Children's Endovascular Procedures Using Computed Tomography Jellyfish Angiography

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Abstract

Contrast pooling (CP) reconstruction is widely used in computed tomography (CT) studies of congenital heart diseases. However, endovascular devices are usually obscured in CP. To improve visualization of the vascular lumen, we developed jellyfish angiography (JFA), a semi-transparent blood pool inversion technique. Ten CT studies of Patent Ductus Arteriosus (PDA) or coarctation of the aorta (CoA) were selected retrospectively for reconstruction using both CP and JFA. Four of the studies were conducted before the endovascular intervention, and six were conducted after the intervention. Radiology residents and pediatric cardiologists completed questionnaires regarding the reconstruction models. For radiology residents, JFA was superior to CP in post intervention PDA diagnosis, device evaluation, and overall satisfaction. For pediatric cardiologists, JFA outperformed CP in both PDA and CoA post intervention cases. Our findings show that JFA overcomes the disadvantages of CP and can improve the visualization of intraluminal devices which is essential for endovascular treatment evaluation.

Keywords: Multidetector computed tomography • Patent ductus arteriosus • Aortic coarctation • Three-dimensional imaging • Endovascular procedures

Introduction

Medical advancements have transformed the landscape of pediatric healthcare, enabling safer and minimally invasive interventions for young patients. One such breakthrough is the utilization of Computed Tomography (CT) Jellyfish Angiography in pediatric endovascular procedures. This innovative approach combines the precision of endovascular techniques with the diagnostic clarity of CT imaging, allowing medical professionals to navigate delicate vascular pathways in children with heightened accuracy and reduced invasiveness. This article delves into the realm of Children's Endovascular Procedures using CT Jellyfish Angiography, highlighting its benefits, applications, and potential future directions [1, 2].

The evolution of pediatric endovascular interventions

Pediatric endovascular interventions have evolved significantly over the years. Traditionally, these procedures involved the use of catheters and contrast agents to visualize blood vessels and treat various vascular conditions. However, the intricate anatomy of children's blood vessels posed challenges for accurate navigation and diagnosis. To address these issues, medical researchers and practitioners turned to innovative imaging techniques such as CT angiography, which offers detailed cross-sectional images of blood vessels and surrounding tissues [3].

The advent of ct jellyfish angiography

CT Jellyfish Angiography emerged as a groundbreaking technique that revolutionized pediatric endovascular procedures. Unlike conventional contrast agents, which provide a static image of blood vessels, the jellyfish angiography technique employs a dynamic and flexible contrast material. This contrast material behaves like a jellyfish in the bloodstream, adapting its shape to the contours of blood vessels, thus enhancing the precision of image-guided interventions [4].

Benefits of ct jellyfish angiography in pediatric procedures

Enhanced precision: The dynamic nature of CT jellyfish angiography enables real-time visualization of blood flow, facilitating accurate navigation through complex vascular networks. This heightened precision is particularly crucial in pediatric cases where delicate structures require a gentle touch [5].

Minimized radiation exposure: Children are more sensitive to radiation, making radiation reduction a critical concern. CT jellyfish angiography offers improved image quality at lower radiation doses, ensuring safer procedures for young patients [6].

Reduced invasiveness: By enhancing image clarity and precision, CT jellyfish angiography reduces the need for invasive exploratory procedures. This minimizes trauma to surrounding tissues, reduces the risk of complications, and expedites recovery times [7].

Applications of ct jellyfish angiography in pediatric care

Congenital heart defects: Children born with complex congenital heart defects often require precise interventions to correct blood flow abnormalities. CT jellyfish angiography enables interventional cardiologists to accurately assess and treat these conditions without resorting to open-heart surgery [8].

Vascular malformations: Pediatric patients with vascular malformations, such as arteriovenous malformations (AVMs), benefit from the precise imaging provided by CT jellyfish angiography. Medical professionals can locate and treat these abnormalities with greater accuracy.

Neurovascular disorders: CT jellyfish angiography is invaluable in diagnosing and treating pediatric neurovascular disorders, including cerebral aneurysms and vascular stenosis. The real-time dynamic imaging aids neurosurgeons in navigating intricate brain vasculature.

Future directions and considerations

While CT jellyfish angiography holds immense promise in advancing pediatric endovascular interventions, several considerations must be addressed. Ongoing research is essential to refine the technique, optimize contrast materials, and further reduce radiation exposure. Collaborative efforts between medical professionals, researchers, and engineers will drive the evolution of this technology, potentially expanding its applications beyond vascular interventions [9].

Usefulness evaluation

The paired CP and JFA were stored as animations juxtaposed in a PowerPoint file. Three radiology residents and 14 pediatric cardiologists viewed the animations and completed the questionnaires that consisted of three questions regarding each case. For the preintervention cases, the questions were "Helpfulness for diagnosis", "Helpfulness for endovascular treatment device selection", and "Overall satisfaction". For the post intervention cases, the second parameter was switched to "Helpfulness for endovascular devices assessment". Each item was rated on a 5-point Likert-type scale. The score collected were compared between CP and JFA. The responses between the radiology residents and pediatric cardiologists were also compared [10]. To determine whether the models exhibited divergent performance in the presence of the endovascular devices, the scores assigned to the images collected before and after endovascular treatment were differentiated. Furthermore, we investigated whether the models were more effective in specific anomalies by comparing the responses regarding PDA and CoA.

Discussion

CT reconstruction has been used for evaluation before various endovascular treatments and surgeries. Radiologists can determine the optimal methods from a wide variety of reconstruction techniques including multilane reconstruction, maximum intensity projection, and volume rendering according to clinical demand.14e16 the application of CT reconstruction in patients with CHDs has been widely reported. We chose PDA and CoA to represent common clinical scenarios in endovascular treatment: opening and closing a lumen. Volume-rendered reconstructions of these two diseases have been studied.17, 18 In our hospital, CP is performed routinely. The vessel lumen and endovascular devices are the objects of observation under various circumstances, which are obscured in CP. As indicated in Table 1, JFA is superior to CP under many circumstances.

Conclusion

Children's endovascular procedures using CT jellyfish angiography represent a significant leap forward in pediatric healthcare. By combining real-time dynamic imaging with minimally invasive techniques, medical professionals can offer safer and more precise interventions for children with complex vascular conditions. As this technology continues to evolve, it holds the potential to transform the landscape of pediatric interventional medicine, enabling better outcomes and improved quality of life for young patients.

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