Surgical Aspects and Techniques for Bone and Soft-Tissue Sarcomas

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Surgical treatment of sarcomas
Survival rate Osteosarcoma (COSS)
5-Year-Survival of Soft tissue sarcoma

- High-grade Sarcoma: 62%
- Low-grade Sarcoma: 87%

dependent of tumour stage

Surgical treatment of sarcomas

Survival and tumor size

Survival and tumor localisation

Adjuvant Chemotherapy in the treatment of soft tissue sarcomas

- Role of neoadjuvant or adjuvant chemotherapy still unclear
- No improvement in the overall survival
- But: In cases of high-risk sarcomas?
- Effectiveness of chemotherapy is tumour entity-dependent
  (chemosensitive: Synovial sarcoma)

Casali et al, Ann Oncol 2008
Adjuvant Radiation therapy in the treatment of Soft tissue sarcomas

- Significant improvement in local tumour control
- But: failed to improve overall survival
- Recommendation for high grade tumours with marginal resection and deep tumours with an extension of $\geq 5$ cm

Mendenhall et al, Am J Clin Oncol, 2009
Surgical treatment of sarcomas

Intraoperative electron boost radiotherapy (IOERT)

Median dose 15 Gy + postoperative external beam radiotherapy 43 Gy
Intraoperative electron boost radiotherapy (IOERT)

n = 86 Orthopedic clinic Heidelberg

- 5y overall survival 62%
  depends on resection status, grading
- 5y local control 77%
  depends on resection status, IOERT dose
- Extremity salvage until death 88%
- Enneking score 78%
- Fracture rate 5%
The complete resection of the primary tumour is pivotal for the oncological outcome.
Surgical treatment of sarcomas

Surgical goal for soft tissue sarcomas

- en bloc resection beyond the reactive area of the compartment
- wide resection margins
- 2-3 cm safety margins

Surgical options

- reconstructive surgery
  - vascular and soft tissue graft, plastic surgery
- ablative surgery
Surgical treatment of sarcomas

- Radical resection
- Wide resection
- Marginal resection
- Intralesional resection

Diagram:
- Compartment
- Soft tissue sarcoma
- Reactive zone

- Intralesional resection
- Marginal resection
- Wide resection
- Radical resection
Surgical treatment of sarcomas

Tumour location soft tissue sarcomas

- Lower extremity: 55%
- Upper extremity: 25%
- Trunk bones: 10%
- Retroperitoneum: 10%

Fletcher et al, WHO classification of tumours, 2002
## Surgical treatment of sarcomas

### Soft tissue sarcomas

**Histological subtypes**  \( n = 1080 \)

- Liposarcomas  \( 33\% \)
- MFH  \( 24\% \)
- Leiomyosarcomas  \( 16\% \)
- Synovial sarcomas  \( 12\% \)
- MPNST  \( 8\% \)
- Rhabdomyosarcomas  \( 2\% \)
- NOS  \( 5\% \)

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Dept. of Pathology, University Heidelberg, 1991-2008
Surgical goal for bone sarcomas

- wide tumour resection
  - 3 cm safety margins
  - adequate soft tissue cover of the tumour

Surgical options

- reconstructive surgery
- ablative surgery
Surgical treatment of sarcomas

- Radical resection
- Wide resection
- Marginal resection
- Intralesional resection

Bone sarcoma
Reactive zone
Surgical treatment of sarcomas

Tumour location bone sarcomas

Lower extremity: Osteosarcoma 80%, Ewing-Sarcoma 65%, Chondrosarcoma 50%
Upper extremity: Osteosarcoma 15%, Ewing-Sarcoma 15%, Chondrosarcoma 10%
Trunk bones: Osteosarcoma 5%, Ewing-Sarcoma 20%, Chondrosarcoma 40%
Reconstructive surgery

- Modular endoprosthesis system
- Autografts (Fibula, cancellous bone)
- Allografts
Surgical treatment of sarcomas

Modular tumour endoprosthesis system (MUTARS)

- Maximum load capacity (lower extremity!)
- Reconstruction of major osseous defects with joint involvement
High Grade osteoblastic Osteosarcoma distal femur

16y old boy
Surgical treatment of sarcomas
Surgical treatment of sarcomas
Surgical treatment of sarcomas

Extendable prosthesis for children (growing prosthesis)
Biological reconstruction

Reconstruction of physiological conditions by using autologous substances
Surgical treatment of sarcomas

Autologous bone

**pros**
- facilitated complication management
- lower infection rate
- lower pseudoarthrosis rate
- higher adaptability
- no logistics (transportation, storage etc.)

**contras**
- limited availability
- insufficient load bearing capacity
- no joint replacement
Infection rate

- Bone autologous: 0.5 - 4%
- Bone homologous: 6 - 30%
Surgical treatment of sarcomas

Autologous bone

- Clavicula pro humero
- Fibula
  with / without caput fibulae
  with / without vascular pedicle graft
- cancellous bone (pelvis, ribs, radius, tibia)
Surgical treatment of sarcomas

13 year old female
Osteosarcoma proximal humerus

Reconstruction with vascular pedicle fibula graft
Surgical treatment of sarcomas

Fracture of fibula graft during kick-boxing
14y following resection of Ewing sarcoma
Surgical treatment of sarcomas

30 year old female Ewing sarcoma tibia

Reconstruction with intraoperative extracorporeal lethal irradiated autologous tibia
Surgical treatment of sarcomas

Ingrowth of tibia following reconstruction with intraoperative extracorporeal lethal irradiated autologous tibia

50y old patient with Adamantinoma
Surgical treatment of sarcomas

Combined vascularized fibula (autograft) and allograft shell “mantle transplant”
Complication rate

Reconstructive surgery

34-60%

- Infection
- Aseptic loosening
- Implant failure
- Fracture
Complication of biologic reconstruction

Fracture of fibula autograft following resection of Ewing sarcoma
### Complication rate
**MUTARS (n=120)**

<table>
<thead>
<tr>
<th>Complication</th>
<th>≥ 5 years</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic loosening</td>
<td>11/63 (17 %)</td>
<td>13/120 (11 %)</td>
</tr>
<tr>
<td>Implant failure</td>
<td>14/63 (22 %)</td>
<td>18/120 (15 %)</td>
</tr>
<tr>
<td>Septic loosening</td>
<td>7/63 (11 %)</td>
<td>11/120 (9 %)</td>
</tr>
</tbody>
</table>
Surgical treatment of sarcomas

Implant failure

Breakage of locking mechanism
Indication for ablative therapy

- Infiltration of nerve and vascular bundle
- Tumour size
- Recurring tumour
- Palliation

30y old patient with MFH
Surgical treatment of sarcomas

Osteosarcoma
distal radius
20 year old male

Ablative therapy
Disadvantage of amputation?

- Function of amputation (n = 16) 65 %

- Function of reconstructive surgery (n = 50) 77 %

- Quality of life, life satisfaction
  - no significant difference
  - dependent on tumour location

Zahlten et al, bjcancer, 2004
Surgical treatment of sarcomas

New developments of exoprosthesis
Complication rate

Amputation

3 - 40 %

- Phantom pain
- Soft tissue necrosis
Surgical treatment of sarcomas

Special ablative surgery: rotation-plasty

ankle joint functions as new knee joint
Surgical treatment of sarcomas
Surgical treatment of sarcomas
Problem cases
Surgical treatment of sarcomas

Tumour size

- Chondrosarcoma G II pelvis
Surgical treatment of sarcomas

Tumour location

- intraspinal Chondrosarcoma metastasis
- Tumour resection not possible
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Tumour location

• long segment involvement of vascular and nerv bundle (Rhabdomyosarcoma GIII)
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Tumour location

- long segment involvement of bone

(Myxofibrosarcoma GII)
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Tumour residuum

- Synovial sarcoma R I resection
- further resection necessary?
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Tumour recurrence

- Spindle cell sarcoma G III left pelvis
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Tumour entity

- Chordoma with high recurrence rate
Surgical treatment of sarcomas

Ewing sarcoma
pre chemotherapy

post chemotherapy

Tumour boundary

- Definition of resection margins after downsizing through neoadjuvant chemotherapy
Solution:

Particle therapy?