Minimal invasive treatment of bone tumors

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Bone tumor

• In addition to the breast cancer also exhibit tumor of the prostate, thyroid, lung and kidney, a particular tendency to bone metastases.

• bone tumor/malignant metastases cause:
  – Severe pain (destruction of bone structure, bone skin irritation, nerve constriction)
  – Fractures
  – Hypercalcemia
  – Severe restriction of quality of life through pain and associated immobilization
  – Often death occurs almost exclusively as a result of complications caused by the bone lesion
Introduction

• Cancer has traditionally been treated either systemically with chemotherapy or locally with surgery or radiotherapy.

• Recent advancements in minimally invasive therapies are adding further tools for cancer management, e.g.,
  – chemoablation,
  – thermal ablation,
  – percutaneous grafting,
  – acetabuloplasty and vertebroplasty [1, 2].
Treatment

• The indication for treatment of bone metastases is usually for:
  – *pain relief*,
  – prevention of *tumor growth*
  – prevent *complications* such as fractures or neurological deficits.

• In some cases, such as in isolated lesions curative treatment can be sought.

Treatment

- Standard treatment may comprise:
  - Surgical removal of the tumor
  - Chemotherapy
  - Hormone therapy
  - Radiopharmaceuticals
  - Bisphosphonates
  - Radiotherapy
  - Pain therapy (opioids, non-steroidal anti-inflammatory drugs [NSAIDs])

Interventional Oncology

- Percutaneous biopsies
- Percutaneous transarterial embolization
- Percutaneous ablative therapies:
  - Ethanol injection PEI
  - Frequency: RF
  - Laser: LITT
  - Microwaves
  - Vertebroplasty
- Interventional Pain practice
Thermal ablation

- In thermal ablation, tumours are heated to temperatures above 60°C until the tumour cells are killed.
- It can be produced by
  - Microwaves,
  - Radiofrequency (RF),
  - high-intensity Ultrasound (US)
  - Laser (LITT)
  - Cryoablation (tumour necrosis by freezing to below −20°C)

Radiofrequency Ablation (RFA)

- Minimally invasive non surgical cancer treatment
- Outpatient setting,
- Significantly reduction of the level of pain
- Limiting the need for strong narcotic pain management
- Safe especially when performing in percutaneous techniques and image control
Radiofrequenz-Ablation (RFA)

- Local therapy procedures by which the tumors or metastases with heat be ablated and destroyed while sparing healthy tissue.
- By intratumoral administration of the radiofrequency wave produces a local heat to 80° C in the immediately surrounding tissue, destroying the tumor tissue.
- The tumor cells are or thermo-coagulated and it comes to denaturation.
StarBurst® RFA-System, Angiodynamics

- Real-time tissue monitoring at the margin of the ablation.
- A single device, spherical ablations (3-5 cm), expandable, multi-array configuration
- Predictable, repeatable ablations
- Multi-point temperature feedback with dynamic, real-time readouts
- Needletrack ablation
- Fits both CT and MRI gantries
OsteoCool Solution,  Baylis medical

- Bipolar Ablation
  - Localizes heating and promotes consistency

- Internal-Cooling
  - Allows larger ablation volumes

- Consistent lesions in vicinity of bone & variable tissues

Electrode

Temperature sensor

Coolant: circulating water
Cool-tip™ RFA-System, Covidien

- Bipolar Ablation
- 17-gauge straight Elektrode
- Single, Cluster & Multiple Electrode
- RF Ablation High-Power Patient Return Electrode

The internally-cooled design limits tissue charring and permits increased energy deposition for potentially larger ablation volumes.
The choice of imaging in interventional oncology usually determines the success, complications and therapeutic success of the treatments.

The Computed Tomography (CT) offers unique advantages over other imaging systems such as MRI, ultrasound, or fluoroscopy.
Image guidance

The advantages are:

- exacte planning of intervention
- 2-3 Dimensional imaging
- excelente contrast between soft tissue and bone
- Fast image acquisition
- Use of magnetic and non-magnetic instruments and equipment
- Possibility of combination with fluoroscopy
Image guidance
Indication to RFA

• Severe pain
• Surgery is difficult or impossible
• Osteoid osteoma (OO)/Chondroblastoma (CB)
• Possible advanced metastatic disease
• Progression despite systemic chemotherapy and radiation therapy, especially in the vicinity of the spine
• Avoiding further tumor growth and possible complications
• Osteolytic or mixed lytic/blastic bone metastasis
  imminent paraplegia
Contraindications to RFA

• Absolute
  – Active infection
  – Uncorrectable coagulopathy
  – Lack of safe access route
    • Cord
    • Nerves
    • Bowel
    • Bladde
    • Skin

• Relative:
  – Spinal lesions
  – Superficial lesions
  – Weight-bearing bones (stress riser)
# HF-Ablation

<table>
<thead>
<tr>
<th></th>
<th>Cool-tip System der Reihe E Elektroden</th>
<th>Zeit</th>
<th>Freiliegende Spitze</th>
<th>Ablationsbreite (A)</th>
<th>Ablationshöhe (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Standard-Ablationsmodus, 3 Elektroden</td>
<td>25 Min.</td>
<td>4,0 cm</td>
<td>6,7 cm</td>
<td>6,5 cm</td>
</tr>
<tr>
<td>II</td>
<td>Standard-Ablationsmodus, 3 Elektroden</td>
<td>16 min.</td>
<td>4,0 cm</td>
<td>5,6 cm</td>
<td>5,9 cm</td>
</tr>
<tr>
<td>III</td>
<td>Standard-Ablationsmodus, 3 Elektroden</td>
<td>16 min.</td>
<td>3,0 cm</td>
<td>5,5 cm</td>
<td>5,2 cm</td>
</tr>
<tr>
<td>IV</td>
<td>Clusterelektrode (3)</td>
<td>12 Min.</td>
<td>2,5 cm</td>
<td>4,2 cm</td>
<td>4,5 cm</td>
</tr>
<tr>
<td>V</td>
<td>Einzelelektrode</td>
<td>12 min.</td>
<td>3,0 cm</td>
<td>3,1 cm</td>
<td>3,7 cm</td>
</tr>
<tr>
<td>VI</td>
<td>Einzelelektrode</td>
<td>6 Min.</td>
<td>2,0 cm</td>
<td>2,3 cm</td>
<td>2,6 cm</td>
</tr>
</tbody>
</table>

![Diagram](image.png)
Common two-patient return electrode configuration

Common four-patient return electrode configuration

9. Uncoil the cords and connect the return electrodes to the return electrode connector.
RFA of osteoid osteoma

CT-guided RFA of foot and ankle osteoid osteoma is a safe and effective procedure, showing similar results for the rest of the appendicular skeleton. Daniilidis K et.al. 12/2012

RFA is a safe and effective long-lasting treatment of OO and OB. Advanced procedural techniques aid treating tumors in critical locations and in the coverage of larger tumors. Besides night pain, RFA also greatly improves other factors negatively affecting the quality of life. Rehnitz C et.al, 11.2012

CT guided RFA combined with a core-drill for biopsy prior to RFA treatment is a highly effective, efficient, minimally invasive and safe method for the treatment of OO, yielding a success rate of 97% combined with a 100% histological verification of the diagnosis after a minimum follow-up period of five years. Neumann D et.al. 04/2012
RFA; BWK 9
54 years, male gender, lung carcinoma, mixed metastasis
RFA; TH 4
36 years, breast Ca., Radiculopathy T4
RFA; BWK 3 & 4

56 years old, female, malignant melanoma, radiation resistance
Case Report

- 59 year old patient with renal cell carcinoma
- unsuccessful radiotherapy and chemotherapy,
- progressive tumor growth with increasing paraplegia
- posterior decompression and fusion with paraplegia and instability TH3 and 4
Follow up

CT-images before and 3 months after RFA
Case Report

- 64-year-old male patient
- multifocal leiomyosarcoma with multiple soft tissue tumors,
- primary diagnosis in 1969
- Acute sciatica 07/02 with sensorimotor L4 and L5 syndrome, with quadriceps and dorsiflexors right hemiparesis

Vertebral body metastasis with spinal canal invasion: radiofrequency ablation in combined therapy with dorsal spondylodesis and radiotherapy

Gevargez A, Ditzen A, Grönemeyer DH.
Pathological fracture of the 4th Lumbar vertebrae with tumor in the spinal canal intrusion
Indication for spinal decompression by instability and progressive neurological deficite
Leiomyosarcoma, as a result of CT-guided biopsy
• Interdisciplinary tumor conference;
• Combination therapy
• 2-sided percutaneous RFA in L4, in Local anesthesia, transpedicular access right (CoolTip ®, Radionics, Burlington, MA, USA)
• Subsequent operative dorsal decompression (bilateral laminectomy and stabilization using spinal fusion on lumbar vertebra 3 to L5)
• Postoperative irradiation with max. 40 Gy.
• Immediate improvement in pain and neurology after the RFA and decompression

• Improvement of foot dorsiflexion within the first 6 months postoperatively
• Improvement in quality of life

• After 5 years of observation:
  – No further tumor growth in lumbar spine
  – Karnofsky performance status of 80% (symptom-related activity limitation, self-sufficiency and self-determination)
  – Numerous resections of soft tissue tumors
    Control rights posterior stabilization, no loosening of the osteosynthesis material, slightly tilting the leading edge
Before RFA

6 months after RFA

significant decrease in the vascularization of bone lesions (contrast enhancement), no further tumor growth
RFA; TH 8
53 years old, male, renal cell Ca., Claudication, paraplegia
RFA; Scapula
54 Jahre, renal cell Ca., pain full arc
RFA; Femur
41 years old, male, renal cell Ca.
RFA, OS Pubis; 43 year, Mamma Ca.
RFA; Metastatic Colon Ca.
Complication

- Bleeding
- Infection
- Risks of conscious sedation / general anesthesia
- Skin burns
- Thermal injury to adjacent structures
- Fracture
- “Post-ablation” syndrome
- Postprocedural pain
Vertebroplasty (VA)

- Severe pain
- Ineffective conservative treatment (bed rest, a back brace or pain medication, side effect of the pain killers)
- Vertebroplasty is also performed on patients who:
  - are too elderly or frail to tolerate open spinal surgery, or who have bones too weak for surgical spinal repair
  - have vertebral damage due to a malignant tumor
  - are younger and have osteoporosis caused by long-term steroid treatment or a metabolic disorder.
Procedure

- **Vertebroplasty** involves injecting a special cement mixture into the small holes in weakened vertebrae to strengthen the spinal bones making them less likely to fracture again and providing pain relief.

- Using image-guidance, a hollow needle called a trocar is passed through the skin into the spinal bone and a cement mixture is then injected into the vertebra.

- In **Kyphoplasty**, a balloon is first inserted through the tube and into the fractured vertebra where it is inflated to push the bone back to its normal height and shape. The balloon is then removed and the cement is inserted into the cavity created by the balloon.
VAPs are well tolerated and effective methods to provide palliative care for cancer patients with VCFs and should be offered to symptomatic patients. Aghayev K et al. 01.2011

In our experience, cementoplasty alone for small lesions or combined with RF ablation in larger lesions is an effective and safe therapy in the palliative management of painful extraspinal bone metastases. Basile A et al. 10.2008
Literatur Review

- Although published studies with small (n = 5-45), heterogeneous patient populations and short-term follow-up (2-22 months) are stocked primarily in the form of case series, they reported all over:
  - immediate pain relief and relief of pain in the course
  - Reduction of opioid consumption
  - pain-free periods
  - Improving the quality of life and activity after treatment of bone metastases by XRF
  - No side effects and little complications

Preoperative RFA in painful osteolytic long bone metastases

- Solitary long bone metastases and a pain score of >5 VAS
- 15 pat. with RFA and surgical stabilization (RFA-SS) and 15 pat. with radiotherapy and surgical stabilization (RT-SS).
- The overall response rate at 12 weeks was 93.3% (14 pat.) in the group treated by RFA-SS and 59.9% (9 pat.) in the group treated by RT-SS.
- RFA-SS is safe and is more effective than RT-SS; furthermore, RFA may become an option for pat. with metastases of the long bones to prevent tumor dissemination and reduce intraoperative blood loss.

RFA in combination with VA

Cementoplasty alone for small lesions or combined with RF ablation in larger lesions is an effective and safe therapy in the palliative management of painful extraspinal bone metastases.

Basile A, et. al; Radiol Med. 2008 Oct;113(7)
Advantage of RFA

- Height Safety by image-guided intervention
- Immediate cell death
- Controllable lesion
- Temperature monitoring of the lesion
- Local anesthesia and sedation
- Minimal incision, minimizing the risk of infection
- No interruption of radiotherapy or chemotherapy
- No systemic side effects
- Most patients can resume their normal activities after a few days again

(Society of interventionellen Radiologen, 2009; Aboulafia, et al, 2007; Dupuy und Goldberg, 2001)
Thank you very much for your attention and your patience!