Seminars in Pediatric Surgery 24 (2015) 212–216

Contents lists available at ScienceDirect

Seminars in Pediatric Surgery

journal homepage: www.elsevier.com/locate/sempedsurg

Conjoined twins: Radiological experience

Sarah G. Watson, FRCR, Kieran McHugh, FRCR, FRCPI, DCH, LMCC*

Department of Radiology, Great Ormond Street Hospital for Children, London, UK

ARTICLE INFO

Keywords:
Conjoined twins
Radiology
MRI
CT
Ultrasound
Nuclear Medicine

ABSTRACT

Imaging plays a key role in the management of conjoined twins. Pre-operative multi-modality studies are vital to assess operability and to aid surgical planning. Technical advances in imaging such as high-resolution isovolumetric magnetic resonance imaging (MRI) techniques and three-dimensional modeling now result in extremely accurate anatomical information. Varied information from a comprehensive radiological work-up enables the surgeons to plan the safest possible operative procedure, helps the anesthetic team before and during surgery, and guides the intensive care team in the post-operative phase. This article will review the radiological techniques used in our institution, highlighting potential pitfalls with the various imaging modalities.

Introduction

Our institution is a tertiary referral pediatric hospital. Twins are therefore delivered at another hospital with obstetric facilities and transferred to us for further evaluation.

Prenatal ultrasound is not discussed in detail in this article, but its role has been described in more detail previously.[1] Suffice to say, antenatal imaging is crucial in diagnosis and prognostication. Fetal echocardiography in particular is vital in assessing future viability. Antenatal and postnatal cardiac imaging will be addressed elsewhere in this issue. We have not found fetal MRI, with the possible exception in pyopagus twins, to contribute useful information that was not available from the ultrasound. If time permits, however, it may be worth pursuing.

The aims of imaging are threefold: firstly to delineate anatomy; secondly to assess the possibility of separation and, finally to counsel parents about prognosis. The imaging that is utilized is dependent on the type of union. Each of the eight types of anatomical union has possible specific associated structural malformations, which are systematically sought.[2]

Emergency separation in the neonatal period is occasionally required. Under these circumstances, there may be time only for baseline radiography, echocardiography, and ultrasonography.

Where elective surgery is being considered, radiological assessment may encompass the full range of techniques available. Ultrasound, MRI, CT, fluoroscopy, angiography, and occasionally nuclear medicine examinations may provide crucial information.

This article will discuss these techniques in the context of the different organ systems and different types of twin connection. Neuroimaging, for those joined at the head, will be discussed elsewhere.

Technical considerations

Neonates may be imaged using a “feed and wrap” technique without the need for anesthesia or sedation, but in our experience, the images obtained are often suboptimal. CT scanning under general anesthesia is ideal, preferably with the babies paralyzed and an option for scans with respiration suspended by the anesthetist(s). These short anesthetics may serve another purpose also in that they inform the anesthetic team how each twin behaves hemodynamically under GA and after contrast administration.

For more complex scans, such as cardiac-gated CT and MRI, for invasive angiographic techniques, and for older infants, general anesthesia is mandatory. However, anesthesia can be high risk in conjoined twins, due to difficulty with access to the airway or abnormal vascular anatomy. In addition, there may be an unpredictable response to anesthetic drugs as a consequence of cross circulation. This is discussed elsewhere in this issue. Careful attention to individual patient identification is crucial, as the twins always have the same surname! We tend to put a cod liver oil capsule on one twin to help identification at the time of cross-sectional imaging.

Plain radiography

A baseline chest and abdominal radiograph is performed as an initial investigation. This may give an idea of the extent of the shared tissues and show unexpected findings such as diaphragmatic hernia, pulmonary consolidation, or intestinal obstruction. Gross bony anatomy is also evident (Figure 1).

* Corresponding author.
E-mail address: Kieran.McHugh@gosh.nhs.uk (K. McHugh).

http://dx.doi.org/10.1053/j.sempedsurg.2015.07.002
1055-8586/

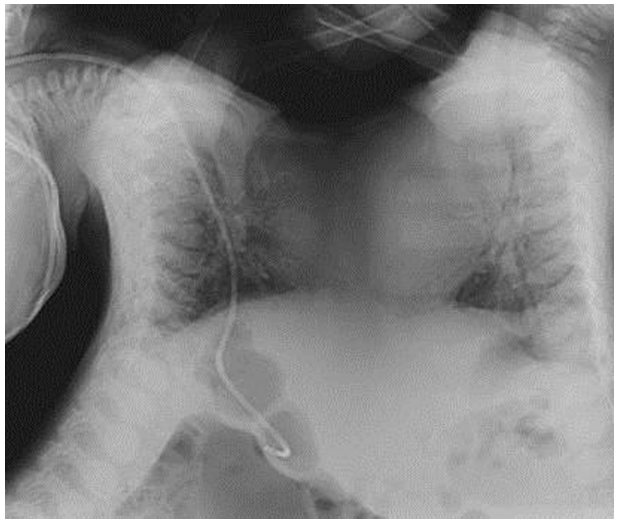

Fig. 1. Plain radiograph of thoracopagus twins demonstrating shared sternum.

Ultrasound

All children undergo baseline echocardiography and abdominal ultrasound scan as soon as possible after arrival at our hospital. Abdominal ultrasound examinations of twins joined at the abdomen can be confusing initially. It may be difficult to work out which twin is being scanned, as either twin's liver can provide an acoustic window into the other twin. Careful scanning, with continuous awareness of which twin is being looked at, can generally solve that dilemma.

Although more detailed information will be gained from subsequent cross-sectional imaging, the ultrasound scan is useful to help define the anatomy and to direct further investigation. It can, of course, be safely performed on the intensive care unit or ward without the need for anesthesia or contrast administration. The baseline ultrasound will demonstrate the number of kidneys and bladders present and assess for complications such as hydronephrosis. The number of spleens, gallbladders, and the liver vascularity may also be assessed.

An attempt is always made to define separate portal and hepatic veins in each twin. This should be routinely documented. The presence of two gallbladders usually indicates separate biliary systems in our experience. In twins joined anteriorly, there may be limited probe access to evaluate the liver and fully visualize shared vessels. In these situations scanning from the sides will prove useful.

All babies undergo a routine cranial ultrasound scan to assess for hydrocephalus, intra-cerebral hemorrhage, or brain malformations. A spinal ultrasound scan is performed where possible (i.e., when babies can safely be turned on their side to allow probe access). This will document spinal cord union in caudally united twins and exclude any unsuspected abnormalities in other types.

Computed tomography (CT)

Multidetector CT (MDCT) allows very rapid scanning, minimizing motion artefact, and provides high-resolution images. CT scanning is the modality of choice for delineating the bony anatomy and three-dimensional reconstructions can be easily performed in varied planes to provide a greater understanding of complex bony anatomy, particularly in those with a conjoined pelvis. In general CT is preferred over MRI, as contrast-enhanced CT provides superior definition of vascular anatomy.

The speed of CT minimizes bowel and other motion artifact and CT has high intrinsic resolution. MRI can, of course, give very useful additional information on spinal cord anatomy and on pelvic organs particularly in girls.

Table
Tips for an optimal pre-operative CT scan.

Two anesthetic teams.
Cod liver oil capsule to identify one specific twin.
Suspended respiration, paralysis.
Careful positioning, everyone aware how each twin is positioned.
If one twin healthier, inject that twin first.
Contrast at 300 mg/ml at 2–4 ml/kg (combined weight). Pump injection.
Arterial and portal venous phase scanning, with delayed urographic CT images at 10 minutes.
Post-process the images, including labeling of each twin.
Consensus double reporting by two radiologists.
Repeat CT for contralateral twin if more information needed, the following day.

Intravenous contrast material for CT and MRI studies is administered with the dose calculated based on the combined weight of the twins. Contrast-enhanced CT is performed with a separate injection of contrast into each twin on different days. For CT studies in twins with a combined weight less than 10 kg, we use a dose of 2 ml/kg of iodine 300 mg/ml. If combined weight is over 20 kg a dose of 2 ml/kg or more may be used although with modern scanners lower doses of iodine could be utilized. We aim to scan early after intravenous contrast injection to acquire arterial phase images initially, with a later delayed portal venous phase also useful, particularly to demonstrate the hepatic veins.

Rather than the concentration of iodine, we believe it is more likely that a slow, but continuous, pump injection gives an optimal contrast bolus. For those twins with pelvic conjunction and concerns over their ureters and bladders, delayed urographic images should be done approximately 10 min after contrast injection.

Without any evidence to support this, when one twin appears healthier or has a more normal heart, we have always opted to inject that twin at the first pre-operative CT. In our experience, this has worked as a sensible and safe approach.

In those twins without large arterial crossing vessels, a separate CT is done on the next suitable day to assess the other twin's major blood vessels. Each twin's vascular anatomy is thus separately assessed by intravenous contrast injection, on different days, to help demonstrate possible shared large vessels passing from one twin to the other and to avoid contrast-induced nephrotoxicity (Table).

Post-processing of the CT images, such as volume rendered images may reveal very useful additional information (Figures 2 and 3). Thoracopagus and omphalopagus twins usually share a liver. Injection of contrast into one twin will result in enhancement of the liver segments supplied by that twin's hepatic artery and portal vein and help the surgeon plan separation planes.

Most thoracopagus twins have shared cardiac structures and complex cardiac defects. Electrocardiographic-gated cardiac CT is standard for demonstrating cardiac anatomy, although complex shared cardiac anatomy precludes successful separation.[3]

MRI

With advances in technology, such as volumetric scanning techniques and ultra-fast sequences, MRI is emerging as a modality to rival the excellent detail provided by CT scanning of twins. There are several potential advantages over CT scanning—it does not use ionizing radiation, and soft tissue resolution is superior. Gadolinium-enhanced MR angiography may be equally useful in assessing shared vascular anatomy.

Cardiac MRI can be used in addition to CT to provide functional assessment as well as exquisite anatomical detail.