Radiosynoviorthesis

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1. Introduction

Small particles labelled with β-emitting isotopes are phagocytosed by macrophage-like synoviocytes. Radiotherapy of the synovium results in synoviocyte and inflammatory cell necrosis, thereby inhibiting cell proliferation and inflammation. Over time, the synovium becomes increasingly fibrous. The vicious circle of synovitis and joint damage is inhibited or temporarily halted.

2. Methodology

This guideline is based on available scientific literature on the subject, the previous guideline (Aanbevelingen Nucleaire Geneeskunde 2007), international guidelines from EANM and/or SNMMI if available and applicable to the Dutch situation.

3. Indications

a. Persistent synovitis, despite adequate medication and/or intra-articular corticosteroids
b. Pigmented Villonodular Synovitis, 6-12 weeks after arthroscopic and/or open surgical synovectomy.
c. Recurrent joint haemorrhage (one joint) in patients with haemophilia.

Contraindications

a. Joint infection
b. Pregnancy and breast-feeding.
c. Ruptured Baker's cyst

4. Relation to other therapies

Other treatments are:

a. Surgical (open or arthroscopic) synovectomy. This treatment is used for many forms of arthritis.
b. Intra-articular osmic acid or chemical synovectomy (is hardly used anymore).

The indications for these other treatments are similar to those of radiosynoviorthesis. These methods also deliver similar effects.

However, advantages of radiosynoviorthesis over surgical synovectomy are:

a. Simple procedure which is not very demanding for the patient
b. No anaesthetic
c. Short rehabilitation
d. Shorter admission duration

Disadvantage of radiosynoviorthesis is the potential leakage to the lymph nodes and the liver.

5. Medical information necessary for planning

a. Diagnosis
b. Past medical history related to the joint to be treated
c. X-ray image of the relevant joint, preferably in the past 3 months
d. Radiographic score

6. Radiopharmaceutical

Depending on the joint, ^{90}Y-silicat, ^{90}Y-citrate (colloid, particle size 200 nm), ^{186}Re-colloid (50-300 nm) or ^{169}Er-colloid are used. Kinetics and dosage are described below.

a. Kinetics

Depending on the type of joint, ^{90}Y-silicate or ^{90}Y-citrate (colloid, particle size 200 nm), ^{186}Re-colloid (50-300 nm) or ^{169}Er-colloid (1000-2000 nm) is administered intra-articularly. The physical properties of the radionuclides used are shown in the table below

Nuclides	T1/2 (hours)	Energy (MeV)		Synovial penetration (mm)		Cartilage penetration
		γ	βmax	mean	max	max
Yttrium-90	65	-	2,27	3,6	11,0	2,8
Rhenium-186	89	0,137	1,07	1,1	3,7	0,9
Erbium-169	226	-	0,34	0,3	1,0	0,2

The pharmacological properties of these colloidal particles are all similar. The colloidal particles are phagocytosed by macrophage-like synoviocytes. Leakage from the joint can occur, both via the lymphatic system and the blood. Leakage to approximately 10% of the injected dose has been described. However, leakage is almost always less than a few percent.

b. Dosage

Target values for the individual radiopharmaceuticals in the various joints, according to the EANM guidelines. The values are given in MBq.

Joint	^{90}Y	^{186}Re	^{169}Er
shoulder		70-190 MBq	
elbow		70-100 MBq	
wrist		40-80 MBq	
metacarpo-phalangeal			20-40 MBq
proximal interphalangeal			10-20 MBq
hip		70-190 MBq	
knee	180-200 MBq		
ankle		70 MBq	
metatarso-phalangeal			30-40 MBq

7. Radiation safety

a. Absorbed dose

The dose absorbed in the joint cannot be accurately determined. It depends strongly on the distribution of the radiopharmaceutical within the joint and on the volume of distribution. After intra-articular administration of 185 MBq of ^{90}Y, the MIRD system can be used to calculate an absorbed dose of 92 Gy for a 100 gram spherical volume. The radiation dose caused by 1% leakage from the knee joint after administration of 185 MBq of ^{90}Y can lead to 10 Gy in the lymph nodes. The environmental dose-equivalent rate due to the presence of pure β-emitters in a joint is very low. Assuming that ^{90}Y causes 1% Bremsstrahlung in tissue, the environmental dose-equivalent rate 1 m away from the knee after the administration of 185 MBq of ^{90}Y-colloid is 0,04 μSv/h. It is even lower for 40 MBq ^{169}Er. The environmental dose-equivalent rate of 150 MBq of ^{186}Re at 1 m is 0,6 μSv/h.

b. Toxicity and side effects

Extra-articular tissue radiation may be caused by:

- Injection of the radiopharmaceutical outside the synovial cavity
- Leakage of the radiopharmaceutical through the injection site
- Drainage of the radiopharmaceutical via the lymphatic system

Acute side effects are rare. Joint inflammation may worsen, lasting for several days and sometimes accompanied by fever, the ESR may increase and leucocytosis may occur. Long term side effects have not been described in the literature, even though this treatment has been in use for 30 years.

8. Patient preparation/essentials for procedure

Requirements for the treatment are:

a. elastic bandage or splint
b. injection needles (the thickness and length depend on the joint to be treated)
c. 3,5 and 10 ml syringes
d. three-way cock
e. Perspex shield
f. disinfectant, preferably iodine (note: hypersensitivity)
g. 0,9% NaCl
h. ampoule of corticosteroids (triamcinolone)
i. anaesthetic
j. contrast if needed

The radioactivity is administered intra-articularly.

The area to be injected can be anaesthetised using e.g. Lidocaine 2% HCl. The joint to be treated is punctured using a needle to which a three-way tap has been attached and, if synovial fluid is present, as much of this should be drained as possible. If no synovial fluid is present, then contrast arthrography or ^{99m}Tc-nanocolloid scintigraphy is desirable to check the location of the needle. A syringe with the required quantity of radiopharmaceutical in 0,5-2,5 ml of 0,9% NaCl solution (depending on the type of joint), optionally mixed with triamcinolone, is subsequently attached in a Perspex shield to the three-way tap. A syringe containing physiological saline only is attached to the other inlet. After administration of the radiopharmaceutical, the needle is flushed with approximately

0,5 ml of physiological saline. After bending the joint several times to ensure adequate distribution of the radiopharmaceutical, the joint is bandaged or splinted for 48-72 h. The following measures are recommended to minimise the radiation dose to the rest of the body caused by leakage from the joint:

a. Avoidance of excessive intra-articular pressure by synovial aspiration
b. Immobilisation of the joint for the first 48-72 h after the injection

9. Acquisition and processing

It is recommended that the distribution of the radionuclide in the joint and any leakage is checked using scintigraphy 24 h after administration of the radiopharmaceutical, with gamma radiation for ^{186}Re and the Bremsstrahlung for ^{90}Y and ^{169}Er. Measuring the distribution of the radiopharmaceutical in the joint and the leakage is an outcome measure of the therapy. Once it has occurred, leakage cannot be contained.

10. Report

The report shall contain the following points:

a. Indication for the treatment
b. The radiographic score
c. Which joint was treated
d. Name and injected quantity of radiopharmaceutical
e. Whether or not the therapy was combined with corticosteroids
f. The distribution of radioactivity in the joint
g. Results of any leakage measurements

It is recommended that the specialist in nuclear medicine or the referring specialist follows up on any complications and on the effect of the treatment.
Women of reproductive age are advised not to become pregnant during the first 4 months.

11. Literature

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