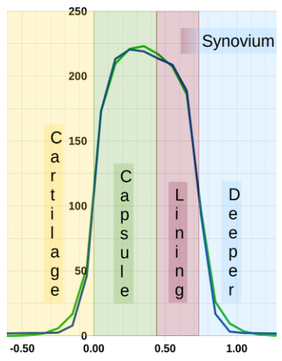


A Comparison of Er-169 and Sn-117m Radiation Synoviorthesis Using Monte Carlo Simulation

Richard E. Wendt III[1] and Nigel R. Stevenson[2]

[1]UT M. D. Anderson Cancer Center, Houston, Texas, rwendt@mdanderson.org
[2]R-NAV, LLC, The Woodlands, Texas, nstevenson@r-nav.com

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center

R-NAV, LLC

Society of Nuclear Medicine and Molecular Imaging
2016 Annual Meeting, San Diego, Abstract 499

Introduction

Radiation synoviorthesis, also called radio-synoviorthesis or radiosynovectomy, is the treatment of arthritic joints with a radioactive material for the purpose of reducing inflammation and improving the patient's mobility and well-being. The treatment is typically a radiolabeled colloid, These particles are postulated to be taken up by the macrophages in the synovial membrane and thereby incorporated into the synovial tissue.

The three most commonly used radionuclides for radiosynoviorthesis are Y-90 for large joints, Re-186 for medium-sized joints, and Er-169 for small joints.

Tin-117m is a metastable isotope of tin that decays by an isomeric transition to stable tin. In the course of this, it emits a prominent gamma ray and a whole host of Auger and internal conversion electrons that have relatively low energies and thus impart a localized dose. It is a potential alternative to Er-169 for radiosynoviorthesis.

This work compares the dosimetry of Sn-117m to that of Er-169 using Monte Carlo simulation in a synovial joint model.

Radionuclide Properties

	Er-169	Sn-117m
$T_{1/2}$	9.4 days	13.76 days
Image-able γ	Negligible	86% 159 keV
X-ray	262% 17 eV	1610% 1.1 keV
Beta	100% 99.6 keV	None
IC e^-	45% 7 keV	115% 135 keV
Auger e^-	216% 344 eV	1420% 442 eV

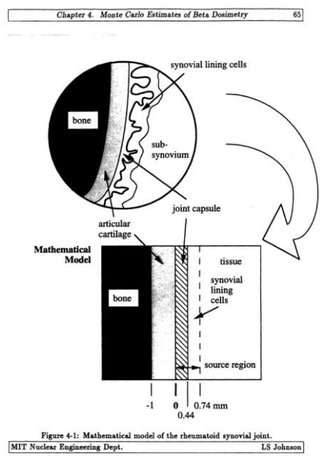
Sn-117m has a longer half-life, which allows more time for deep incorporation into the synovial tissue. It has an image-able gamma ray for post-treatment delivery verification. It has X-ray emissions that are similar to I-125. Er-169 and Sn-117m have similar beta and electron emission energies, although the abundance of Auger electrons from Sn-117m is seven-fold that of Er-169.

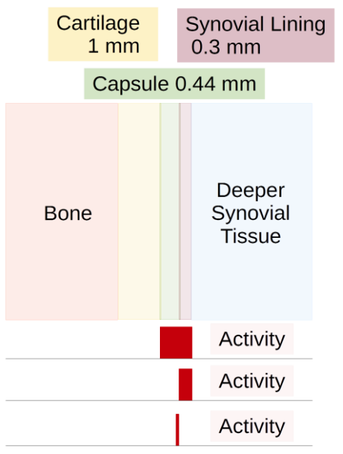
Simulation

We used the GATE Monte Carlo software [http://www.opengatecollaboration.org], which is a layer on top of Geant4. It has been opti-mized for medical imaging and radiotherapy.

The emissions in the source files were derived from ICRP 107 RAD and BET files. Two billion events were simulated for each radionuclide. The geometry followed the Johnson model [LS Johnson, PhD Dissertation, MIT, 1994, http://hdl.handle.net/1721.1/28076].

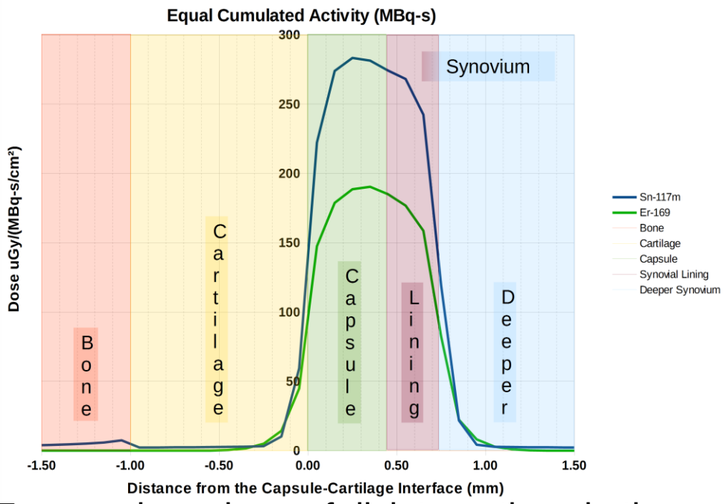
Model of the Joint



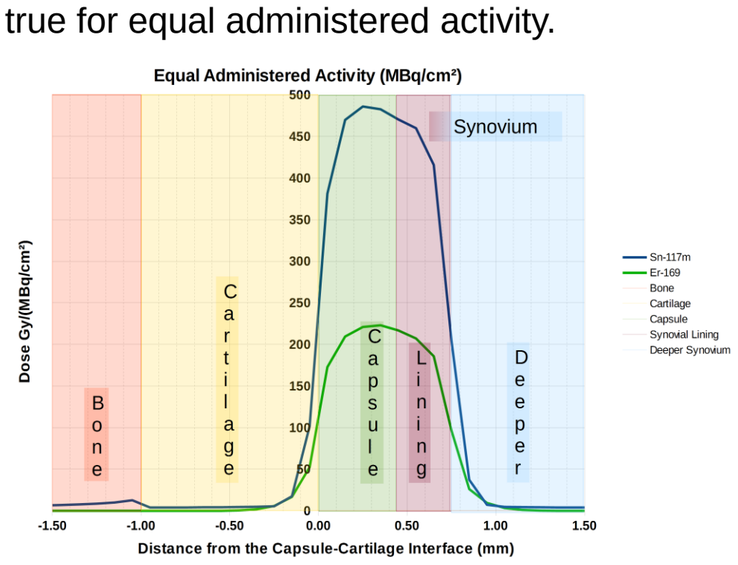


The Johnson model has a synovial lining thickness typical of a mildly arthritic joint. The GATE materials used were rib bone for the bone, cartilage, muscle for the synovium and water for the capsule. Three different uniform distributions of radioactivity were considered: the capsule and synovial lining (Johnson's case), only the synovial lining, and the infinitesimally thin interface between the capsule and lining.

Capsule and Lining



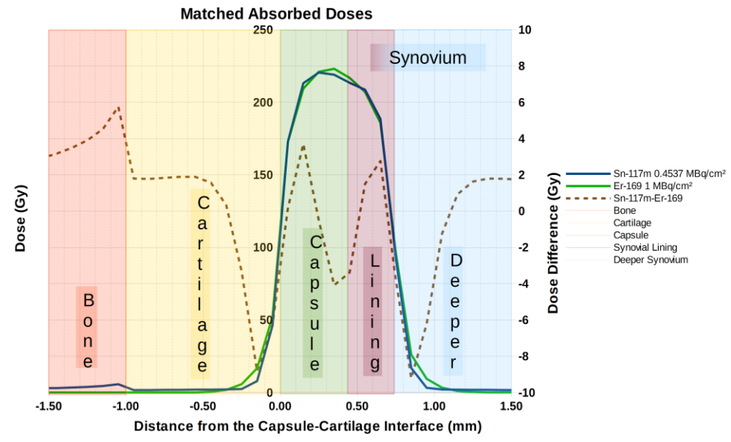
For equal numbers of disintegrations in the sources uniformly distributed in the capsule and lining layer of the synovium, the dose from Sn-117m (blue) is appreciably higher than that from Er-169 (green). The same is true for equal administered activity.



Acknowledgments

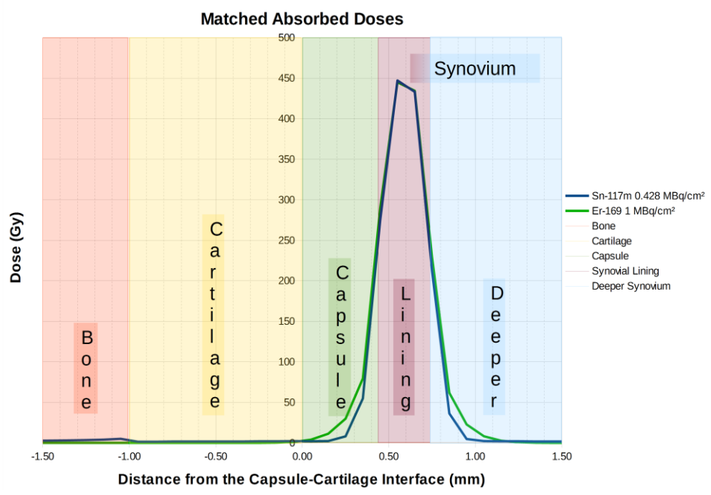
REW gratefully acknowledges a gift to M. D. Anderson Cancer Center from R-NAV, LLC in support of this work. The authors thank Dr. Scott Johnson for permission to reproduce Figure 4-1 from his dissertation.

Capsule and Lining



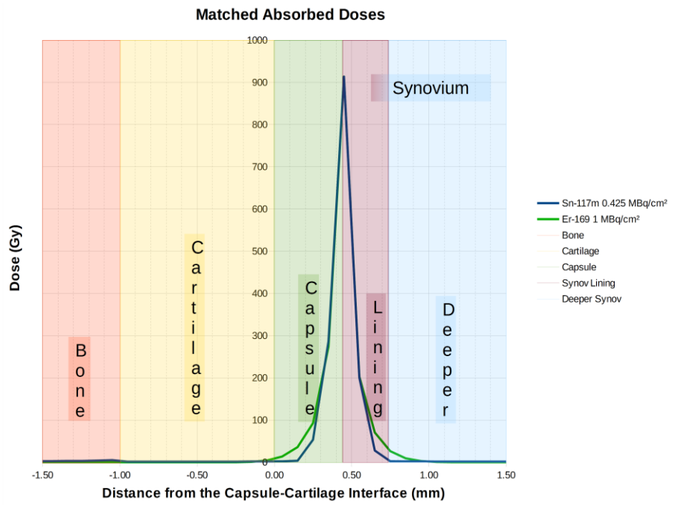
Sn-117m requires 45% of the activity of Er-169 to deliver the same peak dose. Overall, the dose distributions are very similar. Er-169 has slightly wider tails toward the end of the range of the electron dose and Sn-117m has a very low dose at greater distances from its gamma emissions.

Lining Only



With the activity distributed only in the lining layer, 43% as much Sn-117 as Er-169 is needed to deliver the same peak dose and an overall similar dose distribution.

Capsule-Lining Interface



With the activity constrained to a plane, the dose distributions are similar with 43% as much Sn-117m activity as Er-169.

Summary and Conclusion

Sn-117m and Er-169 deliver the same dose distribution to the synovium for all practical purposes. Sn-117m requires about 45% of the administered activity of Er-169 to deliver the same peak dose.

Sn-117m is thus an attractive alternative to Er-169, which is the current radionuclide of choice for radiosynoviorthesis of smaller joints.