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Malignant bone and soft tissue tumors of the shoulder girdle

A retrospective analysis of 30 operated cases

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From 1988 to 1995, 30 patients (16 men) with malignant bone (n 23) and soft tissue (n 7) tumors of the shoulder girdle underwent surgery in our department. The mean age was 34 (6–80) years. 26 patients had primary and 4 had metastatic lesions. The average follow-up period was 3 (2–8) years, at the end of which 18 patients showed no evidence of disease, 2 were alive with disease, and 10 had died (9 because of tumor).

25 of the operations were limb-sparing procedures, while the other 5 were major amputations. Radical resection was performed in 4 patients, wide resection in 25 and marginal resection in 1. Local recurrence was observed in 2 patients.

10 patients with stage IIB tumors of the proximal humerus underwent extraarticular humeral and glenoid resection. Reconstruction was performed with either a modular or an improvised implant. Following surgery, those patients had a concave contour of the shoulder and poor abduction ability. Overall functional outcome was good in 18 patients, moderate in 11 and poor in 1. No correlation was found between functional outcome and reconstruction technique.

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The shoulder girdle is affected by bone and soft tissue tumors one-third as often as the lower extremity. The proximal humerus is the third most common site for osteosarcoma (Dahlin and Coventry 1967, Bovill et al. 1975, Rosenberg et al. 1985, Huvos 1991a, b, Baker et al. 1992). Today limb-sparing procedures are commoner than amputation, which has been the procedure of choice in most cases (Francis and Worchester 1962, Gebhardt et al. 1988, Levine et al. 1994). In most contemporary series, limb-sparing surgery comprises 85% of these procedures (Baker et al. 1992, Lane et al. 1996).

Between 1988 and 1995, 30 patients with malignant bone and soft tissue tumors of the shoulder girdle underwent surgery in our department. We retrospectively analyzed the resection margins, reconstruction technique and functional outcome with the purpose of finding and understanding the relation between type of resection, technique of reconstruction and subsequent functional outcome.

Patients and methods

The study group comprised 16 men and 14 women, mean age 34 (6–80) years. 26 patients had primary tumors of the shoulder girdle (21 bone sarcomas and 5 soft tissue sarcomas) and 4 had metastatic lesions. Primary tumors were located in the proximal humerus (15), scapula (9) and clavicle (2). Metastatic lesions were located in the proximal humerus (2), the scapula (1) and in the axilla (1). All 4 cases of metastatic disease presented with isolated disease after previous operations and radiation therapy and were therefore treated as sarcoma.

All patients with primary tumors of the shoulder girdle underwent the following systemic and local staging studies: plain radiographs of the shoulder girdle and the chest, bone scan, CT of the lesion and chest and MRI of the lesion. Preoperative angiograms were performed in two-thirds of the cases for the purpose of surgical planning. Two-thirds of the biopsies were open incisional and one-third were performed with a core needle. Sarcomas were staged according to the surgical staging system of the American Musculoskeletal Tumor Society (AMSTS, Enneking et al. 1980b).

All 19 patients with osteosarcoma and Ewing's sarcoma were treated with neoadjuvant chemotherapy. Patients with Ewing's sarcoma, soft tissue sarcoma

Clinical data of the 30 study patients treated for musculoskeletal tumors of the shoulder girdle

Case	Age	Sex	Diagnosis [a]	Anatomic site	Stage ([b])	Type of resect.[c]	Surgical margins	Reconstr. type	Follow-up months	Function %	Status ([d])
1	28	F	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Modular	76	77	NED
2	6	M	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Autograft	62	77	D
3	16	M	Osteosarcoma	Prox. humerus	IIIB	FQ	Radical	None	8	–	D
4	23	M	Osteosarcoma	Scapula	IIB	III	Wide	None	32	90	D
5	19	M	Osteosarcoma	Prox. humerus	IIB	FQ	Radical	None	9	–	D
6	23	M	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Modular	50	73	NED
7	13	M	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Modular	10	60	D
8	12	M	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Improvised	32	77	NED
9	26	F	Osteosarcoma	Scapula	IIB	III	Wide	None	37	93	AWD
10	17	M	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Modular	32	80	NED
11	40	M	Osteosarcoma	Prox. humerus	IIB	VA	Wide	Modular	27	53	NED
12	15	M	Osteosarcoma	Prox. humerus	IIB	FQ	Radical	None	25	–	NED
13	25	F	Osteosarcoma	Prox. humerus	IIB	VB	Wide	Modular	22	83	NED
14	10	F	Osteosarcoma	Prox. humerus	IIIB	VB	Wide	Improvised	22	73	NED
15	26	M	Chondrosarcoma	Scapula	IIB	II	Wide	None	22	95	NED
16	11	F	Ewing's sarcoma	Scapula	IIB	II	Wide	None	28	93	D
17	13	F	Ewing's sarcoma	Scapula	IIB	III	Wide	None	53	77	NED
18	10	F	Ewing's sarcoma	Prox. humerus	IIB	VB	Wide	Improvised	43	70	NED
19	17	F	Ewing's sarcoma	Clavicle	IIB	CE	Wide	None	27	97	NED
20	25	M	High-grade STS	Scapula	IIB	II	Wide	None	94	73	NED
21	50	M	High-grade STS	Prox. humerus	IIB	I	Wide	Modular	72	67	NED
22	75	M	High-grade STS	Scapula	IIIB	II	Marginal	None	6	93	D
23	45	M	High-grade STS	Scapula	IIIB	II	Wide	None	26	63	D
24	45	M	High-grade STS	Prox. humerus	IIB	SD	Wide	None	10	–	D
25	70	F	Metastatic breast carcinoma	Axilla	NA	FQ	Radical	None	20	–	D
26	75	F	Metastatic renal cell carcinoma	Prox. humerus	NA	IA	Wide	Modular	44	73	NED
27	65	M	Metastatic adeno-carcinoma of colon	Scapula	NA	III	Wide	None	39	60	AWD
28	65	F	Metastasis of unknown origin	Prox. humerus	NA	IB	Wide	Improvised	23	60	NED
29	69	F	PIS	Clavicle	IIB	CE	Wide	None	85	87	NED
30	80	F	PIS	Scapula	IIB	III	Wide	None	84	37	NED

[a] STS soft tissue sarcoma, and PIS postirradiation sarcoma.
[b] NA not applicable.
[c] Type of resections were classified according to the system proposed by Malawer et al. 1991, and FQ forequarter amputation, CE claviculectomy, and SD shoulder disarticulation.
[d] NED no evidence of disease, AWD alive with disease, and D dead.

and metastatic lesions (15 cases) were treated with radiotherapy, mostly after the operation. Autologous bone marrow transplantation was performed in 2 patients (16, 18, Table).

The surgical resection was classified by the method of Malawer et al. (1991) (Figure 1). Surgical margins were classified as radical, wide, marginal or intralesional, according to Enneking et al. (1980b).

Functional evaluation was carried out according to the AMSTS system (Enneking et al. 1993) in which the parameters evaluated were pain, function, emotional acceptance, hand positioning, dexterity and lifting ability. The function of patients who underwent forequarter amputation or shoulder disarticulation was not evaluated, for obvious reasons. Functional outcome was classified as "good" when the mean rating was greater than 75% of normal function (normal 100%), "moderate" when it was 50–75% and "poor" when the rating was lower than 50%.

Patient's files, operative reports and follow-up charts in the out-patient clinic were retrospectively evaluated. A detailed physical examination was performed by the attending physician and the physiotherapist in the department at the final follow-up visit.

Results

Wide or radical surgical margins were attained in all the 24 patients with bony tumors. Major amputation was performed in 3 of them. Wide margins were achieved in all the soft tissue sarcomas except in patient no. 22, in whom a marginal resection was performed.

Local tumor control was achieved in 28 patients. One local recurrence was observed 4 months after surgery in patient no. 6. The recurrent tumor was located in the soft tissues above the surgical scar and

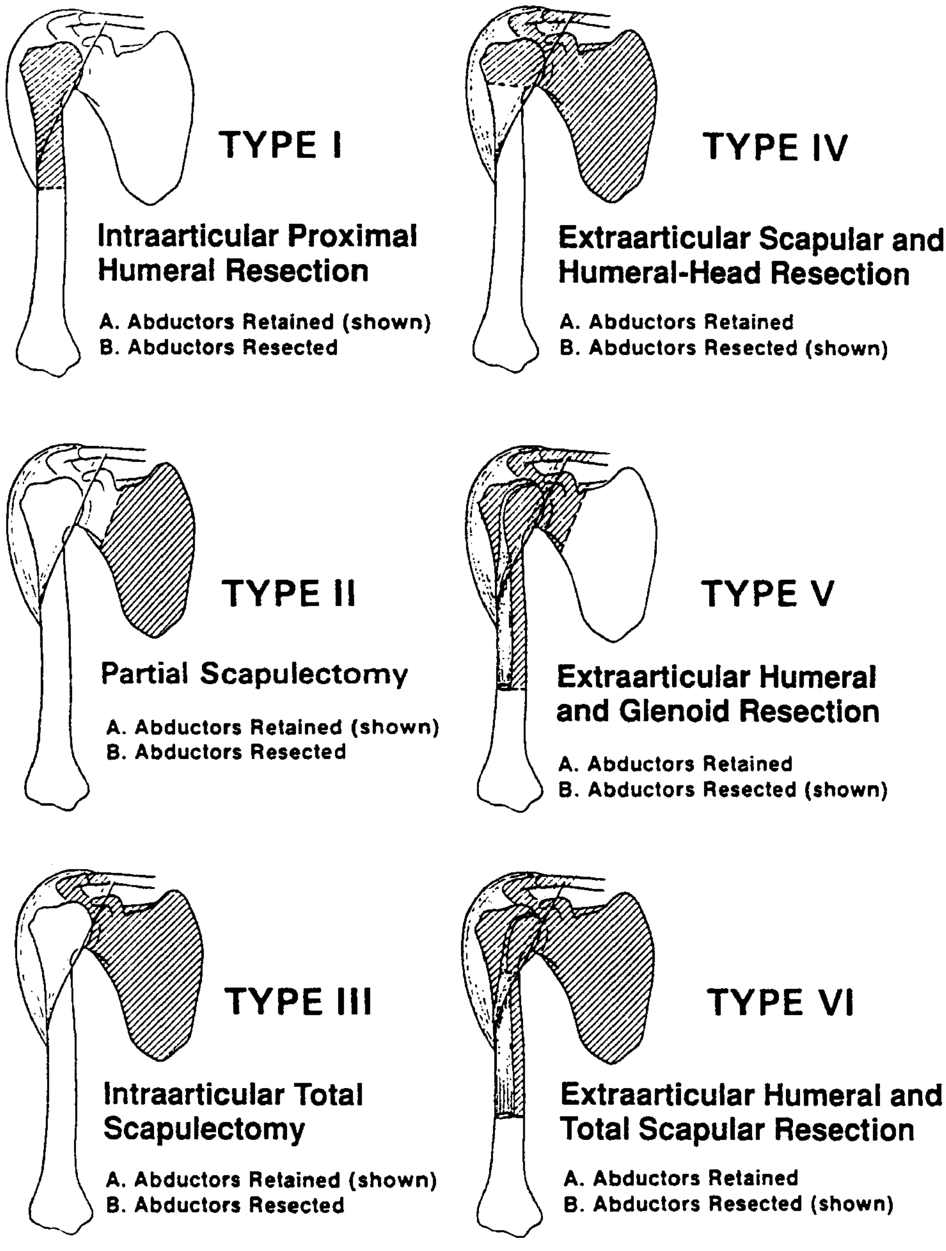

Figure 1. Surgical classification of shoulder-girdle resections (from Malawer et al. 1991). Reproduced with permission from Clinical Orthopedics and Related Research.

was resected leaving wide margins, with no recurrence during the 3 years of follow-up. The second local recurrence was observed in patient no. 22 after postoperative radiotherapy. He died from lung metastases before the local recurrence became symptomatic.

Amputations were performed because there was no response to neoadjuvant treatment or because of invasion of the neurovascular bundle by the tumor. During definitive surgery in patient no. 7, the radial nerve was found to be entrapped in the tumor and was sacrificed.

Function

18 of the patients had good results, 11 had moderate results and 1 had a poor result.

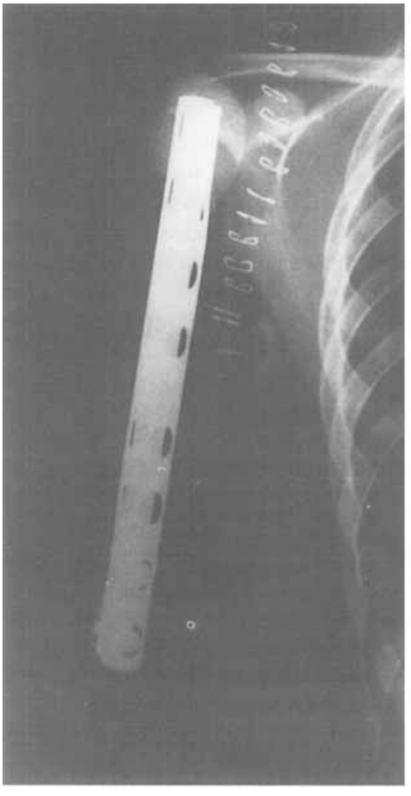

Figure 2. Patient 14. The spacer is composed of two parallel semitubular plates. The humeral head is made of bone cement which was molded by the surgeon.

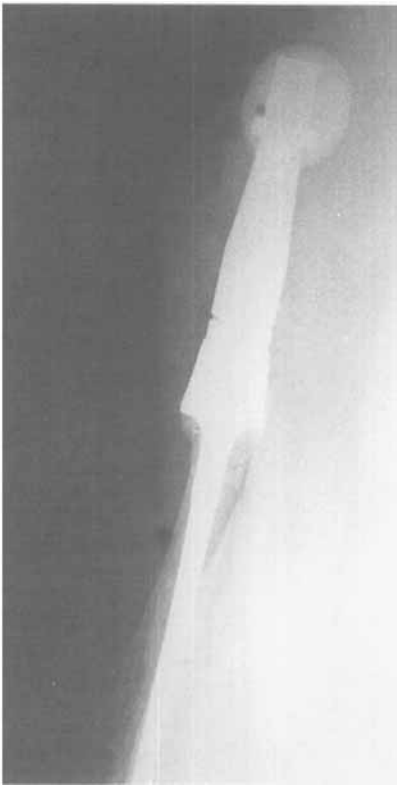

Figure 3. Patient 28. The spacer is composed of distal modular components and a cemented humeral head.

Survival and metastatic disease

At present, 18 patients are alive without disease, 2 are alive with disease and 10 have died. 9 patients died after a median of 2 (0.5–5) years because of metastases. Patient no. 2 died because of heart failure secondary to Adriamycin cardiotoxicity.

Discussion

A neoplasm located in the proximal humerus differs from one in the proximal tibia because of a major difference in the regional anatomy. The former has only one muscular layer covering the bone: the deltoid muscle, which must be sacrificed when extraosseous involvement is suspected or verified. In the popliteal fossa, the popliteus muscle acts as a biological barrier between the tumor and the neurovascular bundle and the outer layer of muscles (Hudson et al. 1985, Malawer 1991, Malawer 1992). Therefore, at the proximal tibia, en bloc resection of the tumor usually has a minor influence on the leg and foot flexor mechanism. Since most sarcomas of the shoulder girdle have extraosseous components (stage IB/IIB, Enneking 1980b), resection of the abductor mechanism (the deltoid and rotator cuff) is mandatory. Accordingly, the Tikhoff-Linberg resection is a suitable type of resection for a stage IIB tumor of the proximal humerus (Petersson et al. 1987, Klein et al. 1989, Baker et al.1992, Malawer and Shmookler 1992, Malawer and Sugarbaker 1992). Various resections of the shoulder girdle have been traditionally reported as a Tikhoff-Linberg or a modified Tikhoff-Linberg resection. The original description (Linberg 1928) is that of an extra-articular scapular and humeral head resection (type VB, Malawer 1991) (Figure 1). When a Tikhoff-Linberg resection is performed, a functional spacer is needed to prevent flailing of the extremity and traction injury to the neurovascular bundle (Ham et al. 1993) (Figures 2–4 for examples).

Jensen and Johnston (1995) reported 19 proximal humeral resections and reconstructions for primary bone sarcomas. In that series, although 8/19 patients were stage IIB and 14/19 patients had an extracompartmental component, according to Enneking et al.

Figure 4. Patient 10. A modular spacer.

(1980b), intraarticular resection with preservation of the glenoid and most of the deltoid muscle (type IA resection) was performed in all patients. Gebhardt et al. (1990) performed a type I resection of the proximal humerus in 20 patients with benign and malignant bone tumors. However, patients with stage IIB tumor were excluded in that series and underwent a Tikhoff-Linberg resection (type VB). We follow the method of Gebhardt et al. (1990): in only one of our patients (no. 11) was the deltoid muscle spared. According to that patient's MRI, the tumor involved the inferior-medial border of the humeral head and neck, sparing the cortex facing the deltoid muscle.

The local recurrence rate is considered as an indicator of properly selected surgical margins. In our series, only 1 patient (Table) had a local recurrence. In Jensen and Johnston's series (1995), 2 of 19 patients had a local recurrence. The use of type I resection in stage IIB disease is too dangerous in terms of local tumor control but, on the other hand, the common practice of performing type VB resection might not be justified in all patients although it is still performed (Malawer et al. 1985, Gebhardt et al. 1990, Malawer 1991, Ham et al. 1993) since the reliability of different imaging modalities in defining preoperatively the invasion in and around the glenohumeral joint by stage IIB tumors of the proximal humerus cannot be adequately determined.

The loss of any component of the abductor mechanism creates a similar functional disability. Our 10 patients who underwent type VB resection were characterized. All had normal dexterity (since the neurovascular bundle was intact), but compromised abduction capability, which subsequently depended completely on trapezius contraction and scapular gliding over the chest wall. Resection of the proximal humerus in children may cause additional problems because of limb-length discrepancy. The proximal humeral epiphysis is estimated to contribute 80% of the final humeral length and 40% of the total upper extremity length (Ogden 1991). An expandable prosthesis has been proposed to solve the problem arising from limb-length discrepancy (Lewis 1986). However, the advantage of such a prosthesis after proximal humeral resection is unclear.

The proximal humerus and glenohumeral joint can be reconstructed either with endoprostheses (Malawer et al. 1985, Bos et al. 1987, Ross et al. 1987, Malawer 1991, Malawer and Sugarbaker 1992, Moeckel et al. 1992) or allografts (including composites) (Parrish 1973, Imbriglia et al. 1978, Enneking et al. 1980a, Mankin et al. 1982, Mankin et al. 1983, Harrington et al. 1986, Kreicbergs and Kohler 1987, Smith and Struhl 1988, Gebhardt et al. 1990, Jensen and Johnston 1995). Although allografts provide ligament and soft tissue attachment sites, their use offers no advantage in the reconstruction after major resections (e.g., type VB) since the the deltoid and rotator cuff muscles are resected (Malawer and Sugarbaker 1992). Gebhardt et al. (1990) reported a 30% allograft fracture rate, a 13% deep infection rate and a 10% local recurrence rate. In our opinion, the use of an endoprosthetic spacer is the preferred method of reconstruction in the shoulder. We chose the specific type of prosthetic reconstruction (endoprosthesis vs. improvised implants) according to the patient's age, oncological status (type of tumor, stage, response to neoadjuvant chemotherapy) and level of activity. Patients 14 and 20 (Figures 1 and 2) were given nonmodular prostheses since they had a poor response to neoadjuvant chemotherapy and an unfavorable histology, respectively.

The postoperative complication rate was low in our series (Quill et all 1990). No flap necrosis, wound healing problems or vascular decompensation were observed, findings consistent with those of Malawer (1985). Transient nerve palsies were the commonest complication in Malawer's series but not in ours.

During the field trials conducted in 1989 by the AMSTS (Enneking et al. 1993) in order to assess the evaluation system, 87 patients had been examined after surgery on the upper extremity. The mean reported rating was 68%, which is about the same as in our patients. Loss of the abductor mechanism is mainly responsible for the reduction in function (Kurer et al. 1988, Kumar et al. 1994). No functional difference was found between our patients reconstructed with different endoprostheses. Although the follow-up time of our reconstructions is short (22–34 months), we found that the use of simple spacers instead of complex endoprostheses was satisfactory. The cost-benefit of such a protocol is also noteworthy.

Patients with stage IIB tumor of the shoulder girdle who underwent type VB resection had a consistent loss of abduction capability and a typical concavity of the operated side of the shoulder girdle, since the deltoid muscle and the underlying acromion were removed (Malawer et al. 1985, 1991, Malawer and Sugarbaker 1992). Since stage IIB tumors represent a spectrum in terms of local invasion, we assume that in a selected group of patients at that stage the glenoid and part of the deltoid muscle could be spared, thus producing better functional and esthetic results. For that purpose, the ability of CT and MR to describe invasion of the glenohumeral joint and deltoid muscle by stage IIB tumors of the proximal humerus should be carefully evaluated.

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