29.1 Introduction
Radiosynoviorthesis (RSO) is a proven important instrument for local treatment of chronic inflammatory joint diseases in the context of medical and orthopaedic efforts. The term radiosynoviorthesis was created by Delbarre et al. 1968, meaning the restoration (orthesis) of the synovium by means of radionuclides. By local administration of radioactive agents an attempt is made to influence the synovial process favourably as an alternative to surgical synovectomy. In the Anglo-American literature the term “radiosynovectomy” or “radiation synovectomy” came into use.

The first descriptions of the method go back to Ishido (1923) and Fellinger and Schmid (1952).

In Germany, RSO nowadays is performed in about 63,000 joints per year, as much as radioiodine therapy in thyroid diseases.

29.2 Indications
Basically RSO is indicated for the local treatment of almost all kinds of chronic synovitis (Mödder 2001a, b; Kampen et al. 2001). The main indications for radiosynoviorthesis are (modified according to German and European guidelines: Farahati et al. 1999; Clunie and Fischer 2003):

- Rheumatoid arthritis
- Seronegative spondyloarthropathy (i.e., reactive arthritis, psoriatic arthritis)
- Haemarthrosis in haemophiliacs
- Recurrent joint effusions (i.e., after arthroscopy)
- Pigmented villonodular synovitis (PVNS)
- Osteoarthritis (activated arthrosis)
- After joint prosthesis: persistent effusions, polyethylene disease
- Undifferentiated arthritis (where the arthritis is characterized by synovitis, synovial thickening or effusion)

Absolute contraindications:
- Pregnancy
- Breast feeding
- Local skin infection
- Acute rupture of popliteal cyst (Baker’s cyst)

Relative contraindications:
- RSO should only be used in children and young patients (<20 years) if the benefit of treatment is likely to outweigh the potential hazards. But it is routinely applied in haemophilic children.
- Extensive joint instability with bone destruction

29.3 Radiopharmaceuticals
The most common and approved radiopharmaceuticals used for RSO are:

- $[^{90}Y]ytrrium$ citrate or silicate ($[^{90}Y]$colloid), only used for RSO of knee joints
- $[^{186}Re]$rhenium$ sulphide ($[^{186}Re]$colloid), used for RSO of middle sized joints
- $[^{169}Er]$erbium$ citrate ($[^{169}Er]$colloid), used for RSO of small joints

Table 29.1. Proven dosages for the most frequently treated joints

<table>
<thead>
<tr>
<th>Joint</th>
<th>Radioisotope</th>
<th>Dose (MBq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee joint</td>
<td>Yttrium-90</td>
<td>185–222</td>
</tr>
<tr>
<td>Glenohumeral joint</td>
<td>Rhenium-186</td>
<td>74</td>
</tr>
<tr>
<td>Elbow joint</td>
<td>Rhenium-186</td>
<td>74</td>
</tr>
<tr>
<td>Wrist joint</td>
<td>Rhenium-186</td>
<td>55–74</td>
</tr>
<tr>
<td>Hip joint</td>
<td>Rhenium-186</td>
<td>111–185</td>
</tr>
<tr>
<td>Ankle joint</td>
<td>Rhenium-186</td>
<td>74</td>
</tr>
<tr>
<td>Talonavicular/subtalar joint</td>
<td>Rhenium-186</td>
<td>55</td>
</tr>
<tr>
<td>Metacarpophalangeal joint (MCP)</td>
<td>Erbium-169</td>
<td>20–40</td>
</tr>
<tr>
<td>Proximal interphalangeal joint (PIP)</td>
<td>Erbium-169</td>
<td>10–20</td>
</tr>
<tr>
<td>Distal interphalangeal joint (DIP)</td>
<td>Erbium-169</td>
<td>10–15</td>
</tr>
<tr>
<td>Metatarsophalangeal joint (MTP)</td>
<td>Erbium-169</td>
<td>30–40</td>
</tr>
<tr>
<td>Thumb base</td>
<td>Erbium-169</td>
<td>30</td>
</tr>
</tbody>
</table>
The physical characteristics of these radioisotopes are shown in Fig. 29.1. Proven dosages are listed in Table 29.1. These radiopharmaceuticals are $\beta$-emitters in colloidal suspensions.

Other radiopharmaceuticals rarely used for RSO are dysprosium-165 ferric hydroxide, holmium-166 hydroxyapatite and samarium-153 hydroxyapatite.

### 29.4 Mechanism of Action

“Synovitis is the villain of the drama” (Mannerfeldt), in rheumatic diseases causing brutal destruction of cartilage, bone, tendons and ligaments correlated with pain, swelling and loss of function. After intra-articular administration the radioactive particles in colloidal form are taken up by phagocytosis in synovial macrophages. A particle size of about 5±10 nm is essential to avoid leakage and provide homogenous distribution on the surface of the synovium. $\beta$-radiation leads to coagulation necrosis, sclerosis and fibrosis of the synovial tissue including vessels and pain receptors, resulting in reducing effusion, swelling and pain of the joint. Due to the fact that cartilage has no ability to phagocytose, this tissue is not a target for the radiation effects (Ishido 1923).

The remark “synovitis is the villain of the drama” is not only valid for rheumatic diseases but also for osteoarthritis (activated arthrosis). Arthritis with typical joint space narrowing as a result of cartilage defects is not associated with pain because cartilage has no nerves and vessels. Only after detritus leads to synovitis does simple arthrosis escalate to inflammation (activated arthritis = osteoarthritis) with pain, swelling and effusions (Otte 2002; Mödder 2001a; Mödder 2006). The rather good effects of RSO in osteoarthritis (i.e., knee joint) will be lacking if mechanical problems such as severe instability and axe deviation predominate.

Simultaneous intra-articular injection of corticosteroids (i.e., triamcinolone hexacetonide or triamcinolone acetonide) is recommended because this might reduce local inflammation due to radionuclide instillation and prolong residence time of the radiopharmaceutical agent in the joint (11). An additional reason is the reduction of the often superposed layer of oedema on the synovium so that the thin film of radioisotopes gets closer to the destructing pannus – resulting in improvement of the effect of RSO.

### 29.5 Side Effects

Early: Temporarily increased synovitis (rapid relief by local application of ice)
Late: Local radionecrosis (rare)

### 29.6 Methodology

#### 29.6.1 Patient Selection

**Rheumatic patients** need systemic treatment with antirheumatoid drugs because rheumatism is a systemic disease. If after at least 6 months a few joints do not show adequate improvement even after corticosteroid injections into the affected joints, these joints are selected for RSO, thus avoiding escalation of systemic therapy with its possible side effects. In monarthritis or oligoarthritis RSO could be the therapy of first choice, after failure of locally administered corticosteroids (Mödder 2001b; Fischer and Mödder 2005).

**Orthopaedic patients** should be selected after failure of local corticoid injection and/or ineffective conservative treatment. But also after plenty of surgical interventions RSO might improve the complaints of the patient, i.e., after total knee replacement (Mödder and Mödder-Reese 2001) or effusions after arthroscopy. Some authors recommend RSO after arthroscopy as a routine method to improve results (Kerschbaumer and Herresthal 1996; Thabe 1997). The time interval between arthroscopy or joint surgery (i.e., villonodular synovitis) and RSO should be planned as (4–)6 weeks.