

# Biomedical Engineering

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## Core Faculty Profile

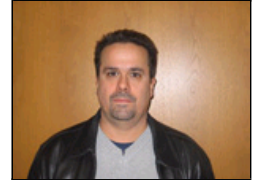
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Timothy J. Carroll

## Research Interests

The role of Magnetic Resonance Imaging (MRI) in day to day clinical practice is growing. Gadolinium based contrast agents have traditionally been used to enhance the signal from flowing blood allowing rapid acquisition of high spatial resolution angiograms for the diagnosis of vascular disease. The ability to view the anatomy in 3D as well as the minimally invasive nature of MRI image acquisitions offer some advantages over more invasive x-ray angiography. My research has been focused on the development of MR k-space sampling and image reconstruction strategies for acquisition of high spatial resolution time-resolved MR angiograms. The ability of time-resolved 3D angiography to depict compromised flow has proven a valuable tools in assessing the severity of vascular disease, a major source of mortality and morbidity in industrialized nations.

Recently, developments in contrast-enhanced MR image acquisitions and data analysis are providing a larger range of options for the diagnosis of ischemic stroke and certain types of cancer. I'm currently working with indicator dilution techniques applied to heavily T2-weighted images for the assessment of cerebral perfusion. These imaging techniques have the potential to allow for rapid, real-time assessment of cerebral blood flow for the triage of patients suffering from acute stroke. In addition, I am using pharmacokinetic models applied to contrast-enhanced, time-resolved T1-weighted uptake curves in tumors to assess vascular volume, blood vessel permeability. These imaging techniques have the potential potential for the staging, and tracking the response to therapy of certain types of cancer.

## Selected Publications

*Peer reviewed:*

1. Mistretta CA, Grist TM, Korosec FR, Frayne R, Peters DC, Mazaheri Y, **Carroll TJ**. "3-D Time resolved contrast -enhanced MR-DSA: Advantages and Tradeoffs". *Magn Reson Med* 40; 571-581: 1998.
2. Zhou Y, **Carroll TJ**, Grist TM, Frayne R. "Design and Validation of a motion stage for in vitro MR experiments", *J Magn Reson Imaging* 10; 972-977: 1999.
3. **Carroll TJ**, Korosec FR, Swan S, Grist TM, Frayne R, Mistretta CA. "A Method for Rapidly Determining and Reconstructing the Peak Arterial Frame From a Time Resolved CE-MRA Exam", *Magn Reson Med* 44; 817-820: 2000.

4. **Carroll TJ**, Korosec FR, Petermann GM, Grist TM, Turski PA. "Carotid Bifurcation: Evaluation of Time-resolved Three-dimensional MR Angiography". Radiology 220; 525-532: 2001.
5. **Carroll TJ**, Korosec FR, Swan JS, Hany TF, Grist TM, Mistretta CA. "The Effect of Injection Rate on Contrast Enhanced Peripheral MRA." J Magn Reson Image 14; 401-410: 2001.
6. Hany TF, **Carroll TJ**, Omary RA, Esparza-Coss EE, Korosec FR, Mistretta CA, Grist TM. "Aorta and Runoff Vessels: Single-Injection MR Angiography with Automated Table Movement Compared with Multiinjection Time-resolved MR Angiography-Initial Results." Radiology 221; 266-272:2001.
7. **Carroll TJ**, Haughton VM, Rowley HA and Cordes D. "The confounding effect of large vessels on MR Perfusion Images Analyzed with Independent Component Analysis (ICA), (AJNR Am J Neuroradiol. submitted June 2001).
8. Swan JS, **Carroll TJ**, Kennell TW, Heisey DM, Korosec FR, Frayne R, Mistretta CA and Grist TM. "Time-Resolved 3D Contrast-Enhanced MRA of the Peripheral Vessels", (Radiology, submitted July 2001).
9. Mazaheri Y, **Carroll TJ**, Du J, Korosec FR, Block WF, Fain SB, Vigen KK, Grist TM, Hany TF, Aargard BD, Strothers CM, Mistretta CA, "Combined Time-Resolved and High Spatial Resolution 3D MRA using an extended adaptive acquisition." (J Magn Reson Imaging, in press Oct 2001).
10. Wieben O, **Carroll TJ**, Swan JS and Frayne R. "Rapid Generation of Preview Images for Real-time 3D MR Angiography", Phys. Med. Biol. 47; 17-24: 2002.
11. **Carroll TJ**, Jobin M, Treyer V, Hany TF, Burger C, Teneggi V and Buck A. "Absolute Quantification of Cerebral Blood Flow with MR, Reproducibility of the Method and Comparison with H215O PET." J Cereb Blood Flow Metab 22;1149-56:2002.
12. Du J, **Carroll TJ**, Wagner HJ, Vigen KK, Fain SB, Block WF, Korosec FR, Grist TM and Mistretta CA. "Time-Resolved, Undersampled Projection Reconstruction Imaging for High Resolution CE-MRA of the Distal runoff vessels" Magn Reson Med 48;516-22:2002.
13. **Carroll TJ**, HA Rowley and Haughton. "Automating the determination of the arterial input function for assessment of regional cerebral blood flow with MRI". Radiology. 227;593-600: 2003.
14. Du J, **Carroll TJ**, Block WF, Fain SB, Korosec FR, Grist TM and Mistretta CA. "SNR Improvement for Multiinjection Time-Resolved High-Resolution CE-MRA of the Peripheral Vasculature. " Magn Reson Med 49;909-917:2003
15. **T.J. Carroll**, K.E. Sakaie, R. McCarthy, K.R. Curtin, T.A. Cashen, W. Shin. "A Method for Improving the Accuracy of Quantitative Cerebral Perfusion Imaging." Submitted to Magn Reson Med, Aug 2003.
16. Omary RA, Schirf BE, Green JD, Kanwar YS, Shea SM, **Carroll TJ**, Carr J, Li D. "Catheter-directed MR Angiography and Cross-sectional Imaging for the Assessment of Renal Artery Stenosis. J Vasc Interv Radiol 16(2):255-60: 2005.
17. Sakaie KE, Shin W, Curtin KR, McCarthy RM, Cashen TA, **Carroll TJ**. "A Method for Improving the Accuracy of Quantitative Cerebral Perfusion Imaging", J Magn Reson Imaging, 21(5):512-519: 2005.
18. Cashen, TA, Carr JC, Shin W, Walker MT, Futterer S, Shaibani A and **Carroll TJ**, "Intracranial Time-Resolved Contrast-Enhanced MR Angiography at 3T", AJNR Am Journ Neuroradiol. 27(4): 822-9: 2006.
19. Shaibani A, Khawar S, Shin W, Cashen TA, Schirf B, Rohani M. Kakodkar S and **Carroll TJ**, "First Results in a MRI-Compatible Canine Model of Acute Stroke. AJNR Am Journ Neuroradiol. (2006, in press).
20. Koktzoglou I, Chung YC, Mani V, Carroll TJ, Morasch MD, Mizsei G, Simonetti OP, Fayad ZA, Li D. Multi-slice Dark-Blood Carotid Artery Wall Imaging: A 1.5 T and 3.0 T

21. Shin W, Cashen TA, Horowitz SW, Sawlani RN and **Carroll TJ**. "Quantitative CBV Measurement from Static T1 Changes in Tissue and Correction for Intravascular Water Exchange." Magn Reson Med. 56;138-145, 2006.

22. Koktzoglou I, Harris KR, Tang R, Kane BJ, Misselsitz B, Weinmann HJ, Lu B, Nagaraj A, Roth SI, **Carroll TJ**, McPherson DD and Li D. Gadoflourine-Enhanced Magnetic Resonance Imaging of Carotid Atherosclerosis in Yucatan Miniswine. Investigative Radiology, 41 (3) 299-304, 2006.

23. Groves EM, Bireley W, Dill K, **Carroll TJ**, Carr JC. Quantitative Analysis of ECG-gated High-Resolution Contrast-Enhanced MR Angiography of the Thoracic Aorta. AJR, 2006 (in press).

24. Rhee TK, Park JK, Cashen TA, Shin W, Schirf BE, Gehl JA, Larson AC, Carr JC, Li D, **Carroll TJ**, Omary RA. Comparison of Intraarterial MR Angiography at 3.0T with X-ray Digital Subtraction Angiography for Detection of Renal Artery Stenosis in Swine. J Vasc Interv Radiol 17;1131-7, 2006.

25. Yang J, Motlagh D, Allen J, Webb A, Kibbe M, Aalami O, Kapadia M, **Carroll TJ**, Ameer GA. Modulating ePTFE vascular graft host response via citric acid-based biodegradable elastomers. Advanced Materials 18; 1493-1498.

26. Sawlani R, Shin W, Horowitz S, Chandler J, **Carroll TJ**. Determining Tumor Grade Non-invasively Using Quantification of Cerebral Blood Volume Through Contrast Enhance MRI. NURJ, Northwestern Undergraduate Research Journal 3; 16-22, 2006.

27. Pinto C, Hickey R, **Carroll TJ**, Sato K, Dill K, Omary RA, Kroeker R, Simonetti O, Carr JC. Time-resolved MR Angiography with Generalized Autocalibrating Partially Parallel Acquisition and Time-resolved Echo-sharing Angiographic Technique for Hemodialysis Arteriovenous Fistula Grafts. J Vasc Interv Radiol 17; 1003-1009: 2006.

*Invited:*

1. Korosec FR, Turski PA, **Carroll TJ**, Mistretta CA and Grist TM. "Contrast-Enhanced MR Angiography of the Carotid Bifurcation." Journal of Magnetic Resonance Imaging 10; 317-325:1999.

2. Turski PA, Korosec FR, **Carroll TJ**, Willig D, Grist TM and Mistretta CA. "Contrast-enhanced Magnetic Resonance Angiography of the Carotid Bifurcation Using a Time-resolved Contrast-kinetics (TRICKS) Technique." Top Magn Reson Imaging 12; 175-181: 2001.

3. **Carroll TJ**. "The Emergence of Time-resolved Contrast-enhanced MR Imaging for Intracranial Angiography." (AJNR Am Journ Neuro Rad, in press Jan 2002)

## Conferences

XV International Meeting of the MR Angiography Club Dublin, Ireland Sept 24-26.

Abstract Titles

1. High Resolution Time-Resolved Pulmonary MRA Using TRICKS with Ultra-short Repetition Times
2. Contrast-enhanced MR angiography of the circle of Willis at 3 Tesla
3. Contrast-enhanced MR angiography (CE-MRA) using a projection-onto-convex-sets (POCS) reconstruction algorithm

## Awards

Whitaker Foundation (RG-03-006). "Determination of pulmonary blood volume in heart failure with contrast-enhanced magnetic resonance imaging" Award \$231,466.00



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