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Opportunities and Challenges in Paediatric Interventional Neuroradiology

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Introduction

Paediatric interventional neuroradiology is a relatively new field of diagnostic and therapeutic care in the paediatric population that has made significant advances in recent decades. However, it continues to lag behind adult interventional neuroradiology for a variety of reasons, including a lack of evidence validating pediatric-specific procedures, a lack of pediatric-specific equipment, and difficulties in establishing and maintaining PINR competencies in a relatively small number of cases. Despite these obstacles, the number and variety of PINR procedures are increasing for a variety of indications, including unique paediatric conditions, and are associated with reduced morbidity and psychological stigma. Continued technological advancements, such as improved catheter and microwire designs and novel embolic agents, are also contributing to the field's growth [1].

Description

Despite this, the use of PINR procedures is increasing in a variety of pathological conditions. Many of the indications are found in the adult population, as well as conditions that are unique to the paediatric population and occur either alone or as part of a larger syndrome. Early treatment of certain congenital pathologies, such as low- and high-flow vascular malformations, can halt their progression, alleviate symptoms, and reduce the psychological burden associated with them. By definition, PINR procedures are minimally invasive, reducing patient burden and minimising intra- and post-procedural morbidity. Continuous technological advancement, such as catheter and microwire designs, the evolution of novel embolic agents, and improved angiographic imaging solutions, leads to the transformation of traditional surgical therapies into less invasive PINR solutions [2].

The current evidence base for minimally invasive neurological interventions in children will be covered in this review, reflecting the rapid growth and increasing demand for PINR procedures. Important issues such as sedation, contrast agent use, and radiation protection will also be addressed, taking into account the unique characteristics of the paediatric population. The goal is to raise awareness of PINR and familiarise readers with its utility and benefits [3]. The risk of radiation exposure should always be balanced by the benefits and risks of a given radiological procedure, and every effort should be made to reduce the radiation dose as much as possible. Additional precautions should be taken, such as reducing fluoroscopy time, using collimation, slowing down the frame rate, retaining the last image, and using digital zoom whenever possible. Any unnecessary radiation of the paediatric eye or gonads should be avoided. Because PINR is a collaborative effort, all participants should be aware of their role in continuous monitoring of fluoroscopy time, radiation dose, image optimisation, and alerting.

Adults generally tolerate interventional procedures because they understand their purpose. In the paediatric population, performing PINR procedures presents unique sedation and anxiolysis challenges. Sedation levels may be higher in this population to reduce motion, increase pain tolerance, and allow for stable positioning during the intervention. Deep sedation or general anaesthesia also causes post-procedure amnesia in children. Drugs should be dosed per kilogramme in paediatrics, taking into account the differences in pharmacokinetics and pharmacodynamics that exist between children and adults. Concerns have been raised about the use of anaesthesia in infants and children, particularly following the Drug Administration's warning that using general anaesthetics and sedation drugs repeatedly or during lengthy procedures may harm brain development in children.

Because of the fluoroscopic guidance and large number of radiographic images, interventional fluoroscopy procedures, particularly longer and more complex neurointerventional procedures, necessitate extensive irradiation. Radiation exposure is a legitimate concern because it has the potential for both stochastic and deterministic effects. Children require extra care because they are more sensitive to radiation and have longer lives to express changes. According to one study, the lifetime risk of brain tumour diagnosis in paediatric patients is increased by 3-40% over the normal background rates, depending on the dose received, age at exposure and gender [4,5].

Conclusion

PINR is a rapidly growing field that is based on technological advances in minimally invasive interventional radiology. Despite the fact that the field is still in its early stages, practising interventional radiologists face numerous challenges. However, as more evidence validates pediatric-specific procedures emerges and endovascular technology advances, the PINR is likely to become the gold standard in the multidisciplinary management of paediatric neurologic conditions. Conscious efforts must be made to educate clinicians and the general public about the tremendous benefits that PINR provides to their patients.

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