# MRI Sialolithography: Direct Visualization of Calculi in the Submandibular Gland Using SWI at 3T

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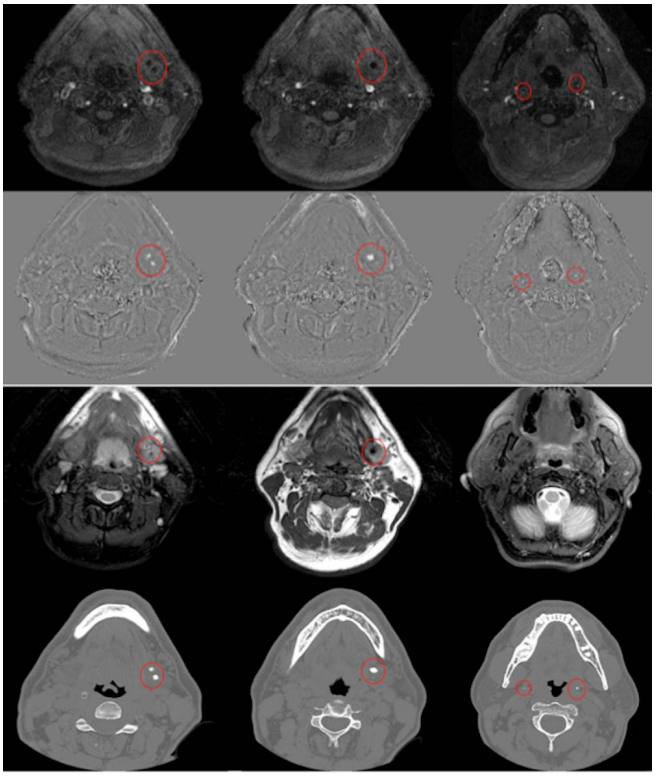
**Introduction:** On conventional MR images, calcifications appear hypointense relative to the surrounding tissue on both T1 and T2 sequences. These standard sequences therefore have low sensitivity and specificity for identifying calcification. Due to the diamagnetic property of calcium, optimized corrected phase images obtained using susceptibility-weighted imaging (SWI) have previously been shown to identify breast-associated calcifications [1]. For glandular tissue CT is the modality with highest sensitivity and specificity and thus has been preferred for imaging of salivary glands over MR imaging [2]. We have developed a technique that allows for the specific identification and localization of calculi within the submandibular salivary gland or duct using MRI. This test is non invasive, and does not require ionizing radiation or the use of sialogogue. The avoidance of radiation is particularly important when imaging a benign disease that affects a younger otherwise healthy population.

**Material and Methods:** Images were obtained on a GE Signa HD 3T system with an 8-channel phased array head coil (GE Healthcare Milwaukee WI). SWI was performed using a high-resolution 3D fully velocity compensated gradient echo sequence (512 × 512 matrix size, FOV=24cm, ASSET factor=2, TE/TR=8/30, FA=15°, rbw= 125 Hz/pixel). Optimized SWI corrected phase images were collected isotropically (spatial resolution = 0.3×0.3×0.3 $mm^3$ voxel size) to minimize phase aliasing. A high pass filter was used on phase images to remove unwanted background noise and unwrap aliased phase. Subsequently a complex threshold filter was applied to both corrected phase and magnitude images. It consisted of application of two thresholds to MR images (magnitude and phase. Secondly application of connectivity filter in order to minimize the probability of Type I and Type II errors (i.e. the error of eliminating signal pixels, and the error of leaving noise pixels, respectively):

$$\text{Probability of Type I error} = \frac{\text{total number of signal pixels removed}}{\text{total number of signal pixels}}$$

$$\text{Probability of Type II error} = \frac{\text{total number of noise pixels left}}{\text{total number of noise pixels}}$$

Corrected positive phase and susceptibility weighted images were compared to routine axial T2-weighted fast spin echo (FSE, TE=98, 320 ×192 matrix size, NEX=2, slice thickness=3 mm) and CT data (kVp=120 kV, 60–80 mA). CT images were reconstructed at 2.5mm thickness from a volume acquisition of the suprahyoid neck with no intra-venous injection.



**Results**: Three small calculi in the left submandibular gland were identified and 1 small calculus was visualized in the left parapharyngeal soft tissue. All were visualized confidently on the filtered corrected phase imaged. T2 weighted images show the larger single stone clearly produces a signal void, while on inferior images 2 smaller calculi are clearly seen on CT and SWI positive phase images.

**Discussion:** MRI traditionally has been considered of limited value in sialolithiasis and sialadenitis. While conventional MRI may visualize the ductal system and may demonstrate edema surrounding the gland or phlegmon within, it has not been able to characterize calculi. MRI can identify dilated ducts, filling defects within a duct or a transition zone within a dilated duct but often cannot tell the difference between a stone, air bubble, inspissated inflammatory debris or a stricture. The demonstration of a filling defect within a duct is often taken to represent a calculus on MRI but plain radiography or CT is often required to confirm this. In addition MR sialogram techniques require the administration of a sialogogue (lemon juice) to stimulate salivary gland secretion in advance of the test. In patients with an obstructed duct this can cause significant pain sometimes leading to premature termination of the MRI. In addition in chronically inflamed, fibrosed or non functioning salivary glands there may be no saliva produced and thus no significant dilation of the ducts post sialogogue leading to no delineation of the filling defect[3]. Thus our technique, which allows the direct and specific identification, of a calcified calculus within the gland or duct is an important advance in the assessment of this disease. We believe that this new technique will mean that MRI will be considered as a 1 stop shop, and the investigation of choice, for evaluation of this disease in the future.

**References:**

**[1]** Fatemi-Ardekani A, Boylan C, Noseworthy MD (2009) *Medical Physics* 36:5429-5436. **[2]** Casselman and Mancuso (1987) *Radiology* 165:183-189. **[3]** Jager *et al.* (2000) *Radiology* 216:665-671.