

# A Novel Swallow Detection Device For Carotid Artery Imaging

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## Target Audience

Clinicians and researchers desiring high resolution carotid artery imaging will benefit from the use of this novel swallow detection device

## Purpose

MRI, with a variety of image contrasts, presents a great advance over x-ray techniques in the ability to discriminate between different types of soft tissue and the potential to discriminate between important atherosclerotic plaque components. Very high spatial resolution 3D TSE MRI techniques would be especially valuable in carotid MRI, but motion artifacts that arise due to the relatively long data-acquisition time results in an unacceptable fraction of non-interpretable studies. Nearly all clinical cervical carotid MRI studies are performed with 2DTSE techniques where motion artifacts corrupt a smaller fraction of studies and motion in one slice does not cause artifacts in an adjacent slice. Even with 2DTSE, in many subjects motion creates obvious blurring or ghosting artifacts that greatly reduce the quality of the images. Blurring and ghosting issues have been attributed to swallowing and the associated palatal motion (1,2). Spatial navigators and dedicated motion detection coils have both shown some success in 3D TSE carotid imaging (3,4). However, placing the spatial navigators on the epiglottis while ensuring there is no interaction with blood in the carotid arteries can be a time consuming task. In addition, low SNR at the deep navigator location from small surface coils can be a problem. A dedicated motion detection coil requires specialized hardware and interaction with the magnetic gradients used for localization must be considered. This work proposes the use of a simple neck pneumatic device which can couple to the existing respiration monitoring system.

## Methods

A piece of foam (about 5x5x2 cm) was molded into a shape sufficient to sit on top of a patient's neck (under the receive coil) and was coated in a plastic dip sealant (Fig 1). A small tube couples the device into the existing respiration monitoring system which detects changes in air pressure. Rather than monitor the air pressure inside a bellows placed around a patient's abdomen, the system now monitors the pressure inside the swallow detection device. When a patient swallows, slight deformations of the device create fluctuations in air pressure that can be detected by the existing monitoring system. All studies were performed on a Siemens Trio 3T MRI scanner. All human studies were approved by the institutional review board and informed consent was obtained from all subjects.

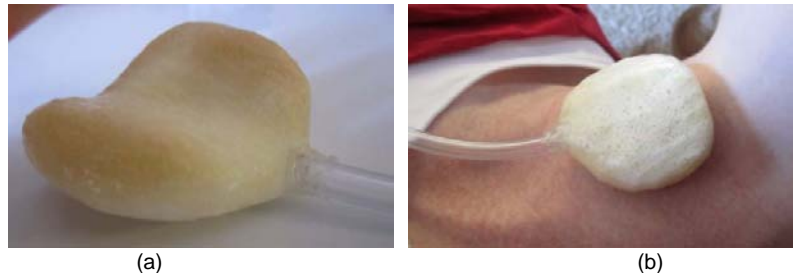


Figure 1: The pneumatic device used to detect patient swallowing. The basic device is shown in (a) with the placement on a volunteer's neck shown in (b).

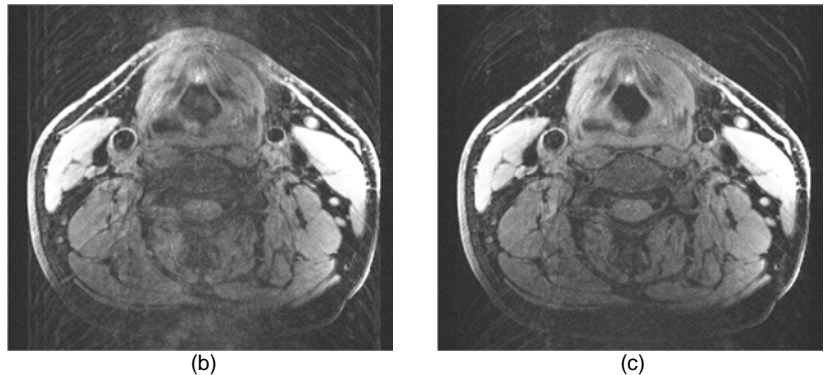
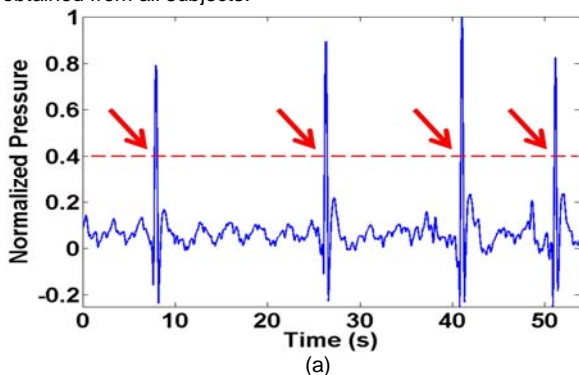


Figure 2: Pressure trace of the swallow detection pneumatic device and resulting images. A threshold pressure (red dashed line) is used to detect swallow events (a). The volunteer had four distinct swallows as indicated by the arrows. Axial 2D TSE data reconstructed using the full two averages of data is shown in (b) and with swallow corrupted data removed in (c).

## Results and Discussion

Figure 2a shows a typical pressure display of the pneumatic device. Breathing is seen to cause small, cyclical fluctuations in the pressure while swallowing causes large, distinct pressure changes. The pressure trace in Fig. 2a was recorded during the acquisition of the image shown in Fig. 2b. The image shows characteristic blurring and ghosting artifacts associated with swallowing motion. The swallow events were then identified (arrows in Fig. 2a) and the corrupt data was removed for the image shown in Fig. 2c. The exclusion of the corrupt data reduces the ghosting and blurring artifacts. While Fig. 2c had corrupt data removed retrospectively, it is a simple task to use the pneumatic device to prospectively detect corrupt data. Anytime the pressure of the device exceeds the threshold pressure, the currently acquired data is reacquired.

## Conclusion

The pneumatic device was able to detect patient swallowing and will be a useful tool in identifying corrupt data which can be removed retrospectively or prospectively reacquired.

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