

COLLEGE OF MEDICINE CURRICULUM VITAE

Manickam Muruganandham, Ph.D.

(December 28, 2006)

I. EDUCATIONAL AND PROFESSIONAL HISTORY

A. Institutions attended, board certification, licensure

Higher Education

1987	B.S. (Physics)	University of Madras, Madras India
1989	M.S. (Medical Physics)	College of Engineering / Adyar Cancer Institute, Anna University, Madras, India
1994	M.Phil. (Biophysics)	National Institute of Mental Health and Neurosciences(NIMHANS), Bangalore, India
1999	Ph.D. (Physics)	University of Delhi, Delhi, India

Postgraduate Education

2000-03 Fellowship Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, NY

Board Certification and Licensure

B. Professional and Academic Positions

1989-1992	Medical Physicist (Clinical Radiation Therapy), V.N. Cancer Center GKNM Hospital, Coimbatore, TN, India
1992-1994	Fellow in Biophysics, Dept. of Biophysics, National Institute of Mental Health and Neuro Sciences, Bangalore, India
1995-2000	Senior Research Fellow, Dept. of Biocybernetics, Institute of Nuclear Medicine and Allied Sciences / University of Delhi, India
2000-2003	Post-Doctoral Research Fellow, Dept. of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, NY
2003-2006	Instructor, Dept. of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, NY
2006-present	Clinical Assistant Professor, Dept. of Radiation Oncology, University of Iowa Hospitals and Clinics, Iowa City, IA.

C. Honors and Awards

1987	V.U. Chidambaranar's Educational Trust Prize for ranking college first in B. S. (Physics)
1989	Radiological Safety Officer (in Medical Institutions) Certification from Bhabha Atomic Research Centre Bombay, India
1990	Certificate of Participation in the Workshop-cum-Familiarization with Nucletron Treatment Planning System, held at Hyderabad, India
1992	Certificate of Participation in Brachytherapy Update, Tata Memorial Centre (Golden Jubilee Scientific Celebrations), Bombay, India
1992	Post Graduate Diploma in Computer Applications, Bharatiya Vidya Bhavan, Bombay, India

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| 1993 | IISc-Continuing Education Credit Certification for proficiency in Programming and Data Structures in C, Indian Institute of Science (IISc), Bangalore, India |
| 1998 | ISMRM travel award, International Society for Magnetic Resonance in Medicine, Berkley, CA |
| 2002 | ISMRM travel award, International Society for Magnetic Resonance in Medicine, Berkley, CA |

II. TEACHING

A. Teaching assignments on semester by semester basis

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| 1990-91 | Physics of X-ray CT, MRI and Ultra Sound
Postgraduate Diploma in Medical Instrumentation Technology course, Coimbatore Institute of Technology, Coimbatore India. |
| 2001 | Part-II Radiation Physics
Radiation Therapy Technology School, Memorial Sloan-Kettering Cancer Center, New York, NY. |

B. Students supervised

C. Other contributions to institutional programs

Translational research conference

July 2006 – present

III. SCHOLARSHIP AND PROFESSIONAL PRODUCTIVITY

A. Publications or creative works

Peer Reviewed Publications

1. Sreenivasan R, **Muruganandham M**, Sharma M, Joshi PG, Joshi NB. Binding of monomeric and oligomeric porphyrins to human glioblastoma (U-87MG) cells and their photosensitivity. *Cancer Letters* (120); 45-51:1997.
2. **Muruganandham M**, Kasi Viswanathan A, Jagannathan JR, Raghunathan, Jain PC, Jain V. Diltiazem enhances Tumor Blood Flow: A MRI study in a Murine tumor. *Int. J. Rad. Oncol. Biol. Phy.* 43, 2,413-421: 1999.
3. Zakian KL, Eberhardt S, Kleinman S, Shukla-Dave A, **Muruganandham M**. Rueter V, Scardino P, Hricak H, Koutcher JA. The Utility of ¹H MRSI in Detecting Cancer in the Prostate Transition Zone. *Proc. Intl. Soc. Mag. Reson. Med.*10, 2002.
4. **Muruganandham M**, XuS, Kalderon N, KoutcherJ. MRI Evaluation of the onset of chronic inflammation after contusion injury in rat spinal cord. *Proc. Intl. Soc. Mag. Reson. Med.*10, 2002.
5. **Muruganandham M**, Chen Y, Scheminda I, Hasmann H, Saltz L, Koutcher JA. The Effects of FK866 on Tumor Metabolism and Growth: ¹H-decoupled ³¹P MRS Study. *Proc. Intl. Soc. Mag. Reson. Med.*10, 2002.
6. **Muruganandham M**, Koutcher JA, QiuHong He. T2 Relaxation measurements of Lactate in abundant Lipid Environment by Selective Multiple Quantum Coherence Transfer, *Proc. Intl. Soc. Mag. Reson. Med* 10, 2002.
7. Zakian KL, Eberhardt S, Hricak H, Shukla-Dave A, Kleinman S, **Muruganandham M**, Sircar K, Kattan MW, Reuter VE, Scardino PT, Koutcher JA. Transition Zone Prostate Cancer: Metabolic Characteristics at ¹H MR Spectroscopic imaging—Initial Results. *Radiology* 229(1):241-7, 2003.
8. Shukla-Dave JA, Koutcher JA, Eberhardt S, **Muruganandham M**, Sircar K, Scardino P, Rueter V, Hricak H, Zakian KL. ¹H MRSI findings in prostatitis. *Proc. Intl. Soc. Mag. Reson. Med.* 11, 2003.
9. **Muruganandham M**, Lupu M, Dyke JP, Matei C, Higgins B, Kolinsky K, Bachynsky M, Grace JU, Koutcher JA. Preclinical Evaluation of Anti-angiogenic agent Roche I by Dynamic Contrast Enhanced MRI at 1.5T. *Proc. Intl Soc Magn Reson Med* 12, 2004.

10. **Muruganandham M**, Koutcher JA, Pizzorno G, Quihong He. In Vivo Tumor Lactate Relaxation Measurements by Selective Multiple-Quantum-Coherent Transfer. *Magn Reson Med*. 52(4): 902-906: 2004.
11. Shukla-Dave A, Hricak H, Eberhardt S, Olgac S, **Muruganandham M**, Scardino P, Reuter V, Koutcher JA, Zakian KL. Chronic Prostatitis: MR Imaging and ¹H MR Spectroscopic imaging-Initial Results. *Radiology* 231(3): 717-24; 2004.
12. **Murganandham M**, Schwartz LH, Kemeny NE, Jarnagin WR, Haviland D, Dyke JP, Koutcher JA. DCE-MRI Assessment of Hepatic Arterial Infusion Chemotherapy in Patients with Unresectable Primary Liver Cancer. *Proc Intl Soc Magn Reson Med* 13. 2005.
13. Zakian KL, Sircar K, Hricak H, Chen H, Shukla-Dave A, Eberhardt S, **Muruganandham M**, Eboral L, Kattan MW, Reuter VE, Scardino PT, Koutcher JA. Correlation of Proton MR Spectroscopic Imaging with Gleason Score based on Step Section Pathology after Radical Prostatectomy. *Radiology* 234(3): 804-14; 2005.
14. Danso M, Jarnagin WR, **Muruganandham M**, Schwartz LH, Goen M, Haviland D, Blumgart L, D'Angelica MD, Dematteo R, Kemeny N. Hepatic Arterial infusion therapy in patients with unresectable primary liver cancer. Use of dynamic contrast enhanced MRI to evaluate response. *Journal of Clinical Oncology, 2005 ASCO Annual Meeting Proceedings. Vol 23, No16S 2005: 4129.*
15. **Muruganandham M**, Alfieri AA, Chen Y, Schemainda I, Hasmann M, Sukenick G, Saltz LB, Koutcher JA. Metabolic Signatures Associated with a NAD Synthesis Inhibitor-induced Tumor Apoptosis Identified by ¹H-decoupled-³¹P Magnetic Resonance Spectroscopy. *Clin Cancer Res* 11(9): 3503-3513: 2005.
16. **Muruganandham M**, Lupu M, Dyke JP, Matei C, Linn M, Packman K, Kolinsky K, Higgins B, Koutcher JA. Preclinical evaluation of tumor microvascular response to a novel antiangiogenic/antitumor agent RO0281501 by dynamic contrast-enhanced MRI at 1.5 T. *Mol Cancer Ther* 5(8):1950-57:2006.

Book Chapters

1. **Muruganandham M**, Jain V, Applications of Magnetic Resonance Imaging Techniques to Monitor the Changes in Tumor Blood Flow and Oxygenation in Animal Tumor Models: *MR Imaging and Spectroscopy in Pharmaceutical and Clinical Research*". Ed. NR Jagannathan, JAYPEE Medical Publishers (p) Ltd, New Delhi, pp. 97-111, 2001.
2. **Murganandham M**, Koutcher. Magnetic Resonance Imaging in Mouse Cancer Models. *Mouse Models of Human Cancer*, Ed. E. Holland, Wiley –USA, pp. 349-363, 2004.

Invited Review Article

1. **Muruganandham M**, Jain V. Dynamic MRI in assessing Tumor Blood Flow and Oxygenation. *Current Science* (76): 744-752: 1999.

B. Areas of Research Interest and Current Projects

Research Interests

Magnetic Resonance (MR) Functional Tumor Imaging in Radiation Therapy (RT)

- Magnetic Resonance Spectroscopic Imaging (MRSI)
- Dynamic Contrast Enhanced Magnetic Resonance Imaging (DCE-MRI)
- MR Diffusion imaging
- Tumor Hypoxia
- MR imaging of tumor redox status.

Image Guided Radiation Therapy (IGRT)

- MR functional tumor imaging guided radiation treatment planning
- Work flow integration of MR functional tumor imaging methods in RT

Imaging Response Assessment of Tumors to Treatment using MR

- Identification of non-invasive MR imaging biomarkers to predict tumor response to treatments

Research Projects – Past

1. NIH ROI-CA 076423 7/7/1999 – 4/30/2005
Role of imagine in pre-treatment risk assessment of prostate cancer patients.
PI: Hedvig Hricak MD PhD
Role: Co-Investigator
2. Hoffmann-La Roche Inc., NJ, USA 2002 - 2003
Effects of anti-angiogenists agents evaluated by NMR.
PI: Jason A Koutcher MD PhD
Role: Co-Investigator
3. DAMD17-03-1-0474 7/1/2003 – 6/30/2006
US Army Breast Cancer Research Program
Multi-Parametric Magnetic Resonance Imaging of Angiogenesis in Breast Cancer
Role: Principal Investigator
4. NIH 1R01CA10454-01A1 7/1/2003 – 6/30/2008
Dynamic Magnetic resonance imaging in bone tumors.
PI: Jason A Koutcher MD PhD
Role: Co-PI
5. NCI funded initiative: 2005 – 2008
Memorial Sloan-Kettering Cancer Center (MSKCC) - Imaging Response Assessment Team (IRAT)
Role: Co-Investigator (MRI)
6. Aventis/Regeneron Pharmaceuticals, USA 2003 – 2006
Dynamic Contrast Enhanced MRI in assessing tumor response to anti-angiogenic agent VEGF Trap in patients with incurable, relapsed or refractory solid tumors or lymphoma in an open label, sequential cohort dose-escalation safety, tolerability and pharmacokinetic study-Phase I
Role: Co-Investigator
7. MSKCC – Institutional Project 2003 – 2006
Evaluation of tumor response by Dynamic Contrast Enhanced MRI in A Phase II study of continous hepatic arterial infusion with floxuridine (Fudr) and dexamethosone (Dex) in patients with unresectable primary hepatic malignancy.
Role: Co-Investigator
8. NIH 1P01CA115675 5/8/2006 – 3/31/2011
Tumor Hypoxia Imaging – Laboratory and Clinical Studies
PI: Clifton Ling
Role: Co-PI: Research Project 2: **Nuclear Magnetic Resonance Imaging of Tumor Hypoxia**
Core Co-leader: **Imaging and Radiochemistry Core**

C. Published reviews of scholarship**D. Grants received****Multi-Parametric Magnetic Resonance Imaging of Angiogenesis in Prostate Tumors**

Source: US Army Prostate Cancer Research Program (PCRP)

Direct Funds: \$98,000

Period of funding: 2002

PI: Manickam Muruganandham, Ph.D.

Score: 1.2

(Not accepted)

Multi-Parametric Magnetic Resonance Imaging of Angiogenesis in Breast Cancers

Source: US Army Breast Cancer Research Program

Direct Funds: \$170, 999

PI: Manickam Muruganandham, Ph.D.

Period of funding: 2002-2006

Score: 1.5

(Accepted)

E. Invited lectures and Conference Presentations**Invited Lectures**

1. **Tumor Blood Flow Imaging using MRI**, Indo-German Workshop on Improving Tumor Radiotherapy, Institute of Nuclear Medicine and Allied Sciences, Delhi, India. March 1997.
2. **Applications of Magnetic Resonance Imaging techniques to Monitor the changes in tumor blood flow and oxygenation in animal tumor models.** Workshop on MRI & MR Spectroscopy in Pharmaceutical and Physiological Research, All India Institute of Medical Sciences, New Delhi, March 2000.
3. **Towards Absolute Quantification of Lactate Levels in Tumors: NMR Relaxation Measurements of Tumor Lactate In Vivo by Selective Multiple Quantum Coherence Transfer.** RAMPS/VACIRCA Young Investigators Symposium, Memorial Sloan-Kettering Cancer Center, Feb 19 2002.
4. **Tumor Lactate Measurements by Magnetic Resonance Spectroscopy.** Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, April 3, 2002.
5. **Multi-parametric Magnetic Resonance Imaging of Tumor Angiogenesis.** Department of Medical Physics, Memorial Sloan-Kettering Cancer Center, Jan 2, 2003.
6. **Dynamic Contrast Enhanced MRI—a Functional Imaging Tool in Oncology.** Molecular Imaging Program in Oncology (MITO), Department of Radiology, Memorial Sloan-Kettering Cancer Center, October 6, 2004.
7. Symposium Presentation, **“Application of Dynamic Contrast Enhanced Magnetic Resonance Imaging in Combination with Lactate-Specific MR Spectroscopy in the Assessment of Breast Tumor Angiogenesis”**, in the Diagnostic Molecular Imaging: MR and Nuclear Applications for Improving Breast Cancer Detection and Diagnosis session at the Era of Hope DOD Breast Cancer Research Program's meeting in Philadelphia, PN , June 10, 2005.
8. **Dynamic Contrast Enhanced MRI (DCE-MRI) — A Functional Imaging Tool in Oncology.** Department of Radiation Oncology and Molecular Radiation Sciences, Johns Hopkins University, Baltimore, MD, Nov 15, 2005.
9. **Functional Imaging of Tumors Using MRI and MRS.** Department of Radiation Oncology, University of Iowa Hospitals and Clinics, Iowa City, IA, April 7, 2006.
10. **Imaging Tumor Response to Metabolic Oxidative Stress by Magnetic Resonance.** Center of Excellence for Image Guided Radiation Therapy(CEIGRT), Department of Radiation Oncology, University of Iowa Hospitals and Clinics, Iowa City, IA, Aug 18, 2006.
11. **Multi-parametric MRI and MRSI in Radiation Oncology.** The University of Iowa College of Engineering Imaging Group (CEIG), Iowa City, IA, Oct 20, 2006.
12. **MR Imaging of White Matter Architecture in Relation to Tumor.** Center of Excellence for Image Guided Radiation Therapy(CEIGRT), Department of Radiation Oncology, University of Iowa Hospitals and Clinics, Iowa City, IA, Oct 27, 2006.

Conference Presentations

1. **Muruganandham M**, Kasi Viswanathan A, Jagannathan NR, Raghunathan P, Jain PC, Jain V. Application of a Fast MRI Sequence to monitor Ca^{2+} -channel blocker-induced changes in Tumor blood flow. 3rd National Magnetic Resonance Society Conference, New Delhi, India, 1997.
2. Sharma, RK, **Muruganandham M**, Raghunathan P, Mitra A, Jain V. ³¹P MRS Studies on the effects of 2-deoxy-D-glucose (2-DG) pretreatment on the radiation induced changes in a mouse tumor model. 29th Annual Conference of Society of Nuclear Medicine India, Chandigarh, India, 1997.

3. **Muruganandham M**, Kasi Viswanathan A, Jagannathan NR, Jain PC, Jain V. Effects of Diltiazem on Tumor Vascular Status and Blood Flow: A noninvasive Dynamic contrast enhanced MRI Study. 29th Annual Conference of Society of Nuclear Medicine India, Chandigarh, India, 1997.
4. **Muruganandham M**, Kasi Viswanathan A, Jagannathan NR, Jain PC, Jain V. Dynamic MRI to monitor Ca²⁺ Channel blocker-induced changes in Tumor haemodynamics and oxygenation. National Symposium on Radiation and Molecular Biophysics, Bombay, India. 1998.
5. **Muruganandham M**, Jagannathan NR, Jain PC, Jain V. Diffusion Weighted MRI to assess changes in Tumor Microcirculation 4th National Magnetic Resonance Society Conference, Bangalore, India. 1998.
6. **Muruganandham M**, Kasi Viswanathan A, Jagannathan NR, Raghunathan P, Jain PC, Jain V. Bold-MRI observation of Ca²⁺ channel blocker-induced changes in tumor oxygenation. Proc. Intl.Soc.Magn.Reson.Med, 6 pp. 842, 1998.
7. **Muruganandham M**, Jagannathan NR, Jain PC, Jain V. Dynamic Diffusion Weighted MRI to monitor Ca²⁺ channel blocker-induced changes in Tumor microcirculation. Proc. Intl. Soc. Magn. Reson. Med, 7 pp. 1373, 1999.
8. Kalderon N, Xu S, **Muruganandham M**, Koutcher J. A window of opportunity For treating spinal cord contusion injury as revealed *in vivo* MRI. 9th International Symposium on Neural Regeneration, Asilomar, CA, 2001.
9. Xu S, **Muruganandham M**, Koutcher J, Kalderon N. Progression of pathology after contusion injury in rat spinal cord: In vivo MRI studies. Soc. Neurosci. Abstr., Vol. 27, Part 2, P. 2118, 2001.
10. Zakian KL, Sircar K, Kleinman S, Shukla-Dave A, **Muruganandham M**, Kattan M, Eberhardt S, Reuter V, Scardino P, Hricak H, Koutcher JA. Correlation of Proton MR Spectroscopic Imaging with Gleason Score Based on Step Section Radical Prostatectomy. RSNA 88th Scientific assembly and Annual Meeting, Chicago, IL, 2002.
11. Kalderon N, **Muruganandham M**, Koutcher J. Allen Revisited: Decompress-Ion is Crucial for Repairing the Contusion-Injured Rat Spinal Cord by Radiation Therapy, Soc. Neuroscience 32nd Annual Meeting, Orlando, FL, 2002.
12. **Muruganandham M**, Koutcher JA, Quihong He. T2 Mapping of Lactate in Lipid-Rich Environment by Selective Multiple Quantum Coherence Transfer. 43rd Experimental NMR conference, CA, 2002.
13. **Muruganandham M**, Lupu M, Dyke JP, Koutcher JA. Application of Dynamic Contrast Enhanced Magnetic Resonance (MR) Imaging in Combination with Lactate-Specific MR Spectroscopy in the Assessment of Breast Tumor Angiogenesis. The 4th Era of Hope meeting for the Department of Defense Breast Cancer Research Program, Philadelphia, PA. June 8-11, 2005,
14. **Muruganandham M**, Lupu M, Dyke JP, Matei C, Kolinsky K, Higgins B, Koutcher JA. Preclinical evaluation of tumor microvascular response to a novel antiangiogenic/antitumor agent RO0281501 by dynamic contrast enhanced MRI at 1.5T. AACR-NCI-EORT International Conference on Molecular Targets and Cancer Therapeutics: Discovery, Biology, and Clinical Applications, Philadelphia PA, Nov 2005.
15. Lockhart AC, **Muruganandham M**, Schwartz L, Koutcher J, Donnelly E, Andal R, Furfine ES, Chevalier P, Spriggs DR, Rothenberg ML, Cedarbaum JM, Cohen DP, Dupont J. Pharmacodynamic Indicators of VEGF Trap Activity in Patients with Advanced Solid Tumors. AACR-NCI-EORTC International Conference on Molecular Targets and Cancer Therapeutics: Discovery, Biology, and Clinical Applications. Philadelphia PA, Nov 2005.

F. Pending decisions (grant proposals, book contracts)

Research grants:

1. **Imaging Tumor Response to Metabolic Oxidative Stress by Magnetic Resonance (MR).**
Principle Investigator: Manickam Muruganandham PhD.
Co-Investigators: William R Kearney PhD, Ken Dornfeld MD PhD, John E Bayouth PhD.

This developmental project was submitted as a part of The University of Iowa "In Vivo Cellular and Molecular Imaging Center (ICMIC)" NIH P50 grant application titled "Molecular Image-Guided Cancer Therapy: Diagnosis and Assessment of Response".

2. **Imaging Tumor Response to Metabolic Oxidative Stress by Magnetic Resonance (MR).**

P.I's: Ken Dornfeld MD PhD, Manickam Muruganandham PhD, Larry Oberley PhD, and William Kearney PhD.

This collaborative proposal was submitted to "Carver College of Medicine Collaborative Pilot Grant" mechanism with a major aim to develop non-invasive in vivo magnetic Resonance Spectroscopy (MRS) approach to study the effects of BCNU and radiation treatments in glioma patients.

Research article publications:

1. **Muruganandham M**, Schwartz LH, Goen M, Haviland D, Blumgart L, D'Angelica MD, Dematteo R, Kemeny N, Jarnagin WR. Hepatic Arterial infusion therapy in patients with unresectable primary liver cancer. Use of dynamic contrast enhanced (DCE) MRI to evaluate response. *(to be submitted)*

IV. SERVICE

A. Memberships in Professional Organizations

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| 1998-current | Member, International Society for Magnetic Resonance in Medicine (ISMRM) |
| 2004 | Consultant, Aventis / Regeneron Pharmaceuticals DCE-MRI Expert Consensus Meeting, New York, NY |

Reviewer

Physics in Medicine and Biology

B. Clinical assignments since last promotion (if applicable)

1. 3T MR imaging protocol optimization for radiotherapy simulation.
2. Quality control of simulation CT.
3. Prepared informal *White Paper* on "*Magnetic Resonance Applications in Radiation Oncology*" to initiate radiation oncology clinical research collaborations with Siemens MR R&D group.