

High Resolution MRI of the Sellar Structures via Transsphenoidal Placement of a Dedicated Interventional Pituitary Coil: Development and Cadaveric Testing.

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Target audience: Neuroradiologists, neurosurgeons, and MRI physicist involved with intraoperative MRI or with an interest in imaging of the pituitary.

Purpose: To demonstrate the feasibility of transsphenoidal placement of a dedicated surface coil to enable high resolution imaging of the pituitary gland in an interventional MRI suite.

Methods: *Specimens:* Two cadaver heads (one fresh, one fixed with intravascular latex injection) were procured through the Maryland State Anatomy Board. *Pituitary Coil:* A dedicated pituitary surface coil was built to operate at 1.5 T. A double turn, 12 mm diameter surface coil was made of 1 mm diameter copper wire insulated with TEFLO, with 14 cm leads to extend the length of the nasal cavity. For safety reasons (related to tissue heating), the coil was fully encased in plastic to ensure that a 4 mm gap would be maintained between the floor of the sella and the coil when placed in the sphenoid sinus. The angle of the coil could be adjusted to the particular anatomy of the sphenoid bone. To maintain this flexibility and to further insulate the leads, the twisted section of the leads was housed within an 8 mm silicone tube. The coil leads were connected to the interface box containing control circuitry using a cable with 4 braid wave traps to suppress shield currents during body coil RF transmission. Coil position was visualized in images using a fiducial marker (Izi Medical Products, Inc.) affixed to the nasal face of the coil. *Imaging:* Clinical pituitary MRI was obtained in an intraoperative MR suite using an 8 Channel SENSE head coil (Achieva 1.5T, Philips, Andover, MA). Then, a sublabial transsphenoidal approach to the sella was performed to allow for placement of the surface coil through an operative corridor. Imaging was repeated using the Q-body coil and the pituitary surface coil. A balanced fast field echo sequence (BFFE) was used to generate $250\mu\text{m} \times 250\mu\text{m} \times 500\mu\text{m}$ coronal and sagittal images (scan time 6:21) in clinically feasible scan times.

Results: In both cases the coil could be placed within 1 cm of the sellar floor. ROI analysis indicated $\sim 5\text{-}10$ fold increase in SNR when using the pituitary coil compared to the 8-channel head coil. Line profile of SNR from case 2 (Fig. 1) shows that, as expected, the gain

in SNR that strongly depends on distance from the coil. BFFE high-resolution imaging (Fig 2.) shows a number of features not normally visible on clinical imaging including the pituitary capsule, the intercavernous (coronal sinus) and microcalcifications in the pars intermedia.

Discussion: In certain clinical situations, routine pituitary MRI fails. Notably, up to 50% of corticotroph adenomas (clinically manifest as Cushing's disease) cannot be identified¹, presumably due to small size or poor MRI contrast to noise. When adenoma is not identified, exploratory surgery is much less successful in curing the patient, and in many cases, eventually leads to radiation therapy and the risk of panhypopituitarism.² Current invasive methods to detect these adenomas (petrosal sinus sampling) entail some degree of risk and often fail to localize the adenoma. Intraoperative detection of these adenomas should enable directed surgery, which, as with preoperatively detected adenomas, should enjoy a high success rate.¹ This study demonstrates the feasibility of such a device. Other coil configurations are being investigated to optimize the performance and utility of the coil while maintaining an adequate margin of safety for patient studies. In future studies, placement of the surface coil in patients will be needed to determine if the gains in SNR through the transsphenoidal placement of the surface coil will result in the detection of occult microadenomas.

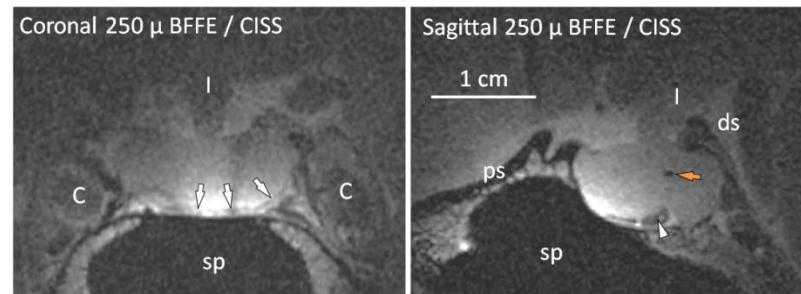


Fig. 2: MRI of sella using transsphenoidal pituitary surface coil in a cadaver. Note the pituitary capsule (white arrows), intercavernous sinus (arrowhead), and microcalcification (orange arrow). ds - dorsum sellae, ps - planum sphenoidale, sp - sphenoid sinus, I - infundibulum, C - carotid.

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Conclusion: Transsphenoidal placement of a surface coil near the floor of the sella provides dramatic improvements in SNR allowing for pituitary imaging at unprecedented resolution.

References: [1] Lonser, et. al., J Clin Endo Met, 98:892-901, 2013. [2] Pouratian, et. al., J Clin Endo Met, 92:3383-8, 2007. [3] Oldfield, et. al., N Engl J Med, 325:897-905, 1991.

