Complex Reconstructions of the Humerus and Shoulder

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Tumours Humerus

- third most common site for sarcoma and second for metastasis

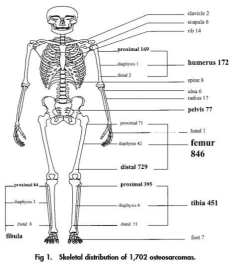

Fig 1. Skeletal distribution of 1,702 osteosarcomas.

Bielack et al J Clin Oncology 2002

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Shoulder EPR Germany

- >25.000 primary shoulder EPR per year
- about 10% revisions (2500) per year



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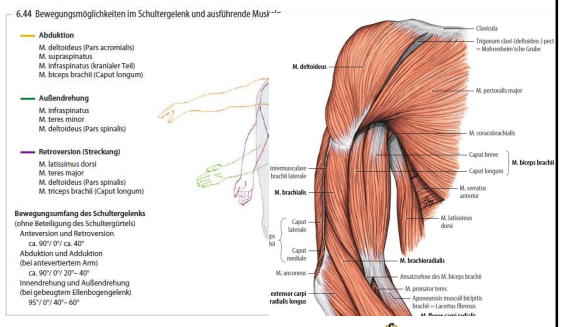
Anatomy



Sobotta Atlas der Anatomie des Menschen Obere Extremität Urban Schwarzenberg

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Proximal Humerus Resection

- Loss of shoulder girdle musculature
- Loss of rotator cuff
- Loss of tendons attachment

- High grade sarcoma → loss of axillary nerve /deltoid function

Aim ?!

- Remove the tumour
- Reduce pain
- Preserve function (elbow joint, hand)
- Restore cosmetics
- Restore active function (shoulder joint)

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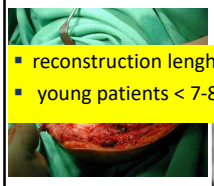
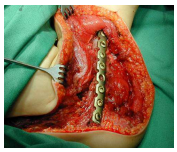
Clavicula-pro-humero



- reconstruction lenght < 8 to 10 cm
- young patients < 7-8 years



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Use of Vascularized Free Fibular Head Grafts for Upper Limb Oncologic Reconstruction

Satoshi Onoda, M.D.

Background: Transfer of a vascularized fibular graft is the method of first choice

Fig. 4. (*Left*) At 3 months postoperatively, the patient could grip a book with the affected limb. (*Right*) At 3 months postoperatively, the patient demonstrates elevation of the upper limb.

Plastic and Reconstructive Surgery • March 2011

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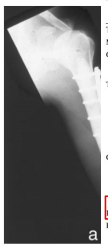
Reconstruction of the proximal humerus after wide resection of tumours

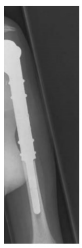
R. W. Rödl, G. Gosheger, C. Gebert, N. Lindner, T. Ozaki, W. Winkelmann

From Münster University Hospital, Germany

Table I. Details of the patients and outcome after reconstruction of the proximal humerus after wide resection for sarcomas of the bone

	Total	Type of reconstruction: Allograft	Clavicle	Prosthesis
Total number of patients	45	11	15	19
Mean age at diagnosis in years	27	20	18	37
Gender				
M	22	7	8	7
F	23	4	7	12
Type of disease				
Osteosarcoma	27	4	10	13
Ewing's sarcoma	7	5	2	0
Chondrosarcoma	11	2	3	6
Mean length of defect (cm)	16	16	14	17
Joint resection	25	2	10	13
Abductors intact	3	3	0	0
Revised patients	15	3	10	2
Complications				
Implant	7	3	4	0
Interface	5	1	4	0
Infection	4	0	4	0
Tumour	2	0	0	2
Others	3	0	3	0
Implant removal	7	2	3	2
Functional results (MSTS score)				
Pain	4.8	5.0	4.9	4.6
Emotional acceptance	4.0	3.8	4.1	4.0
Function	3.9	2.8	4.5	4.0
Hand positioning	2.8	2.8	2.7	2.9
Manual dexterity	5.0	5.0	5.0	4.9
Lifting ability	3.2	2.8	3.3	3.2
Total score (%)	79	74	82	79





Radiographs showing the th … ection of sarcoma: a) osteoarticular allograft; b) cla…

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Proximal humerus reconstruction after tumour resection: biological versus endoprosthetic reconstruction

Michiel A. J. van de Sande · P. D. Sander Dijkstra · Antonie H. M. Taminiau

Table 2 Postoperative resu

	Infection superfici	AWOD, n (%)	MSTS, n (%)
,D,)			

Table 3 Overview of recent literature for the three types of reconstruction [2, 4, 6, 7, 14, 16]

Reconstruction	n	Mean follow-up (months)	Complication rate (%)	Reoperation rate (%)	Implant survival (without revision) (%)
Allograft	52	72	49	36	62
Composite	52	76	40	21	88
EPR	149	43	11	7	91

[a] 100% of surviving patients
[b] One DOD and one DOAD

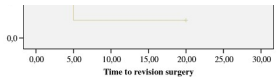

Fig. 1 Kaplan-Meier implant survival curve subgroup analysis for the different types of reconstruction techniques with revision surgery as endpoint

International Orthopaedics (SICOT) (2011) 35:1375–1380
DOI 10.1007/s00264-010-1152-z

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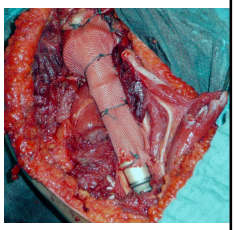
Soft tissue re-attachment

- Trevira-Tube for primary stability
- tight mechanical link between musculature and prostheses
- re-attachment of the musculature in anatomical position
- Transpositioning of the M. latissimus dorsi, M. subscapularis,

→ Bateman procedure



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Problem

- massive constriction of the active range of motion in the shoulder joint
- Preservation of elbow and hand function

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conventional prox. humerus-replacement

Kumar et al. ROH (JBJS Br 2003)

n=100 proximal Humerus

flexion 54°

abduktion 44°

Cannon et al. (J Shoulder Elbow Surg 2009)

n= 83 patients with axillary nerve preservation

active abduktion 41°

active flexion 42°

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Functional improvement after axillary nerve transection

- Bateman-procedure in combination with a conventional implant and latissimus transfer according to Gerber
- 3 Patients → no improvement of function

Gosheger et al. Arch Orthop Trauma Surg 2005

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Curr Rev Musculoskelet Med (2016) 9:443–48
DOI 10.1007/s12178-016-9368-0

SHOULDER ARTHROPLASTY (G ATHWAL, SECTION EDITOR)

Expanding roles for reverse shoulder arthroplasty

Peter N. Chalmers[1] · Jay D. Keener[2]

Table 1 Representative Outcomes from recent series of RTSA performed for indications other than rotator cuff tear arthropathy or a massive irreparable rotator cuff tear

Outcomes of reverse shoulder arthroplasty for alternative indications

Author	Year	Indication	*N*	F/U, years	AFE	ASES	Constant	Complications	Re-operations
Miruno [30]	2013	Glenohumeral OA	27	4.5	152°	NA	76 %	15 %	4 %
Sebastiá-Forcada [31•]	2014	Acute PHFx	31	2.4	120°	NA	56 %	6 %	3 %
Raiss [32•]	2014	Sequelae of PHFx	32	4.0	110°	NA	46 %	41 %	28 %
De Wilde [33]	2011	Tumor	14	7.7	157°	NA	76 %	21 %	14 %
Patel [34]	2012	Revision arthroplasty	31	3.4	108°	66	NA	10 %	10 %
Young [26]	2011	Inflammatory arthritis	18	3.8	139°	NA	65 %	33 %	0 %
Muh [28•]	2013	Mixed (Young patients)	67	3.1	134°	72.4	NA	15 %	11 %

Unless otherwise specified, results are displaced as arithmetic means

N number of shoulders, *F/U* length of follow-up, *AFE* active forward elevation, *ASES* American Shoulder and Elbow Surgeons Score, *NA* not available, *OA* osteoarthritis, *PHFx* proximal humeral fractures

reliably. The long-term survivorship of the implant has not yet been described, but short- and mid-term follow-up results suggest that these results are durable.

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Reverse prostheses in shoulder arthroplasty

- improved active abduction and elevation in patients with unreparable rotator cuff tears
- higher joint stability

Table III Functional results of total series (N = 42)

Functional results	Pre-operative	Follow-up	Change	P value
Pain (15 points)	3.3 (0-11)	11.1 (3-15)	+7.8	<.0001
Activity (20 points)	6.1 (1-14)	14.5 (4-20)	+8.4	<.0001
Mobility (40 points)	14.8 (0-36)	24.4 (4-38)	+9.6	<.0001
Strength (25 points)	1.3 (0-12)	6.0 (0-12)	+4.7	<.0001
Constant score (100 points)	25.4 (7-59)	55.8 (0-11)	+30.4	<.0001
Adjusted Constant score (%)	35.8 (9.84)	78.8 (9.11)	+43	<.0001
Anterior active elevation (deg)	82° (20-180)	123° (40-170)	+41°	<.0001
Passive anterior elevation (deg)	125° (30-180)	138° (70-175)	+13°	NS
Active external rotation (deg)	5° (-40–+70)	7° (-30–+60)	+2°	NS
Active internal rotation (deg)	Sacrum (thigh-TH7)	Sacrum (thigh-TH7)	0	NS

NS, nonsignificant.

Boileou et al. J Shoulder Elbow Joint 2009

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Function (n=42)

Function overall: → MSTS 23/30
→ ASES 67/100

invers Implant

→ MSTS: 25/30

→ ASES: 71/100

conventional implant

→ MSTS: 21/30

→ ASES: 61/100

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Complications n=6 (14%)

- 1 x early infection (MRSA)

–> explantation and spacer implantation

-3 x repetitive subluxations

→2x restabilization with conservative treatment
→1x revision surgery

- 2x luxations no surgery (→ 1x axillary nerve damage, 1x progressive disease)

Un

mid-long term results (20/42)

- mean FU 53 (24-176) months

→ Only 1 implant related complication (chronic instability)

→ no glenoid loosening

active anteversion 79° (20°-160°)

retroversion 43° (30°-70°)

abduction 80° (20°-180°)

external rotation 35° (10°-60°)

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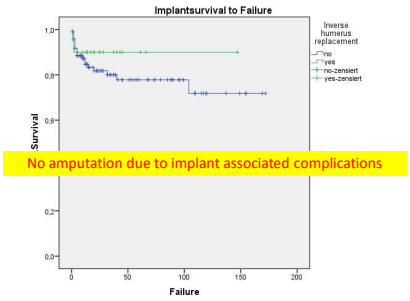
Complications
Conventional v.s. Inverse Implant



No amputation due to implant associated complications

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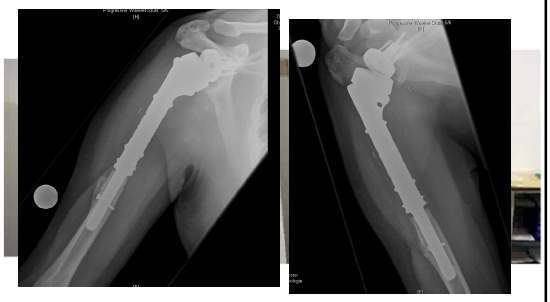
FU 150 months



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Inverse with Bateman after axillary nerve transection

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de Wilde et.al.

- N= 14
- composite allograft with inverse-implant
- detachment of the Deltoid-muscle in just 2 cases !!
- medium FU of 7 years
- 156° active abduktion
- complication-rate of 29% (4/14)

  (2x dislocations,1 x implantat infection, 1x aseptic loosening)

De Wilde et.al. Clin Orthop Relat Res 2011

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■ ONCOLOGY

Reverse shoulder replacement after resection of the proximal humerus for bone tumours

A. K. S. Kaa, P. H. Jørgensen, J. O. Sejbjerg, H. V. Johannsen

From Department of Orthopaedic Surgery, University Hospital of Aarhus, Aarhus, Denmark

- abduction of 78 ° (range 30°-150°)

Table I. Details of the patients, and the results (MSTS, Musculoskeletal Tumor Society; TESS, Toronto Extremity Salvage score)

Patient	Age (yrs)	Follow-up (mths)	Tumour	MSTS score (%)	TESS (%)	Humerus resection (cm)	Prosthesis loosening
1	57	74	Chondrosarcoma	87	91.13	13	No
2	43	46	Chondrosarcoma	90	53.23	7.5	Yes
3	40	76	Haemangio-endotheliosarcoma	73	88.71	10	No
4	29	62	Aneurysmatic bone cyst	-	52.68	6	Yes
5	49	136	Chondrosarcoma	73	80.65	18	No
6	45	18	Chondrosarcoma	60	30	8	No
7	70	16	Myelomatosis	87	79.3	-	No
8	19	12	Osteogenic sarcoma	-	66.13	15	No
9	63	12	Metastatic sarcoma	73.3	75	12	No
10	79	12	Renal cell carcinoma metastasis	70	87.5	10	No
Mean	41.5	46.4		76.7	77.7	11	

- 2x perioperative pathological fracture

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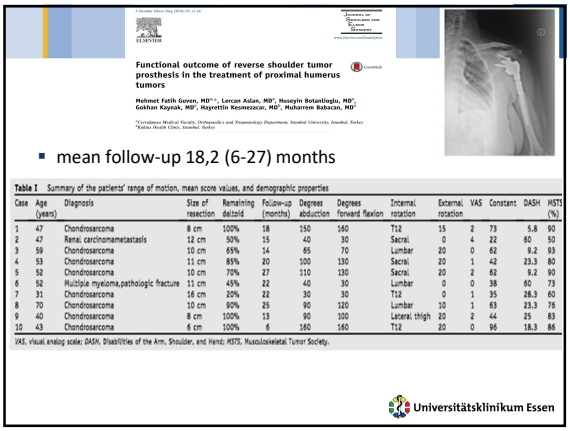

Functional outcome of reverse shoulder tumor prosthesis in the treatment of proximal humerus tumors

Mehmet Fatih Guven, MD*,†, Lercan Aslan, MD*, Huseyin Botanlioglu, MD*, Gokhan Kaynak, MD*, Hayrettin Kesmezacar, MD*, Muharrem Babacan, MD‡

- mean follow-up 18,2 (6-27) months

Table I Summary of the patients' range of motion, mean score values, and demographic properties

Case	Age (years)	Diagnosis	Size of resection	Remaining deltoid	Follow-up (months)	Degrees abduction	Degrees forward flexion	Internal rotation	External rotation	VAS	Constant	DASH	MSTS (%)
1	47	Chondrosarcoma	8 cm	100%	18	150	160	T12	15	2	73	5.8	90
2	47	Renal carcinomametastasis	12 cm	50%	15	40	30	Sacral	0	4	22	60	50
3	59	Chondrosarcoma	10 cm	65%	14	65	70	Lumbar	20	0	62	9.2	93
4	53	Chondrosarcoma	11 cm	85%	20	100	130	Sacral	20	1	42	23.3	80
5	52	Chondrosarcoma	10 cm	70%	27	110	130	Sacral	20	2	62	9.2	90
6	52	Multiple myeloma,pathologic fracture	11 cm	45%	22	40	30	Lumbar	0	0	38	60	73
7	31	Chondrosarcoma	16 cm	20%	22	30	30	T12	0	1	35	28.3	60
8	70	Chondrosarcoma	10 cm	90%	25	90	120	Lumbar	10	1	63	23.3	76
9	40	Chondrosarcoma	8 cm	100%	13	90	100	Lateral thigh	20	2	44	25	83
10	43	Chondrosarcoma	6 cm	100%	6	160	160	T12	20	0	96	18.3	86

VAS, visual analog scale; DASH, Disabilities of the Arm, Shoulder, and Hand; MSTS, Musculoskeletal Tumor Society.

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Inverse after extra-articular resection

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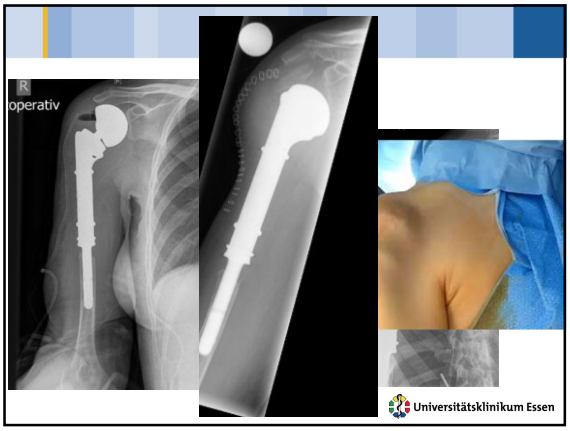

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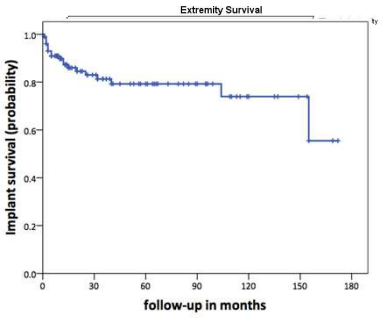
Overall Implant/Extremity-Survival (118 proximal Humerus Endoprosthetic Replacements 1999-2012



Streitbürger et al. 2015 ISOLS

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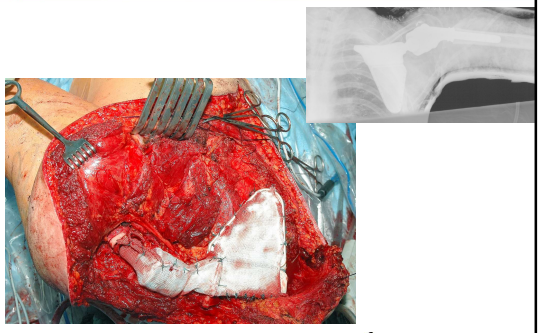
Scapula Replacement



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Is Scapular Endoprosthesis Functionally Superior to Humeral Suspension?

Tamir Pritsch, MD; Jacob Bickels, MD*; Chia Chun Wu, MD*; Malcolm H. Squires, MS*; and Martin M. Malawer, MD, FACS*,†,‡*

TABLE 3. Results of Reconstruction

Reconstruction Mode	Maximal Degree of Shoulder Abduction			MSTS Score		
	0°–19°	20°–39°	> 40°	< 50%	50–75%	> 75%
Suspension of intact proximal humerus	8	3	—	3	6	2
Suspension of proximal humeral prosthesis	3	2	—	1	4	—
Humeral suspension – total (Group I)	11	5	—	4	10	2
Scapular endoprosthesis (Group II)	2	6	7	1	4	10
Comparison of Groups I and II		p = 0.001			p = 0.001	

We found scapular endoprosthetic reconstruction to be a safe and reliable procedure offering better overall functional and cosmetic results than humeral suspension reconstruction. We recommend performing scapular endoprosthetic reconstruction after total scapular resection whenever the rhomboids, latissimus dorsi, deltoid, and trapezius are preserved. Additional studies are warranted be-

CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 456, pp. 188–195

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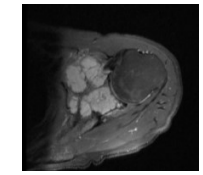

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Conclusion

- excellent extremity survival rate!
- Amputation just in case of local recurrence
- reverse implant design sig. improves funct
- difficulties in young children (<6-7 years)
- sometimes individual solutions are neede

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Thank you !!

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