

## Swaddle Coils for a Newborn

A.M. Flynn<sup>1</sup>, J.R. Corea<sup>1</sup>, P.B. Lechene<sup>1</sup>, P.D. Calderon<sup>2</sup>, T. Zhang<sup>3</sup>, G.C. Scott<sup>3</sup>, S.S. Vasanawala<sup>4</sup>, A.C. Arias<sup>1</sup>, and M. Lustig<sup>1</sup>

<sup>1</sup>EECS, Univ. of California, Berkeley, CA, United States, <sup>2</sup>Diamant Engineering, Castro Valley, CA, United States, <sup>3</sup>EECS, Stanford Univ., Palo Alto, CA, United States,

<sup>4</sup>Radiology, Stanford LPCH, Palo Alto, CA, United States

**Target audience:** Pediatric radiologists, hardware engineers.

**Purpose:** We use flexible printed coils here to create a swaddle body array for an infant, in an effort to recoup some of the achievable SNR lost when a receive array does not fit well. A swaddle is a tightly wrapped blanket mimicking the womb's familiar close-quarters. Newborns are often scanned in poorly fitting coils, such as adult head coils or adult cardiac coils, which may sit several inches above the baby's chest. In addition, technologists often prop up coils with cushions to reduce weight on the child, offsetting the array even further from anatomy. In both cases, the resulting images can display poor SNR. Reduced SNR precludes the opportunity to accelerate the acquisition, which would especially benefit this vulnerable patient population, as small children often have to be sedated before an MRI exam. Consequently, we have been exploring printed electronics technologies [1,2] as one approach for making flexible coils [3] and have previously reported imaging results from prototype arrays made via screen printing [4-6]. Here, we present a swaddle system for newborns which not only provides flexibility and tight fit, but naturally restricts motion in a way that is comforting to the child (and his/her parents). Modular and easy to apply, swaddle coils can improve image quality and enhance clinic workflow.

**Methods:** As in [4], the coils are printed onto PET plastic substrates using Creative Materials 118-09A silver ink for the coil loop conductors and 116-20 dielectric ink for the tuning and matching capacitors. A 6 mil thick DuPont Pyralux flex circuit holds the discrete Q-spoiling PIN diode and inductor, and attaches to the printed coil using plastic snaps. Coils pairs are sewn into pouches made from flame-resistant DuPont/Springfield Nomex MHP fabric. Each pouch has a cleanable water-resistant front cover (Babyville polyurethane laminated fabric) along with a backside "stick-able" Velcro Veltex material. Silicone rubber jacketed RG-178 type coaxial cable (Cooner Wire non-magnetic CW2040-3050SR) is used to connect to a gateway adapter. The swaddle itself is cotton flannel or velour and has patches of Velcro hook connectors sewn around its periphery so that pouches can be arranged on the swaddle in a modular way. The coil pouches conform snugly whether the swaddled infant is premature or full term. Figures 1a through 1d illustrate one pouch attached to the chest, much like a bib, and a second pouch attached to the back. Since these swaddle coils were not yet IRB-ready for scanning infants, we imaged an adult wrist in a Siemens 3T Trio scanner using a turbo spin echo sequence: 110/3500 ms TE/TR, 150 mm FOV, 3 mm slice thickness, 0.47x0.47x3 mm<sup>3</sup> resolution, 90° flip angle and 4 averages.



**Figure 1.** Left to right: a) Newborn-sized doll in a swaddle. b) Pouch, with Veltex backing, attached to the front of the swaddle. c) Inside view of the pouch. d) Second pouch and coil pair attached to the doll's back for a 4-channel array. e) Adult human wrist imaged with the coil pair shown in c).

**Results:** Figure 1e displays an example of the quality of the images attainable with a 2-channel coil pouch. In this case, the pouch was taped around the patient's forearm, oriented with one coil towards the fingers and one coil towards the elbow, and produced excellent image quality with adequate SNR, desirable soft-tissue contrast and very high spatial resolution.

**Conclusion:** Although medical devices require careful attention to consensus safety standards, there are a wide variety of high performance textiles available today. While this swaddle coil array design has not undergone official compliance testing, our exploration of the design space gives us confidence that printed electronics can be packaged to meet the needs of pediatric patients while maintaining high degrees of flexibility.

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### References:

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