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Cover Story:

The Future is Digital

Children in the Spotlight: When Every Second Counts

The University Hospital of the Free University of Brussels (UZ Brussel) in Belgium is pioneering the use of real-time deep learning-based image reconstruction (DLIR) on CT scan, exploring the benefits it offers for rapid pediatric evaluation, including lower dose and enhanced efficiency.

In healthcare, it is acknowledged that the sooner a patient receives the right diagnosis and the right care in the right place with the right resources, the better the chance of a positive outcome. Time is of the essence. Every second counts, and reacting in a timely manner can make all the difference, especially when the patient is as vulnerable and delicate as a newborn baby. It's all about caring for tomorrow, today.

In Belgium, doctors were working against the clock when a critically ill 18-day-old baby was admitted to the UZ Brussel emergency ward, having already collapsed twice. A correct diagnosis was needed immediately, and the medical team reacted swiftly after a positive thransthoracic ultrasound exam, by performing a CT scan. Using a system incorporating a DLIR application, they were able to obtain high quality images with a reduced radiation dose.

This combination of rapid action and advanced technology was the key to saving the newborn's life. In a few minutes, the high quality images enabled the medical staff to identify a rare congenital cardiac condition and arrange transfer to a specialist facility. UZ Brussel's rapid diagnosis and decision-making were acclaimed by the receiving hospital, highlighting the importance of having access to such high quality imaging, allowing the team to find an answer in record time.

Dr. Koenraad Nieboer, a specialist in emergency radiology at UZ Brussel, led the team behind the newborn's case. He said: "We were able to perform a very, very low dose CT scan and generate excellent quality 3D images with realistic texture to diagnose an extremely rare cardiac condition. The images were straightforward to interpret, giving us confidence in our diagnosis, and the child was transferred to a specialist cardiac hospital for surgery."

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After the CT scan, the patient's cardiovascular system was reformatted, creating nearly noiseless 3D volume rendered images in a time-efficient manner. This data was sent to the specialist cardiac surgeons prior to the child's admission to their hospital, allowing them to visualise the pathology, plan their approach to surgery and prepare in advance. Dr. Koenraad Nieboer added: "The technology allowed us to diagnose the condition accurately and with the minimum of tests, using procedures that asked less of the patient. The surgeons really appreciated the quality of the images we generated; they had never received such good 3D images of a baby before. Consequently, they were able to do what they do best, care for their patient."

Achieving a balance between efficiency and lower dose

A couple of decades ago, the emphasis for radiology exams was purely on image quality, with little concern about the radiation dose. With the realization that the dose levels used with filtered back-projection (FBP) were very high, the focus switched to developing alternative iterative reconstruction methods. The difficulty was that noise increased as the dose was reduced. A balance had to be struck, using the lowest radiation dose possible without compromising image quality.

Attention turned to model-based iterative reconstruction, where parameters are manually designed and optimized by human experts, which proved an effective means of reducing both the dose and noise while continuing to generate good quality images. However, the process takes around 30 minutes and image texture can be compromised. Several generations of iterative reconstruction later, users began to request a faster solution that delivered a more natural looking texture. By then, artificial intelligence (AI) had come to the fore, enabling the development of an algorithm – TrueFidelity™ – capable of generating the same image quality as FBP at a low dose, with minimal noise and in real time. This DLIR technique contributes to increase the speed and efficiency of imaging, producing intelligent image noise reduction and restoring the preferred noise texture. This leads to improved objective and subjective image quality compared to FBP and iterative reconstruction.

Dr. Koenraad Nieboer said: "We are in an era of deep learning, where artificial intelligence has made it possible to train an engine to recognise and adjust for noise, and to produce the same high quality images as FBP, but at a much lower dose and in real time."

The need to lower the radiation dose without compromising on image quality and, at the same time, improve efficiency, has been an ongoing challenge for radiologists everywhere. DLIR is the future, allowing the dose to be further reduced compared to previous techniques, and enabling high quality, real-time imaging to help increase the speed of patient assessment and streamline the treatment pathway. ■