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MINISYMPOSIUM: SPECIALIST PEDIATRIC RADIOLOGY— DOES IT ADD VALUE?

Pediatric interventional radiology — does it add value?

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Abstract
Although attempts have been made to show that pediatric interventional radiology adds value in children's hospitals, none has been particularly persuasive. An analysis of individual procedures would seem to be the most scientific approach, but there are numerous problems, including the effects that different health care systems have on clinical practice and the difficulty of generalizing the results of a single-center study to other hospitals, even within the same type of health care system. It is unsurprising that there are no published randomized controlled trials comparing both the costs and outcomes of specific pediatric interventional radiology procedures with surgical alternatives, and in fact these may not be feasible. There is only anecdotal evidence of the value of pediatric interventional radiology in multidisciplinary teams in children's hospitals. Currently, the best justification may be the counterfactual: demonstrating what can go wrong if pediatric interventional radiology expertise is not available.

Keywords Children · Diagnostic value · Interventional radiology · Review · Therapeutic value

Introduction

What is pediatric interventional radiology?

The term interventional radiology was first used just over 50 years ago [1], so it is a comparatively young specialty. Pediatric interventional radiology really only became a standard part of medical care in children's hospitals in the 1980s [2, 3], but by 2018 the Society for Pediatric Interventional Radiology had grown to 276 members [4]. Pediatric interventional radiologists perform various diagnostic and therapeutic procedures using image guidance, many of which were previously carried out by surgeons or other specialists. Although the specialty has grown spectacularly in recent years, the value of these changes in pediatric practice has not yet been systematically evaluated.

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What is value?

Value is a simple term, but its meaning in the context of health care is notoriously difficult to pin down [5]. Clearly, families will prioritize a better patient experience and reduced morbidity and mortality, whereas governments or insurers may be forced to take a broader view. Even if you accept that the dollar (or euro, or pound) is the appropriate unit of value in health care, it is not always obvious which costs should be included in the financial analysis [5]. When comparing the costs of a pediatric interventional radiology procedure with a surgical operation, for example, should the indirect costs (such as parental time off work or child care expenses for the patient's siblings) be taken into account? These problems have been well summarized by Roudsari et al. [5], who have examined different approaches to analyzing the value of interventional radiology in adults and children.

Does pediatric interventional radiology add value?

It is easy, and apparently reasonable, to assume that pediatric interventional radiology adds value, but it is much more difficult to prove it. Other authors have attempted to demonstrate the value of interventional radiology in adult practice using

various methods ranging from sending questionnaires to colleagues [6] to detailed cost analyses of specific procedures [7]. There has been much less research into the value of pediatric interventional radiology [8].

On the face of it, analyzing individual procedures would seem to be the most scientific approach, but there are problems with this, including the effects that different health care systems have on clinical practice and the difficulty of generalizing the results of a single-center study to other hospitals, even within the same type of health care system [5].

Procedure-level evaluation of pediatric interventional radiology

The problems of procedure-level evaluation are exemplified in a paper in which the authors compared the costs and complications of central venous port devices inserted by surgeons and pediatric interventional radiologists [8]. In a detailed analysis, Hancock-Howard et al. [8] found that the costs (direct and indirect) and the complication rate were both lower when procedures were performed by interventional radiologists. This was, however, a retrospective (and therefore non-randomized) study, and it is impossible to be sure that the patient groups were similar. Indeed, more of the children in the surgical group had been diagnosed with acute lymphoblastic leukemia. Although this difference was not statistically significant, it could well have caused an increase in mean operative time because children with acute lymphoblastic leukemia often undergo other procedures under the same general anesthetic as port insertion, such as bone marrow aspirates and lumbar punctures, and conceivably also the increased complication rate. Retrospective studies are often regarded as a valid but lesser level of evidence than randomized controlled trials, but it might be better to use them only as hypothesis-generating exercises. One retrospective comparison of image-guided pediatric gastrostomy (performed by interventional radiologists) and endoscopic gastrostomy (performed by surgeons) suggested that complications were more common in interventional radiology patients [9]. When the same center performed a randomized controlled trial it was unable to show any difference [10]. In retrospect, it was clear that the patient groups in the non-randomized study were systematically dissimilar.

The problem with randomized controlled trials is, of course, that they are difficult. One important reason for this in pediatric interventional radiology is that they are ethically problematic. For example, it has never been shown that renal biopsy with real-time ultrasound guidance is superior to using ultrasound to mark the skin and then performing blind biopsy. A randomized controlled trial would be impossible now, partly because the latter technique is almost extinct [11], but also because it would be unethical, given that there is no realistic chance that blind biopsy is better.

Finally, even if pediatric interventional radiology techniques can be shown to be superior to open surgery, many surgeons have quite correctly responded by changing their practice and now perform image-guided procedures themselves [12]. This is good for patients, but does not demonstrate to hospital managers that there is any added value in funding a pediatric interventional radiology service.

Team-level evaluation of pediatric interventional radiology

Given the problems with procedure-level evaluation of value, it might be better to take a different approach. Does including an interventional radiologist in a multidisciplinary team improve outcomes for children treated in pediatric centers?

A good place to start to answer this question is pediatric oncology, which has been at the forefront of multidisciplinary teamwork for several decades. As recently as 2004, American Academy of Pediatrics guidelines first suggested that the multidisciplinary oncology team should contain diagnostic pediatric radiologists, as well as various surgical specialists, dentists and gynecologists, but made no mention of interventional radiologists [13]. It is now the standard of care that the team includes a diagnostic radiologist, even in resource-challenged settings [14].

In many pediatric centers in 2020, of course, pediatric interventional radiologists perform more procedures on children with cancer than all the surgical specialties put together. We suggest that an interventional radiologist is an indispensable part of any pediatric oncology service. Although we have no proof that survival or other key measures of patient outcome are better in oncology teams with interventional radiologists than those without, there are clinical scenarios where access to interventional radiologist opinions and technical expertise may be required for safe patient management (Figs. 1 and 2).

Elsewhere in pediatric practice, there is only anecdotal evidence concerning teams including interventional radiologists. Kocyildirim et al. [15] reported improved patient outcomes for children with congenital tracheal stenosis following the establishment of a multidisciplinary airway team in a pediatric referral center. This was achieved while also reducing the financial costs per patient by about two-thirds [15]. Unfortunately, in addition to the other problems of retrospective reviews, the effects of teamwork may have been confounded by a simultaneous change in the main method of surgical repair used for these patients.

Ultimately, however, this type of study may be the best evidence we will get for the value of interventional radiology

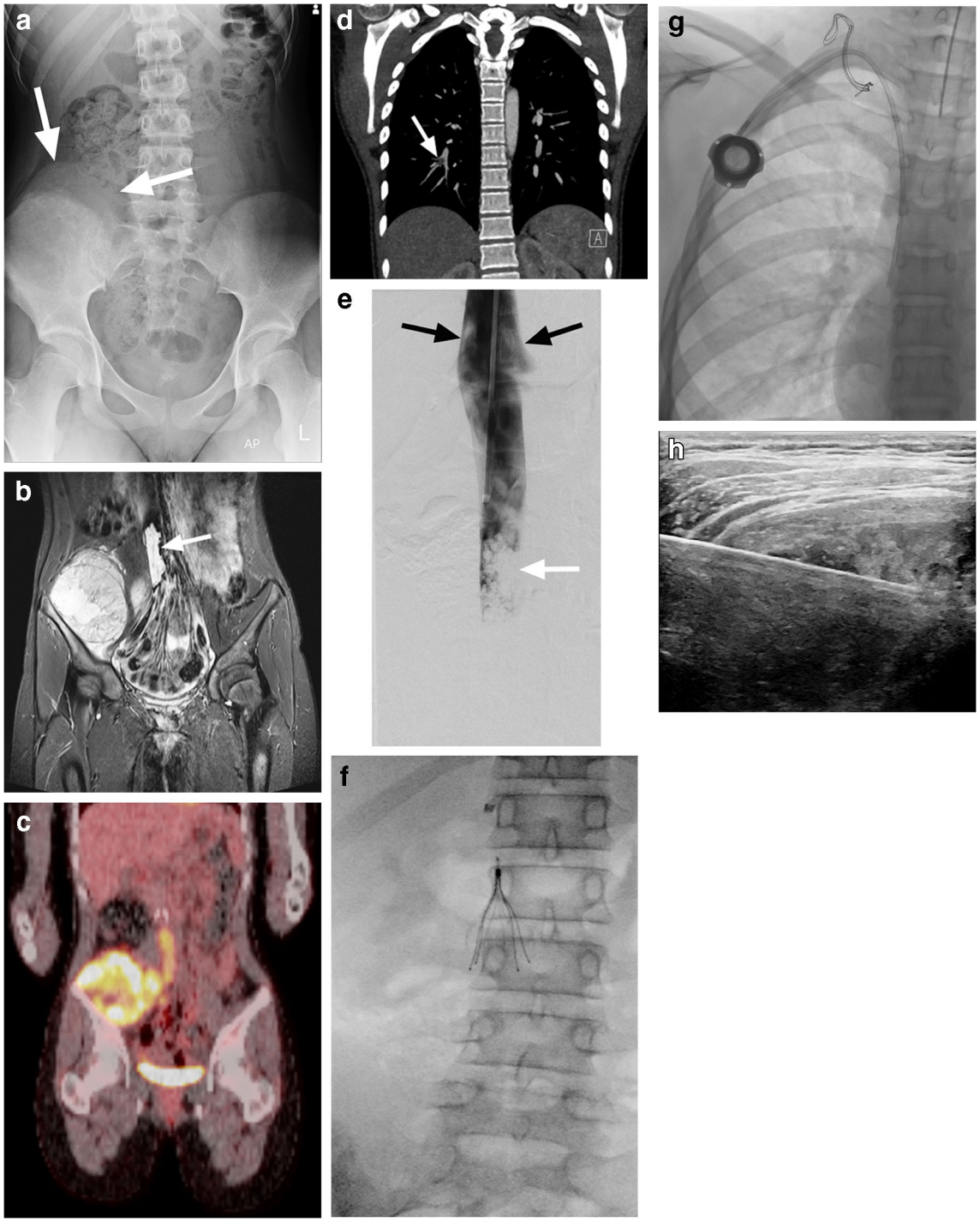

Fig. 1 A 12-year-old girl with osteosarcoma. **a** A radiograph shows a large soft-tissue mass (*arrows*) with permeative destruction of the right iliac crest. **b** A fat-suppressed T2-weighted coronal MRI shows an intravascular tumor extending into the inferior vena cava (IVC, *arrow*). **c** A coronal ^{18}F-fluorodeoxyglucose (FDG) PET-CT image shows FDG avidity in the primary and intravascular components of the tumor. **d** Small pulmonary emboli were present on staging CT (*arrow*). **e** The decision was made to place an IVC filter to prevent further tumor embolism. Inferior caval venography performed through a sheath inserted via the right internal jugular vein confirms the intravascular tumor (*white arrow*). The orifices of the renal veins are shown by jets of non-opacified blood (*black arrows*). **f** An IVC filter (Celect Platinum Vena Cava Filter; Cook Medical, Bloomington, IN) has been deployed with its lower end above the tumor and its upper end below the level of the renal veins. **g** The right internal jugular venous access was then used to insert a venous port device. **h** Finally, the primary tumor was biopsied percutaneously under ultrasound guidance

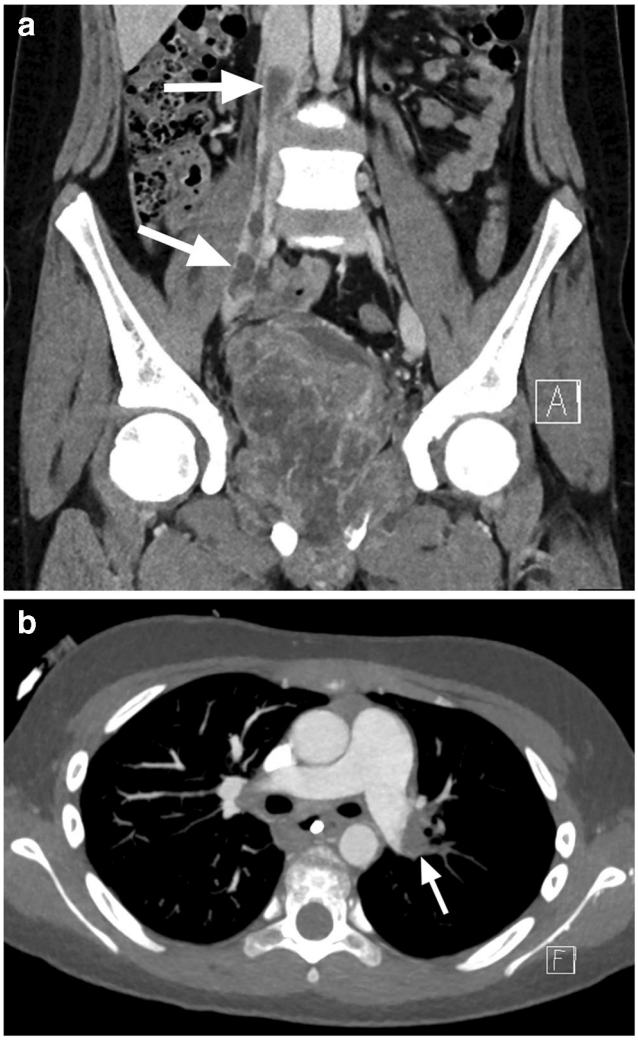

Fig. 2 A 13-year-old boy with undifferentiated sarcoma. **a** Contrast-enhanced CT shows a large pelvic tumor with an intravascular tumor extending into the inferior vena cava (IVC, *arrows*). No IVC filter was placed at diagnosis. **b** Twelve days later, the patient developed chest pain and dyspnea, with circulatory collapse. CT shows a tumor embolus occluding the bifurcation of the left pulmonary artery (*arrow*). This was removed at emergency pulmonary embolectomy

in pediatric teamwork because randomized controlled trials will rarely be feasible.

Conclusion

The evidence for improved patient survival following the establishment of a pediatric interventional radiology service is very poor. There is, however, an opportunity for significant cost savings by the wider adoption of minimally invasive interventional radiology techniques. Overall, it seems highly likely that children's hospitals benefit from strong pediatric interventional radiology services. Globally, the distribution of pediatric interventional radiologists is very patchy, and steps should be taken to improve this so that more children can benefit from minimally invasive procedures.

Compliance with ethical standards

Conflicts of interest None

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