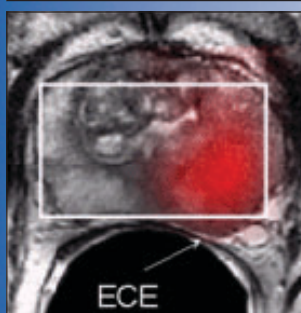
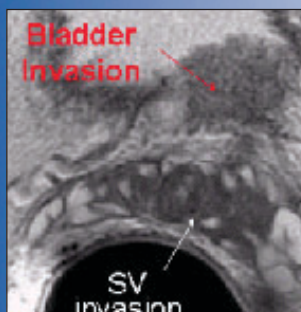
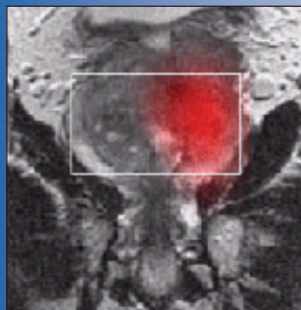


## Benefits at a Glance:

- PROSE provides a comprehensive clinical staging exam of the prostate and pelvis.
- Endo-rectal/phased array coil combination allows small FOV imaging of prostate combined with a full imaging exam of the pelvis.
- Robust user interface provides streamlined setup of spectroscopy acquisition.
- Automated prescan, shim, and recon allow technologist to efficiently perform the exam.
- 2D and 3D CSI techniques provide increased diagnostic capabilities.
- Improved saturation of lipids and use of VSS RF Pulses improves resulting spectra.
- Specialized coil intensity correction provides better visualization of anatomy and pathology near the endo-rectal coil.
- FuncTool CSI visualization tools expand physician interpretation options.

### Case Study 1:



Overlaid Choline/Citrate image

# PROSE

## Prostate Spectroscopy/Imaging Exam

**John Kurhanewicz, Ph.D.**

*University of California, San Francisco*

### Clinical Benefits

Working as a team, the radiologist, oncologist, and urologist can integrate prostate spectroscopy and imaging into a clinical MRI staging exam for prostate cancer. As a billable, FDA-cleared technique, prostate spectroscopy and imaging can be completed in less than an hour and provides a comprehensive exam that covers the entire pelvis.

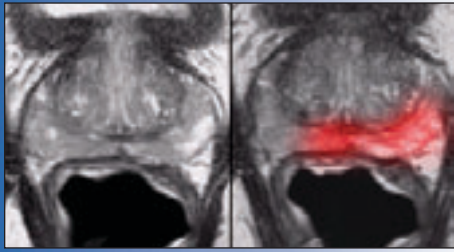
This type of team approach expands the options for treatment of the patient. The oncologist and urologist need focal information regarding the size and location of the tumor, whether it is benign or malignant, and whether metastasis has occurred outside the prostate gland. Historically, in cases of prostate cancer, the gland was surgically removed. With answers to the above questions, the gland can be preserved with treatments such as brachytherapy, 3D conformal radiation therapy, and systemic hormone deprivation. The combined MRI/MRSI exam is also used to target regions for ultrasound-guided biopsy in a growing number of patients who have had negative biopsies yet still have elevated or rising PSAs. With this procedure, the physician team can select therapy that best suits the type and extent of prostate disease on a patient-by-patient basis.

### Case Study #1

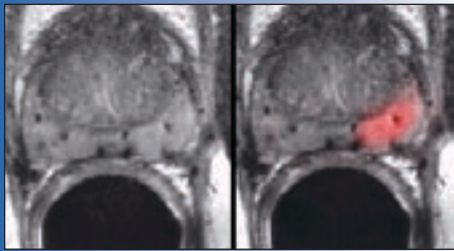
In a 67-year-old prostate cancer patient (who wanted brachytherapy), MRI/MRSI demonstrated a large-volume tumor with ECE on the left side, bilateral seminal vesicle invasion, and invasion into the bladder neck.

Based on the results of the MRI/MRSI, brachytherapy was not appropriate, and complete hormone ablation therapy with 3-D conformal radiation was suggested.

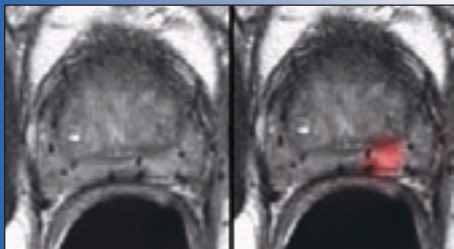
### Case Study 2:



Prior to therapy



Three months after brachytherapy



Twelve months after brachytherapy

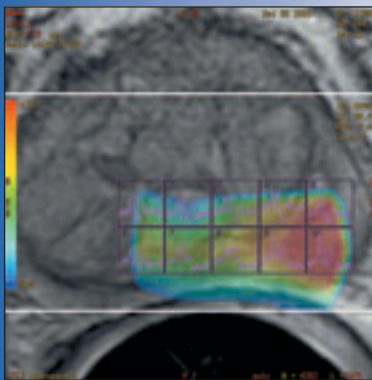


Figure 1

Prostate image with (Choline + Creatine)/Citrate ratio map, and spectral grid overlays. The ten spectra, labeled 1 to 10, demonstrate the presence of choline, creatine, and citrate resonances at  $\sim 3.2$ ,  $\sim 3.0$ , and  $\sim 2.6$  PPM, respectively. A shifted lipid resonance appears in several of the spectra around  $\sim 2.0$  PPM. The white line on the image is the edge of the localized PROSE volume. Image and spectra courtesy of UCSF Medical Center.

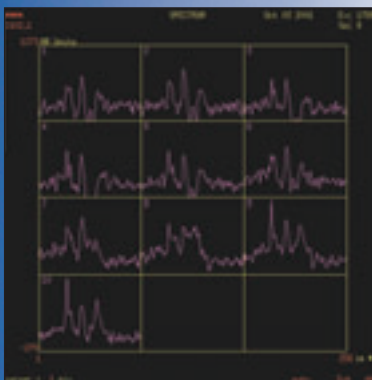


Figure 2

### Case Study #2

For a patient for whom brachytherapy was recommended, MRSI was used pre- and post- brachytherapy to monitor treatment.

#### Technique

Until recently, prostate spectroscopy was thought to be a “research only” application. With the release of PROSE, an exclusive GE Medical Systems product, many patients of GEMS MR customers will benefit from this new technology. By combining the prostate imaging exam with the spectroscopy exam, a more comprehensive study can be done, increasing diagnostic capabilities and ultimately providing more treatment options for the patient. This robust product was designed for streamlined data acquisition, and it eliminates the need for off-line reconstruction of spectroscopy data. The technologist simultaneously acquires imaging and spectroscopy data, which the system automatically reconstructs into spectra for the radiologist to interpret. The spectroscopy data can be ported, interpreted, and stored on a PACS workstation as well as on traditional archiving and filming methods.

PROSE is a version of PRESS (Point RESolved Spectroscopy), and can be used to acquire a single spectrum or two- and three-dimensional Chemical Shift Images (2D and 3D CSI) from the prescribed PRESS volume (Figures 1 and 2).

Expanded display of the ten prostate spectra (TR/TE 1000/130) in the spectral grid shown in the previous display. The spectra are identically scaled for direct comparison. Spectra courtesy of UCSF Medical Center.

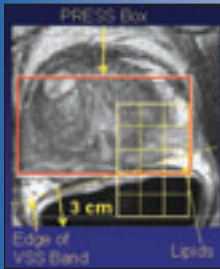


Figure 2a

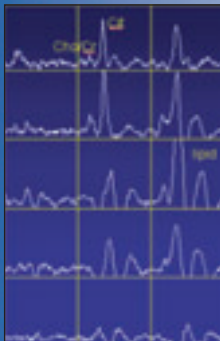


Figure 2b

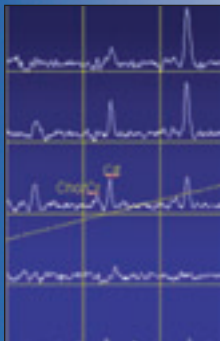


Figure 2c



Figure 3a: Without Endo-rectal Coil intensity correction.

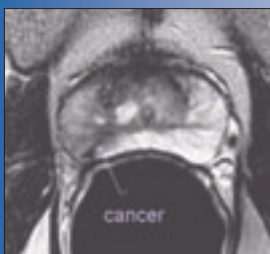


Figure 3b: With Endo-rectal Coil intensity correction.

Fully-automated Auto Prescan, Auto Shim, and Auto Reconstruction of data are among the unique features included in the PROSE package. In addition, graphic prescription of 4 to 10 Very Selective Suppression (VSS) RF pulses around and through the ROI are employed. In the default mode, 6 VSS pulses are placed at the edges of the PROSE volume, leaving 4 VSS pulses that can be graphically prescribed (Figure 2a). The lipid suppression afforded by the placement of a VSS band at the corner of the localized PROSE volume is demonstrated in Figures 2b and 2c. To correct for surface coil intensity near the prostate gland from the endo-rectal coil, the PROSE package includes the Prostate Analytical Coil Correction (PACC), which has been specifically designed for use with the endo-rectal coil (Figures 3a & 3b). In addition to the automated reconstruction of the spectroscopy data, the FuncTool CSI visualization tool provides many other post-processing options.

### Images and Protocol

Normal glandular prostate cells manufacture citrate, which is secreted into ducts. In the presence of prostate cancer, there is decreased citrate, resulting in loss of cellular function and ductal morphology. Additionally, choline increases due to increased proliferation membrane changes and increased cell density (Figure 4).

1. Sagittal localizer images: FSE TR=1000, TE=90, FOV24x24, 5 thick/1.5 spacing, 256X192 1 NEX total time: 1:39 mins.
2. Axial or Axial Oblique SE images: SE, TR766, TE8, FOV24x24, 5 thick/1.0 spacing, 256x192 1 NEX total time: 5:49 mins.
3. Axial or Axial Oblique T1 FSE images: TR 6000, TE96, FOV14x14, 3 thick/0.0 spacing, 256x192 3 NEX total time: 3:42 mins.
4. Coronal FSE images: TR5000, TE96, FOV16x16, 3.0 thick/0.0 spacing, 256x192 3 NEX total time: 3:05 mins.
5. Axial or Axial Oblique MRS (PROSE): Using corrected images from series #3 as ROI localizers, PROSE, spectral spatial RF enhanced dynamic range, TR1000, TE130, 6.9 spacing, thickness will be based on the results from gRx, FOV11x11, phase16, freq 8, locations per slab 8, 1 NEX total time: ~17 mins.

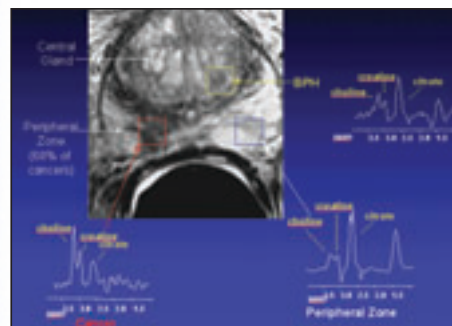


Figure 4

## System Requirements

### Field Strength

- 1.5T

### Computer

- Octane

### Software

- 9.0

### Array Processor

- Reflex 20
- Quad i860
- Reflex 50
- Reflex 100/512BAM

### Gradients and IPGs

- Base
- SmartSpeed
- HiSpeed SGD
- HiSpeed+ACGD
- EchoSpeed SGD
- EchoSpeed+ACGD
- TwinSpeed ACGD
- IPG1
- IPG2

### RF and Bandwidth

- CERD
- UCERD
- UCERD2
- +/- 64 kHz
- +/- 125kHz

## Summary

As a combined imaging and spectroscopy product, PROSE provides revolutionary advances in diagnosis, staging, and follow-up of prostate disease. The streamlined design of the PROSE product allows the technologist to perform the entire imaging and spectroscopy exam and the automated reconstruction of the spectroscopy data precludes the need for off-line reconstruction. Additional post-processing tools provide the radiologist with expanded interpretation options. The exemplary data provided to the physician team allows tailored treatment plans specific to each patient. Currently GE Medical Systems is the only MR manufacturer to offer an FDA-cleared imaging and spectroscopy package for the study of the prostate.

## Testimonial

*“At UCSF we add a spectroscopy (3-D MRSI) sequence to all patients receiving a high resolution MRI staging exam for prostate cancer, and have scanned over 3,200 patients to date. Prior to the release of PROSE, prostate spectroscopy could only be performed at a few research institutions and required the involvement of MR physicists for data acquisition and off-line processing. Physicians in hospitals around the world will now be able to utilize this exciting new technology to fully assess the clinical utility of combined imaging and spectroscopy in the management of patients with prostate cancer. Studies in pre-prostatectomy patients have indicated that the metabolic information provided by 3-D MRSI combined with the morphologic information provided by MRI can improve the assessment of cancer location and extent within the prostate, of extracapsular spread, and of cancer aggressiveness. Because the ability to detect and determine the spatial extent of cancer using MRI alone is hampered due to therapy induced morphologic changes, we believe that MRSI will have it’s greatest impact on assessing the effectiveness of prostate cancer therapy.”*

– John Kurhanewicz, Ph.D.

University of California, San Francisco



## GE Medical Systems

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