Customised Rotational Imaging Support for Paediatric MRI (CRISP-MRI)

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Introduction

Traditional X-ray fluoroscopy methods for upper gastro-intestinal (GI) tract imaging in children require postural alteration to help move contrast media to the required locations and for visualisation. Typically, an examination involves supine imaging to visualise the stomach and then turning the child right side down (90° clockwise) to encourage gastric emptying and visualisation of the proximal duodenum, and then finally supine (90° anticlockwise) to image the distal duodenum and duodeno-jejunal flexure. We are establishing an equivalent MRI technique for imaging the paediatric gut as part of an ethically approved study. One of the difficulties in replicating the fluoroscopic environment within MRI is the inability to gently and easily rotate the child within the MRI scanner in order to facilitate gastric emptying. Conventional MR methods usually require sedation or anaesthesia of the child, and the choice of coil has a significant impact on the ability to turn the child. Here, we describe a custom-built coil insert which allows for gentle rotation of a child within a rigid surface coil, to permit appropriate MR fluoroscopic examinations.

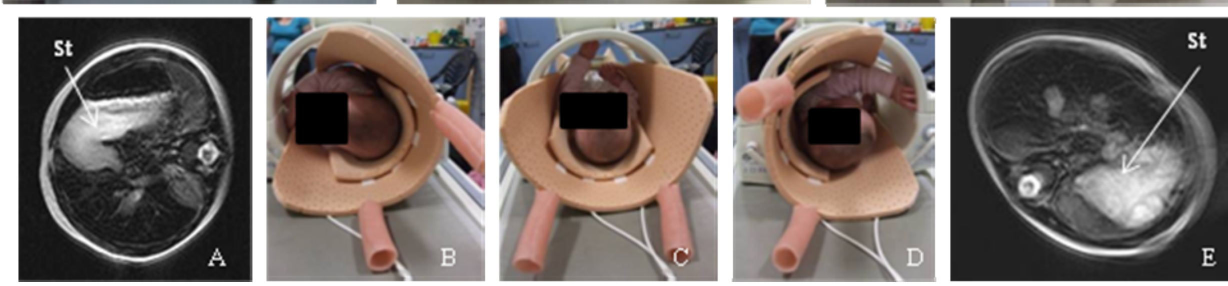
Materials and Methods

The materials to be used in a paediatric support should conform to strict requirements: in addition to it being non-ferromagnetic and easily cleanable, it must have some rigidity to reduce gross movements and gently constrain a child, but also sufficient flexibility to allow for movement. Ideally it would be lightweight and sufficiently "breathable" to allow for normal temperature regulation. Further it would require a suitable mechanism to allow easy rotation with minimal friction in relation to adjacent coil material to allow for rotation but with sufficient resistance to allow a specific position to be maintained. We reviewed the current orthopaedic literature and plaster cast construction materials for guidance. Our hospital custom builds supports for traumatic bone and joint injury, using two specific materials Plastazote® is a thermosetting closed cell cross-linked polyethylene nitrogen-expanded Zotefoam, which is a chemically inert foam which is lightweight, tough, flexible and moisture resistant, can be heat-moulded into any shape, and is used in packaging, educational toys, camping mats and protective sports padding. Large sheets (1 x 1.5 m) are available at 3 - 12 mm thickness to be customised to shape to the joint or limb to be cast. Vitrothene is a high molecular weight and low density polyethylene vitrite polymer which is widely used in the leisure industry in swimming pools and ice rinks. It is also a thermosetting plastic used as a backing to add to plastazote mould to provide structural rigidity for orthopaedic supports.

A single piece of 6mm Plastazote was heat moulded to the shape of the internal diameter of a quadrature headcoil (GEHT, Waukesha, WI), with a 3mm Vitrothene plastic backing for rigidity, to encompass just over 180 degrees of a child's body. Vitrothene handles were added to the ends of the device beyond the imaging field of view of the coil, and alternative handles were cut directly into the Plastazote to aid initial positioning. Velcro straps were added to ensure stability for the child during placement.

Results

The structure allows for rotation of a child within a fixed head coil (see figures). Figure 1 shows the support from above (A), within the head coil with a 4 month old child within the support (B) and with the complete head coil in situ (C). Examples from an upper GI contrast study using MR fluoroscopy are presented: Figure 2 shows the support from the head end with the child in situ demonstrating 90 degree rotation both clockwise (B) and anticlockwise (D) from the central (middle; C) position. Axial T2w images of a patient through the upper abdomen demonstrate the effect of rotation on fluid within the stomach (St), with the patient imaged feet first lying on their right side (A) and left side (E). Full parental consent was obtained for all images displayed.



Conclusion

This work describes and demonstrates the design and implementation of a simple rotational device to enable gently rotating a child in a controlled manner inside a fixed volume coil within the MR bore during an MR examination. This type of device should help facilitate MR fluoroscopy in small children and further evaluation is planned. A range of similar inserts could be developed to accommodate different sized children and different types of RF coil.

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