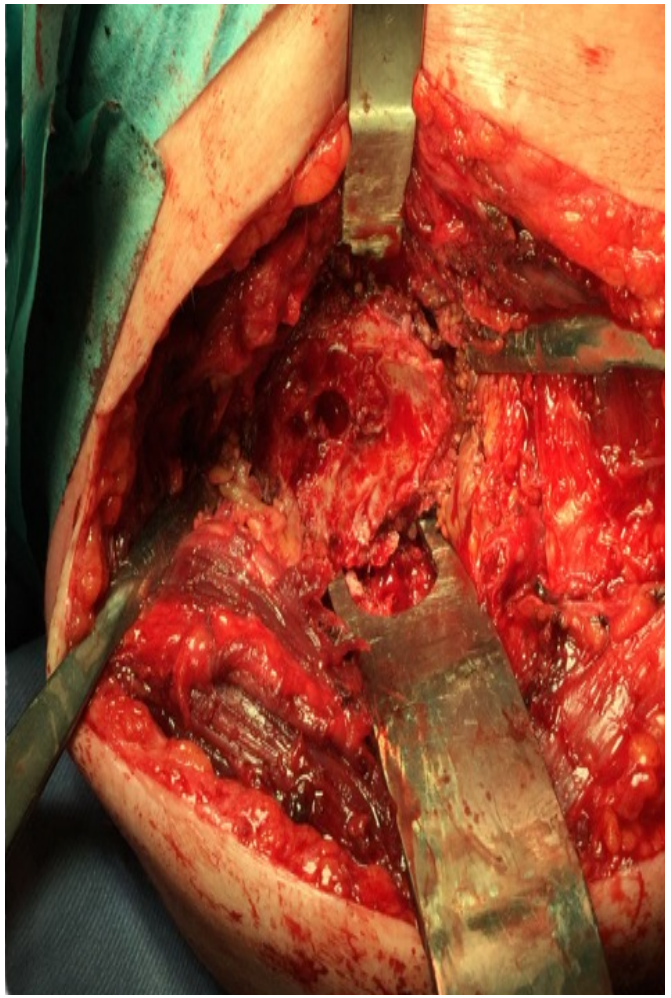
QUALITY

MORPHOLOGY

STOCK AFTER REMOVAL

BONE LOSS → before and…AFTER removal





Implants:

BONE-PRESERVING

vs.

NOT

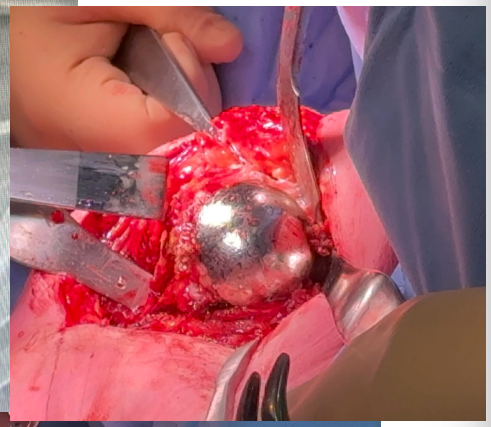
- GLENOID FIXATION
- SCAPULAR NOTCHING
- HUMERAL STEM/LESS
- MICRO/MACRO-MOTION

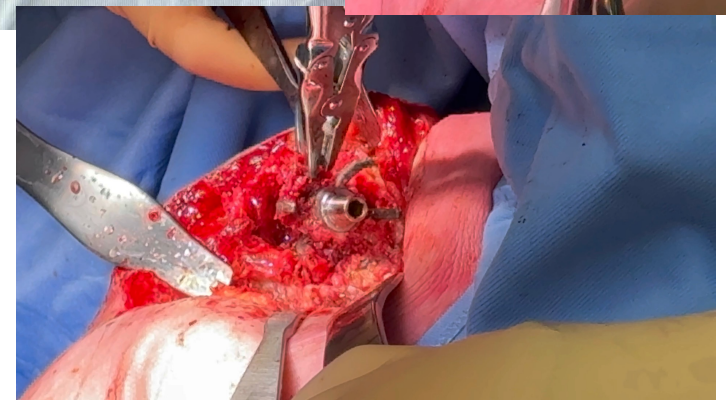
BONE LOSS → before and…AFTER removal

FIRST IMPLANT
→ Second problem

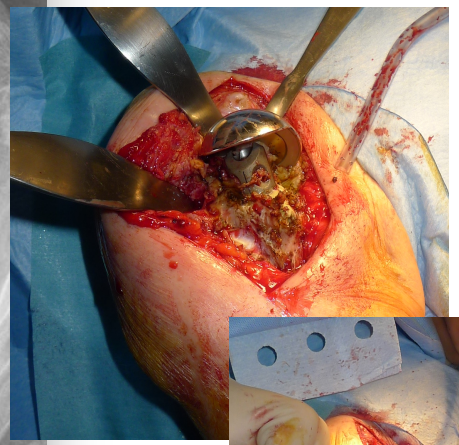
BONE - PRESERVING

Glenoid?

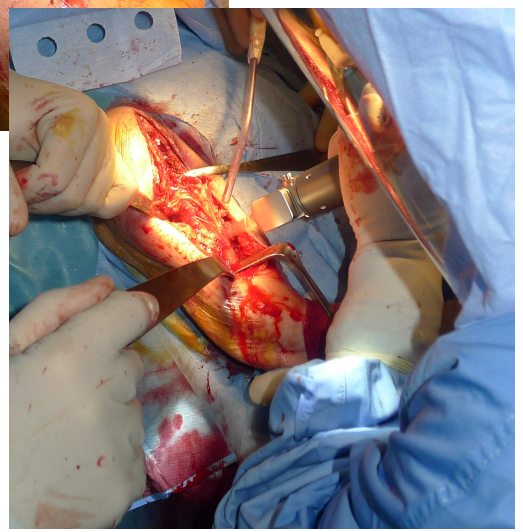


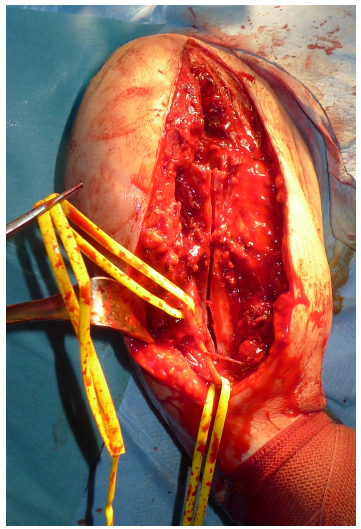


PRESS – FIT/CEMENT



Humerus?





BONE LOSS → how much for a custom?

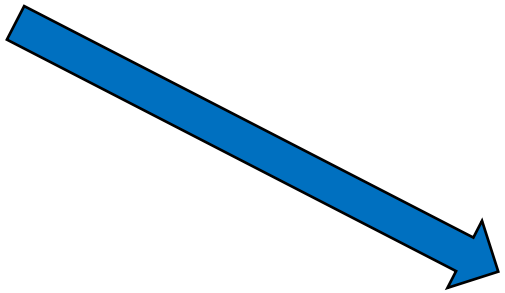
BIOMECHANIC STABILITY → criteria to succeed

“50 % RULE”

1. Minimum of 30%-50% of the baseplate or the baseplate bone graft composite should be resting on the native glenoid vault
2. 50% of central peg in native scapula
3. Minimum of 2 opposite locking screws in native scapula

Management of glenoid bone defects with reverse shoulder arthroplasty—surgical technique and clinical outcomes

Ashish Gupta, MBBS, MSc, FRACS[a,b,*], Christoph Thussbas, MD[a], Michael Koch, MD[a], Ludwig Seebauer, MD[a]



If you cannot respect them… CUSTOM comes

CUSTOM MADE IMPLANTS

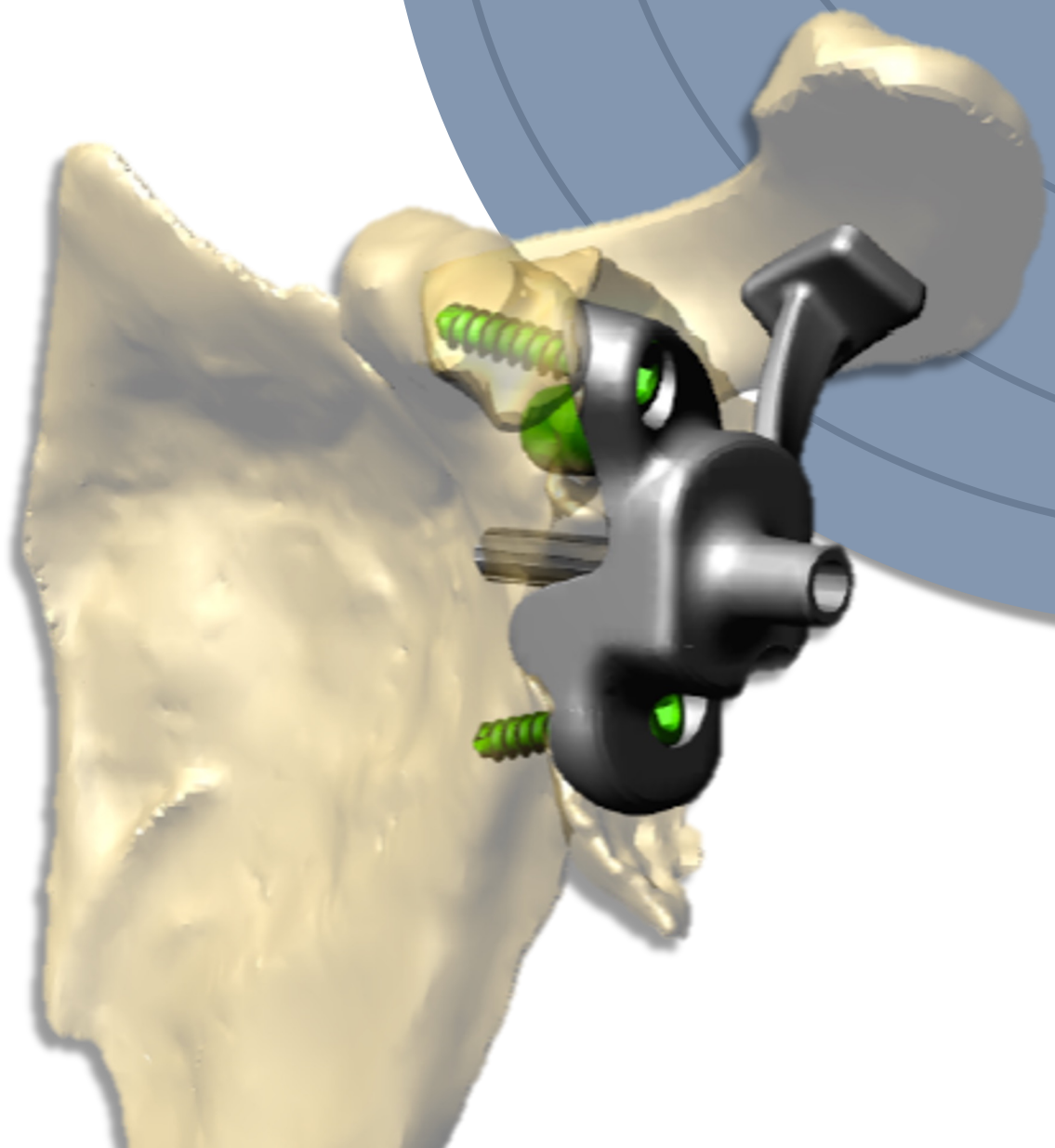
CAD-CAM SYSTEM **(CT BASED)**

FLANGES OR PADS FIXED TO THE **CORACOID BONE** OR **SCAPULAR SPINE**

WEDGES

PSI

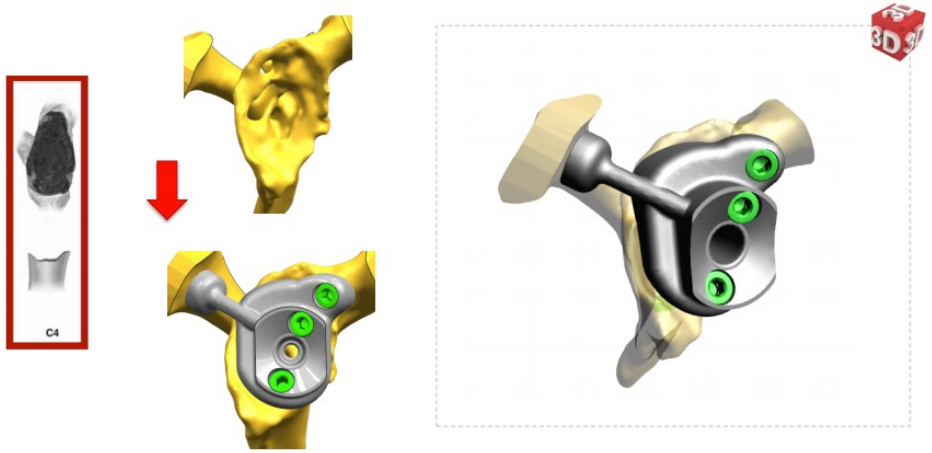
TRABECULAR METAL



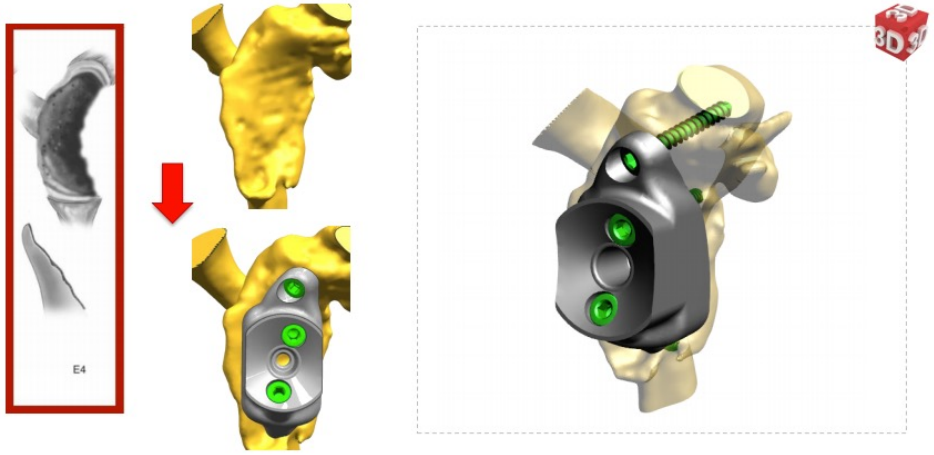
CUSTOM MADE IMPLANTS

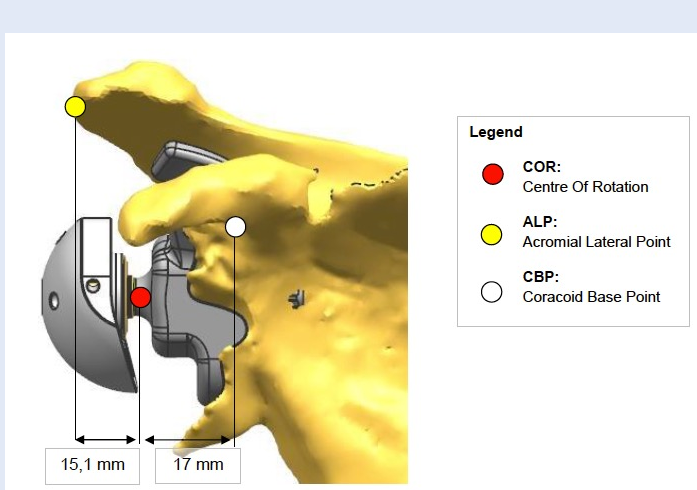
BIOMECHANICAL STUDY

Shoulder – Defects C4



Shoulder – Defects E4



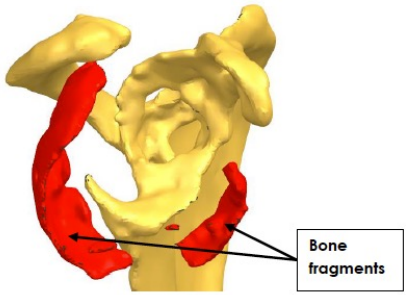


C.O.R.

Original joint line/interface ??

CUSTOM MADE IMPLANTS

SOFTWARE PLANNING



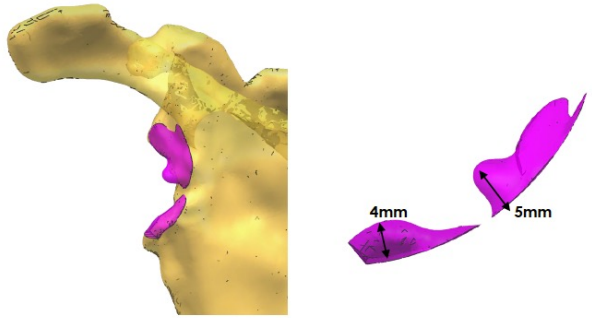


Fig. 3: Bone to be reamed (magenta colour)

OSTEOPHYTES
→ **removal**

– Very low bone thickness

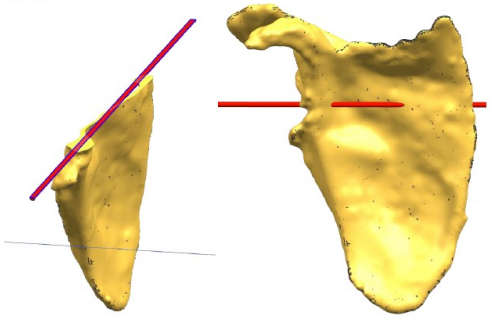


Fig. 2: Low bone thickness (left), K-wire direction (right)

GUIDE-WIRE
→ **positioning**

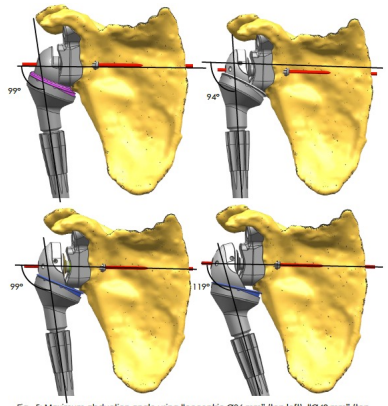
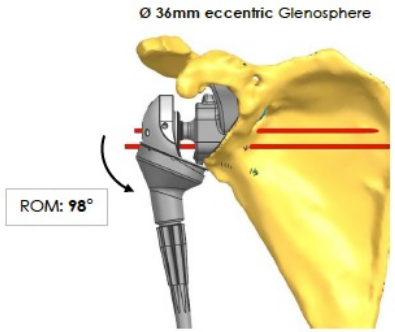
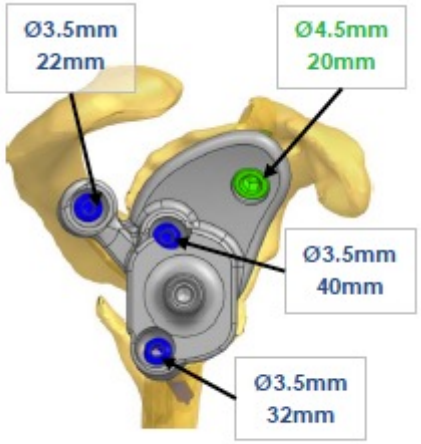
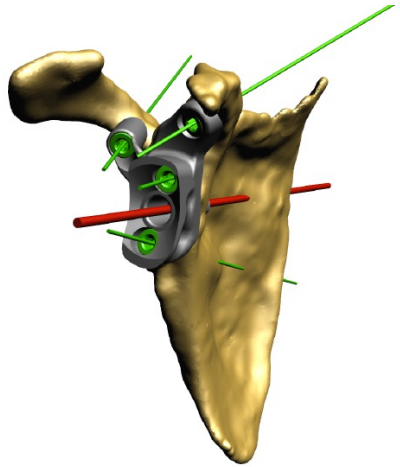


Fig. 5: Maximum abduction angle using "eccentric Ø36 mm" (top left), "Ø40 mm" (top right), "Ø44 mm" (bottom left) and "eccentric Ø44 mm" (bottom right) Glenospheres, after manual cleaning of inferior osteophytes



ROM
→ **different glenosphere sizes**

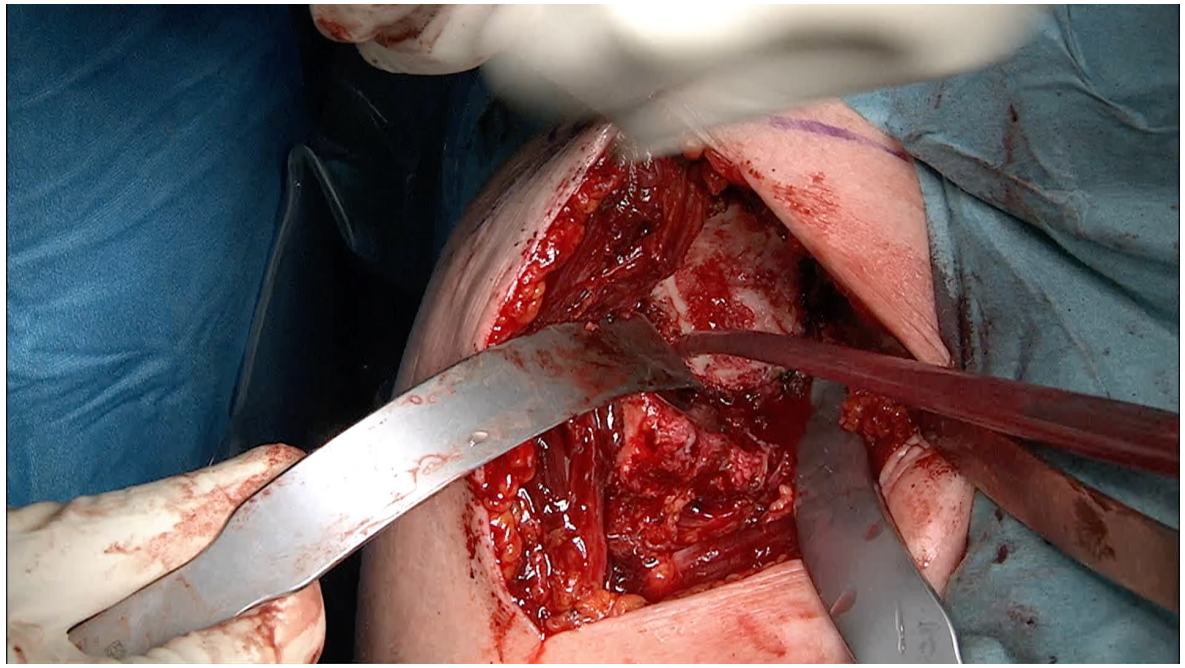


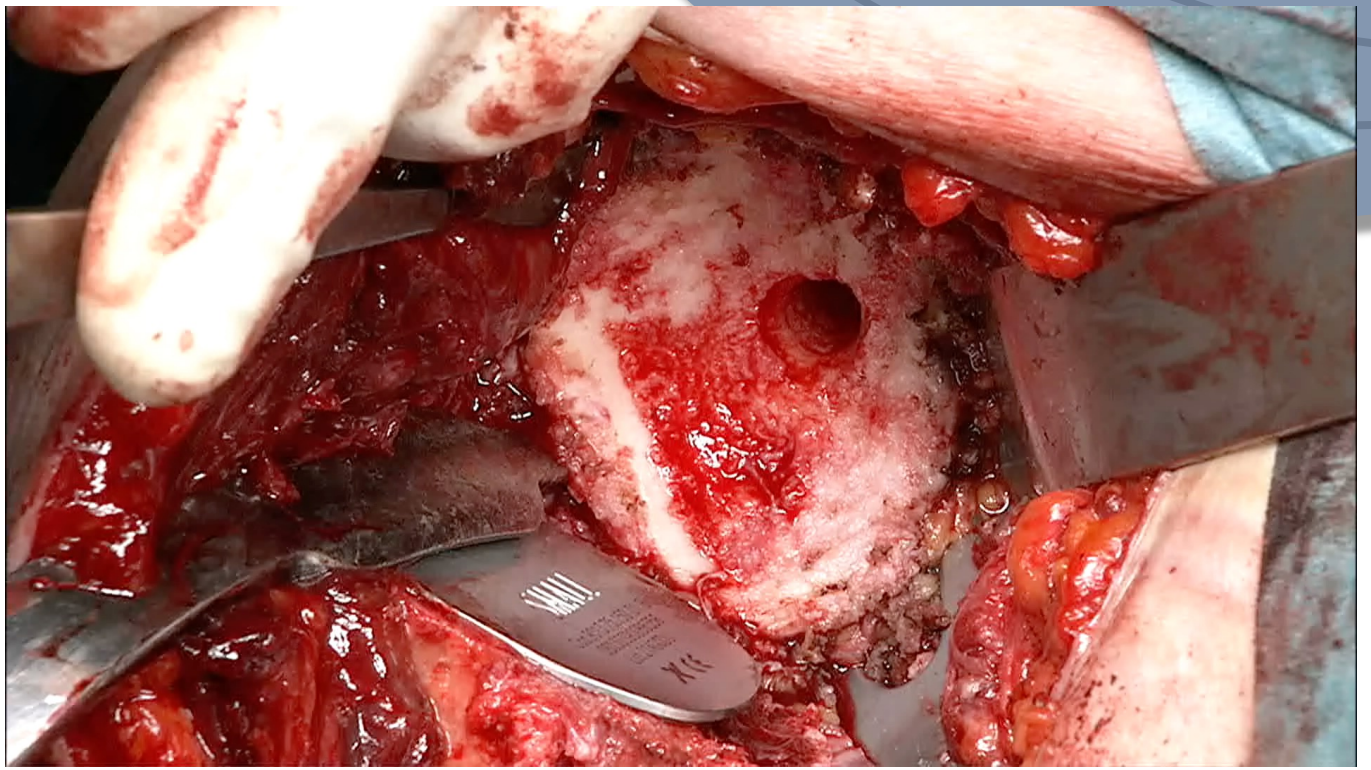


SCREWS
→ **lenght and direction**

CUSTOM MADE IMPLANTS

Surgical Technique

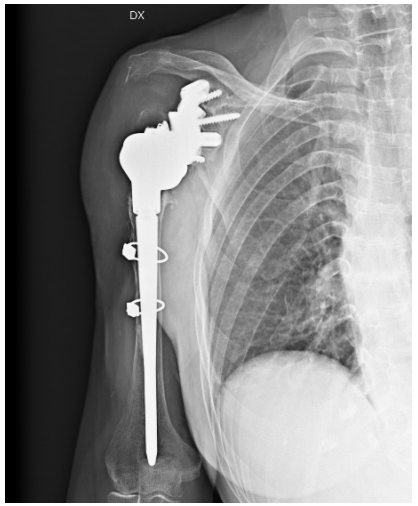


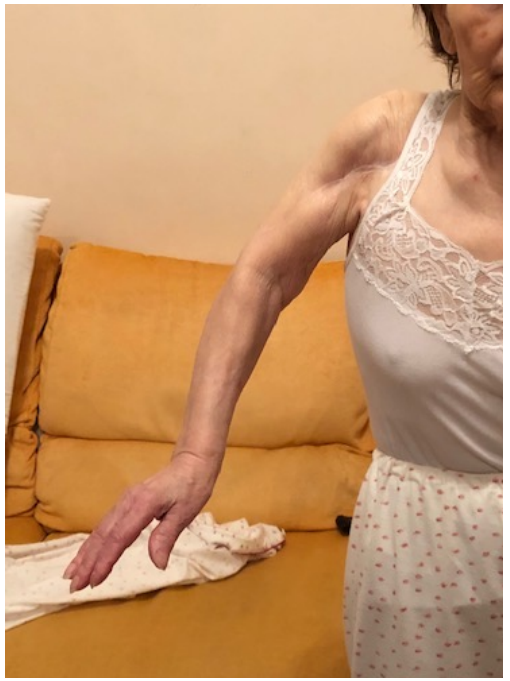


REVISION with CUSTOM MADE

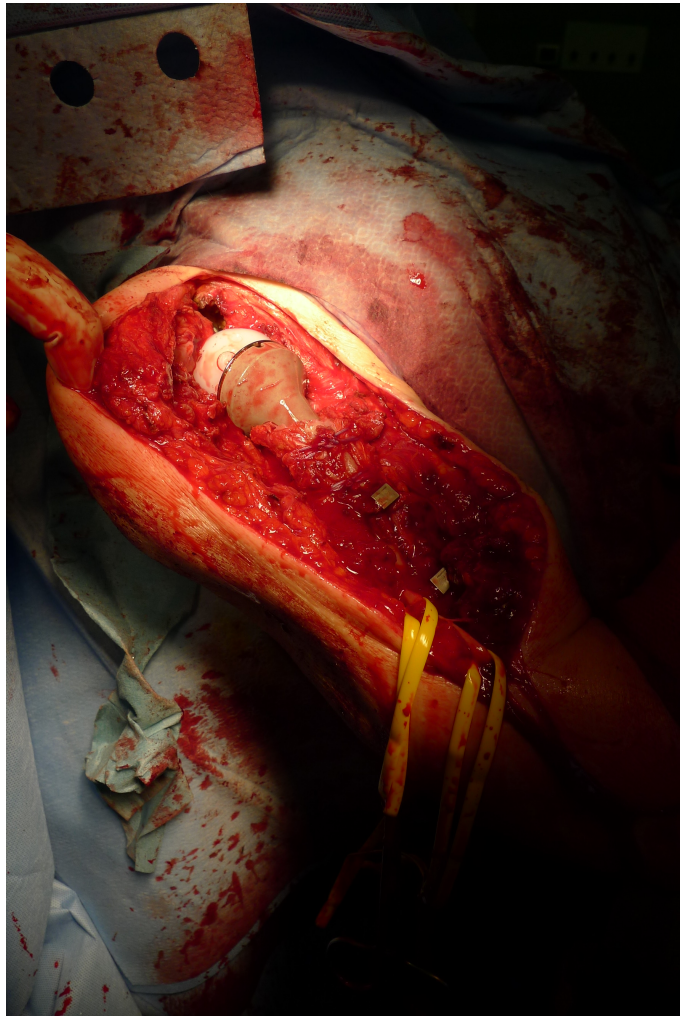
74 y, F
E4, infection
several procedures (6)
2y FU CS 12

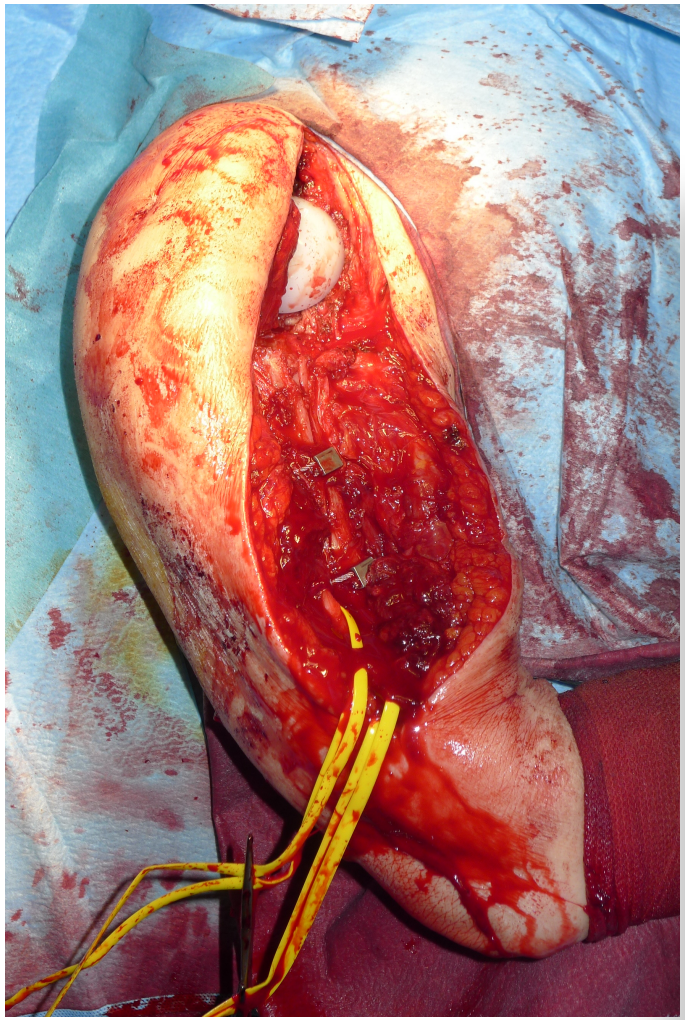
Not just «put and go»
…also remove





REVISION with CUSTOM MADE





Not an easy surgery…

For ?

CUSTOM MADE: outcomes

Table II Range of motion and patient-reported outcome measures prior to surgery and at last follow-up

Patient No.	Follow-up, mo	aFF, °		aABD, °		aER, °		DASH score		Constant score		ASES score		SST score		SANE score		VAS pain score	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	27	45	110	45	85	30	45	76.7	29.2	45.0	54.9	50.0	71.7	10	10	50	55	6	0
2	27	100	120	70	90	45	50	39.2	10.8	38.0	68.5	66.7	96.7	7	12	30	85	2	0
3	27	10	117	10	88	10	52	67.5	18.3	20.0	61.4	56.7	75.0	3	9	10	70	1	0
4	24	45	90	45	75	0	35	46.7	21.7	25.7	56.3	50.0	78.3	6	10	25	65	2	0
5	22	45	90	45	45	10	45	62.5	23.3	22.0	44.8	11.7	81.7	2	8	30	80	8	0
6	20	45	135	40	90	0	30	24.2	9.2	13.0	70.1	45.0	83.3	2	11	20	80	3	0
7	19	0	120	0	90	0	−30	82.5	63.3	8.0	47.5	13.3	68.3	0	7	2	60	8	0
8	18	80	150	45	75	−20	45	33.3	16.7	25.7	71.2	33.3	95.0	7	9	20	85	6	0
9	18	45	90	45	45	30	10	72.5	62.5	13.0	28.8	11.7	55.0	3	8	10	60	9	3
10	18	80	150	45	70	0	40	69.2	30.0	27.0	84.0	8.3	98.3	3	12	10	99	10	0
11	17	45	128	45	67	20	25	52.5	12.5	NA	61.5	NA	91.7	NA	10	40	75	7	0
12	15	45	100	45	80	10	−20	42.5	35.8	25.0	41.0	41.7	51.7	6	6	25	60	5	3
13	14	70	135	70	60	40	30	56.5	20.0	20.0	74.0	21.7	93.3	7	10	50	65	9	0
14	13	60	130	30	75	20	40	70.0	67.0	17.0	57.8	13.3	55.0	3	6	30	70	9	4
15	13	45	160	45	100	0	60	55.0	2.5	22.0	85.0	16.7	100.0	3	12	20	100	9	0
16	12	45	165	45	85	50	30	64.7	49.2	23.0	69.5	43.3	78.3	2	10	15	75	3	0
17	12	45	120	30	80	25	30	42.5	20.0	29.0	56.3	33.3	85.0	7	9	30	90	6	0
18	12	110	120	60	80	30	50	75.8	36.7	44.0	55.4	26.7	63.3	6	9	40	25	8	2

aFF, active forward flexion; *aABD*, active abduction; *aER*, active external rotation; *DASH*, Disabilities of the Arm, Shoulder and Hand; *ASES*, American Shoulder and Elbow Surgeons; *SST*, Simple Shoulder Test; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale; *Pre*, preoperative; *Post*, last follow-up visit; *NA*, not available.

Conclusion

The VRS is a patient-matched custom metal glenoid implant for use in rTSA with severe glenoid bone deficiency, and it is the only implant of this type commercially available for use in the United States. Preliminary results of this series of patients are promising, but longer follow-up is necessary to determine the longevity of this implant.

Rangarajan R et al, J Shoulder Elbow Surg 2020

Preliminary results

Table 1 Summary of patient characteristics

Name	Gender	Age	Classification (Antuna)	Classification (Seebauer)	CS preop	CS postop	ASES preop	ASES postop	VAS preop	VAS postop
CM	F	74	Severe combined	E4	5	12	10	25	8	5
OF	F	66	Severe combined	C4	13	17	25	55	6	0
VG	M	71	Severe combined	E4	18	38	23.3	71.6	8	0
DBN	M	48	Severe combined	E4	20	28	13.3	40	8	2
BN	F	56	Severe combined	E4	18	26	16.7	46.7	8	3
MW	M	69	Severe combined	E4	16	28	3.3	36.7	10	4

Name	Ant. elev. preop	Ant. elev. postop	Abduction pre	Abduction post	Intrarotation pre	Intrarotation post	Extrarotation pre	Extrarotation post	Notching (y/n)
CM	15°	25°	15°	25°	Lateral thigh	Lateral thigh	< 10°	< 10°	y
OF	35°	NA	40°	NA	Lateral thigh	Lateral thigh	< 10°	NA	n
VG	70°	90°	60°	80°	Gluteus	Gluteus	< 10°	< 10°	n
DBN	60°	70°	30°	50°	Lateral thigh	Lateral thigh	< 10°	< 10°	n
BN	40°	65°	30°	50°	Lateral thigh	Lateral thigh	< 10°	< 10°	n
MW	30°	60°	40°	70°	Lateral thigh	Lateral thigh	< 10°	< 10°	n

NA not applicable, *y* yes, *n* no

The most reliable outcome of custom-made implants in severe glenoid bone loss is the decrease in pain. A large variety of outcomes were noted regarding functionality and, therefore, a significant clinical improvement is not guaranteed. Computer analysis of residual shape and amount of glenoid bone stock, in association with new classifications, could enable the surgeon to obtain good clinical and radiological outcomes, including the most difficult cases.

Porcellini G et al, J Orthop traumatol 2021

CUSTOM MADE: outcomes

Quantifying success after first revision reverse total shoulder arthroplasty: the minimal and substantial clinically important percentage of maximal possible improvement

Kevin A. Hao, BS[a], Keegan M. Hones, MD, MS[b], Daniel S. O'Keefe, BS[a], Supreeya A. Saengchote, MS[a], Lacie M. Turnbull, MD[b], Jonathan O. Wright, MD[b], Thomas W. Wright, MD[b], Kevin W. Farmer, MD[b], Aimee M. Struk, MEd, MBA, ATC, LAT[b], Ryan W. Simovitch, MD[c], Bradley S. Schoch, MD[d], Joseph J. King, MD[b,*]

Quantifying success after first revision reverse total shoulder arthroplasty: the minimal clinically important difference, substantial clinical benefit, and patient acceptable symptomatic state

Kevin A. Hao, BS[a], Keegan M. Hones, MD[a], Daniel S. O'Keefe, BS[a], Supreeya A. Saengchote, MS[a], Madison Q. Burns, BS[b], Jonathan O. Wright, MD[b], Thomas W. Wright, MD[b], Kevin W. Farmer, MD[b], Aimee M. Struk, MEd, MBA, ATC, LAT[b], Ryan W. Simovitch, MD[c], Bradley S. Schoch, MD[d], Joseph J. King, MD[b,*]

How to evaluate efficacy ?

Costs/effectiveness ??

minimal and substantial clinically important percentage of maximal possible improvement → (MCI-%MPI and SCI-%MPI)

CUSTOM MADE: final implant

Positioned as planned ?

CUSTOM MADE: final positioning

Acceptable ?

Table 4. Differences in implant position compared to the planning report [a].

	Difference of Orientation (deg)		Difference of Position (mm)		
Patient	Inferior Inclination	Retroversion	Posterior	Superior	Medial
2	2	7.5	4	0.5	0.5
3	3	2	3	1.5	0.5
4	2	3	2	1	0.5
5	1	2	3	0.5	0.5
7	3	2	3	1.5	0.5
8	1.5	4	2.5	0.5	0.5
Mean	2.1	3.4	2.9	0.9	0.5
±SD	±0.8	±2.2	±0.7	±0.5	±0.0

[a] All measurements are rounded to the nearest 0.5 mm and 0.5%. SD, Standard Deviation.

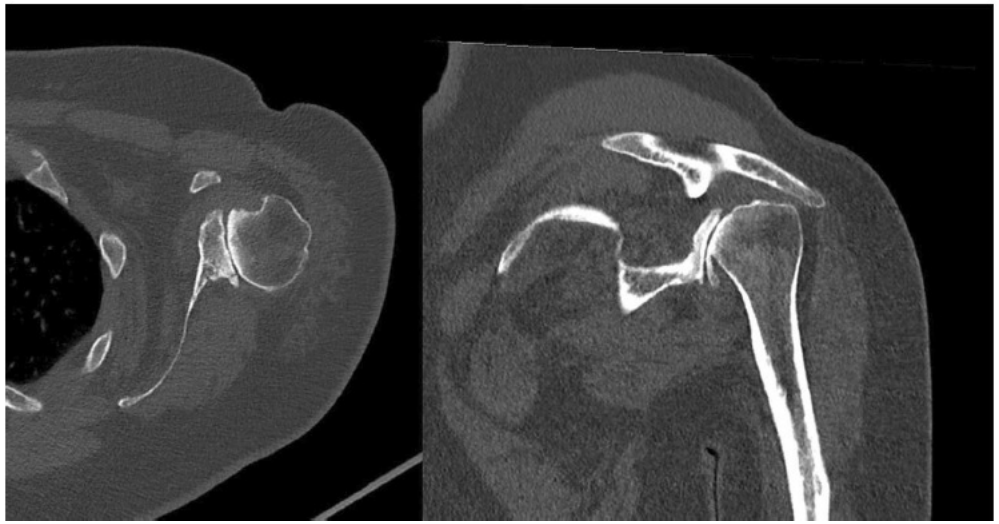
Inclination 2.1° ± 0.8°

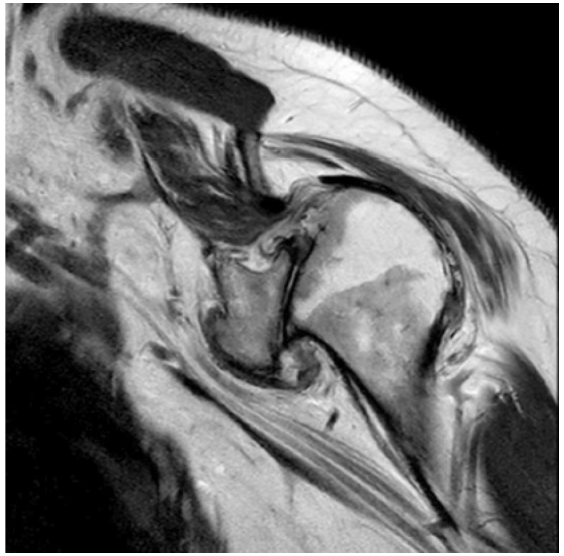
Retroversion 3.4° ± 2.2°

Posterior 2.9mm ± 0.7mm

Ortmaier R et al, J Clin Med 2022

CUSTOM MADE: not only for revisions

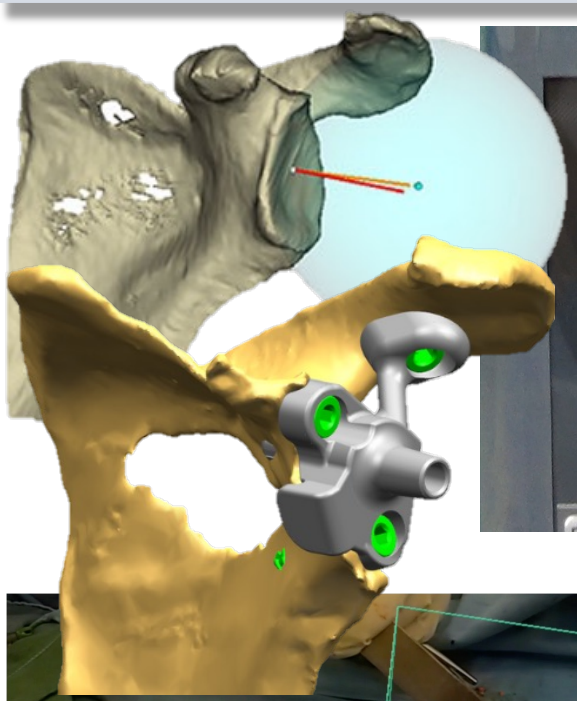


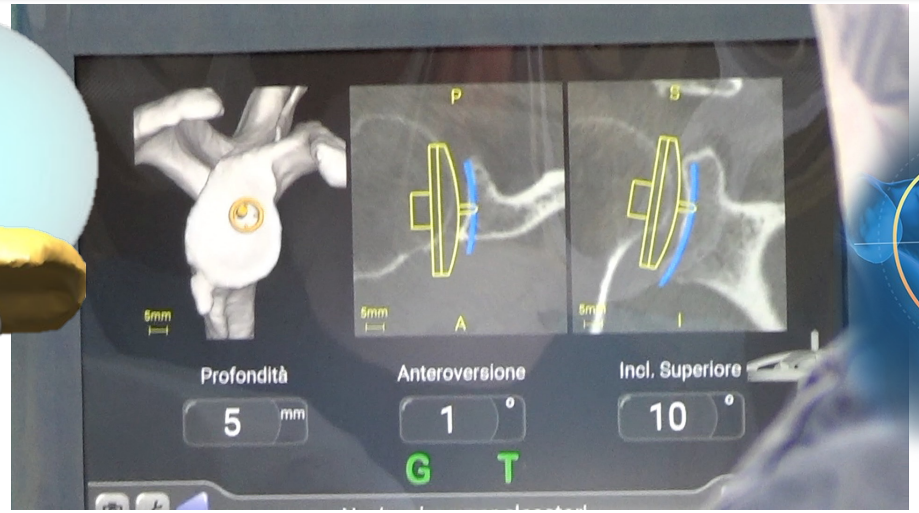


Reverse shoulder arthroplasty in obstetric brachial plexus injury: our experience with shoulder motion analysis

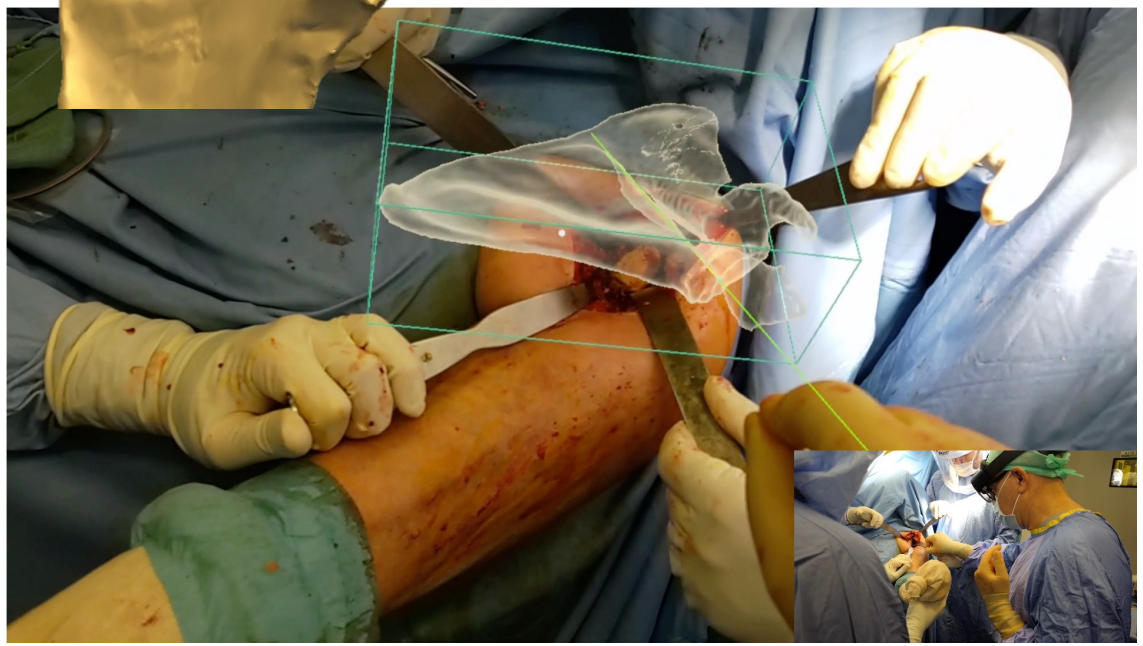
Giuseppe Porcellini[1*], Marco Montemagno[2], Chiara Manzini[1], Gabriele Fiumana[3], Andrea Giorgini[1], Gianmario Micheloni[1] and Luigi Tarallo[1]

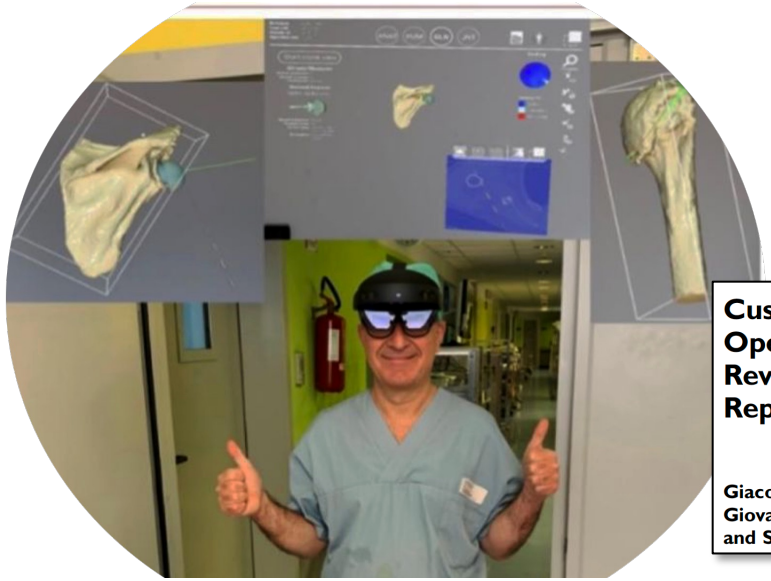
CUSTOM MADE: will disappear in the future?





Or will be a «daily» activity ?





Custom-made Glenoid Baseplate and Intra-Operative Navigation in Complex Revision Reverse Shoulder Arthroplasty: A Case Report

Giacomo Peri, MD[1,2,*], Elisa Troiano, MD[1,2,*], Giovanni Battista Colasanti, MD[2], Nicola Mondanelli, MD, PhD[1,2] and Stefano Giannotti, MD[1,2]

CONCLUSIONS

- EVALUATION OF BONE LOSS
- CHANGES PRE – POST REMOVAL
- COST/EFFECTIVENESS
- FUTURE TECHNOLOGIES

FIRST IMPLANT
→ The most important choice

REVISION with CUTOM MADE

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Shoulder Elbow Team
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GRAZIE PER L'ATTENZIONE

Prof. Giuseppe Porcellini

Dott. Rocco Bonfatti, Dott. Alessandro Donà
Dott. Andrea Giorgini, Dott. Gian Mario Micheloni