Advancing Pediatric Imaging with 16-Slice CT

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Introduction

Pediatric imaging presents many unique and difficult challenges to the radiologist. Correct and rapid diagnosis is extremely important in pediatric imaging and to that end we constantly strive for tests that offer more information, accuracy and versatility. However, it is also our duty to provide tests that are safe and minimise exposure to ionizing radiation.

In recent months there has been significant interest and concern regarding the radiation exposure to children from medical tests. CT is a significant contributor to pediatric radiation exposure and much attention has been focused on dose reduction in pediatric CT. Fortunately, the new generation of 16-slice scanners led by the Toshiba Aquilion™ is able to deliver on the promise of rapid, accurate diagnosis while minimising radiation exposure.

The Toshiba Aquilion 16-slice scanner with its capability for true isotropic 0.5 mm resolution is changing the way we think about and perform pediatric CT. It is faster, safer and uses less radiation than single-slice and four-slice scanners.

The benefits affect all areas of pediatric CT, and new applications are present in vascular, neuro, orthopedic and body imaging.

Radiation dose and safety benefits

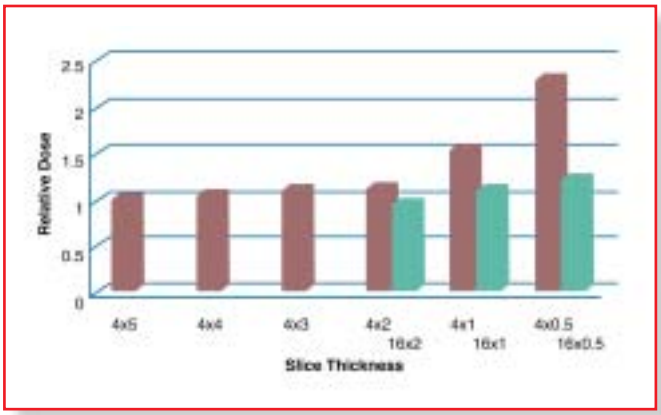
An important consideration in pediatric CT is minimisation of radiation dose. Dose reduction with 16-slice technology is accomplished in multiple ways:

- An efficient detector design permits the use of lower technique. Very low mAs scans can be performed without sacrificing diagnostic accuracy (Table 1).
- 16-slice scanning results in the reduction of radiation buildup from slice penumbra by using greater table increments per rotation (Table 2).
- Elimination of the need to scan in multiple planes. One high-resolution isotropic acquisition provides images in any plane or 3D volume. This is very beneficial for applications such as sinuses, IACs, facial bones, and extremities.
- The availability of high-resolution data permits the equivalent of multiple exams in one acquisition: e.g. scan the neck, chest, abdomen, pelvis in a trauma patient and also reconstruct the spine; or scan the chest and obtain both conventional and high-resolution CT images at the same time.
- Dose modulation per slice using Real Exposure Control. This feature automatically adjusts the radiation administered (mAs) to the thickness of the body part being scanned based on attenuation measurements obtained from the scout view. This reduces ra-

Patient Weight (kg)	Chest (mAs)	Abdomen (mAs)
< 15	15	20
15 – 24	20	30
25 – 34	30	50
35 – 44	50	80
45 – 54	65	100
> 55	90	140

Table 1: Recommended pediatric protocols. Aquilion 16-slice, 100-120 KV, 0.5-second rotation.

Table 2: As compared to 4-slice CT, 16-slice permits isotropic imaging at even small fields of view without significant increase in radiation dose.



diation exposure to lesser attenuating body regions such as the thorax.

- Faster imaging results in fewer poor-quality scans related to motion. Consequently, there is less need to repeat exams.

Safety is also improved by significantly reducing the need to sedate patients. Shorter exams are better tolerated by children. Also accurate timing of contrast bolus using SureStart™ and acquisition coverage rates up to 90 mm/sec minimises contrast usage.

Clinical benefits

The advantages of 16-slice technology improve all areas of pediatric CT imaging. Below are a few examples of how this technology is changing the practice of CT.

Vascular imaging

Non-invasive CT angiography can diagnose vascular abnormalities in the brain, chest, heart and abdomen and in many cases eliminate the need for invasive catheter angiography. CT can easily demonstrate congenital vascular anomalies in any part of the body as well as aneurysms, AVMs and traumatic abnormalities without the need for additional studies. Spatial resolution is superior to MRA and allows for detection of small vessels. Rapid temporal resolution minimises motion artifacts.

Orthopedic imaging

A single isotropic axial data set acquired at 0.5 mm will yield 3-dimensional data that can be reconstructed in any plane or viewed as a volume. This improves diagnostic accuracy and can greatly aide surgical planning. Skeletal anomalies can be beautifully displayed in 3 dimensions.

Trauma imaging

Fast, high-quality diagnostic images of the head, neck, chest, abdomen and pelvis can be obtained in seconds. High-quality reconstructions of the spine or pelvis can be obtained from the original data set. Additional scanning is not necessary. Rapid scanning and diagnosis in critical cases allows a patient to go from the emergency room to the CT suite to the operating room in a matter of minutes, saving critical time. CT angiography can eliminate the need for catheter angiography in chest, brain, abdominal or limb trauma.

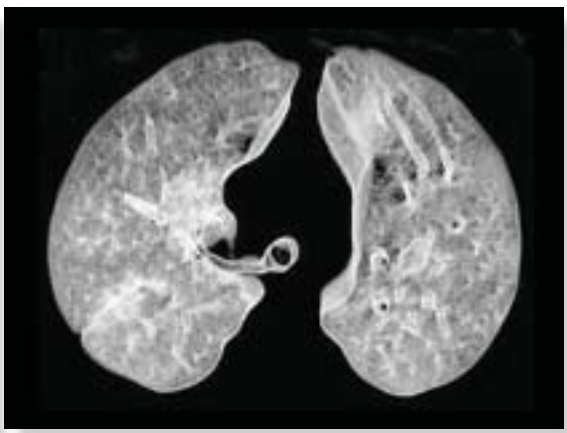
Body and neuro imaging

Faster scanning produces images of higher quality with less motion artifact. High-resolution data sets generate multiplanar reformats of superior quality to improve diagnosis. Many exams can be done in infants and young children without sedation. Multiplanar reconstruction of data sets eliminates the need to scan in more than one plane and can greatly improve diagnosis.

Case 1

History: 2-year-old boy with recurrent episodes of right upper lobe pneumonia. Diagnosis: Aberrant tracheal bronchus (Pig Bronchus) to the right upper lobe causing recurrent pneumonia. Clinical Significance: This child had an earlier CT scan on a single detector scanner and the diagnosis was missed. The ability to perform superior multiplanar and 3D reconstructions in this case greatly aided diagnosis. Once the diagnosis was made, a surgical consult was ordered to discuss surgical options with the family.

Coronal 3D transparent airway view of the lungs and bronchial tree demonstrates an aberrant bronchus to the right upper lobe arising from the trachea.

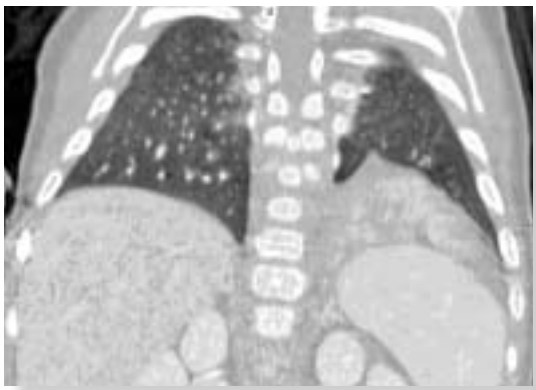


Axial 3D transparent airway view shows the abnormal bronchus arising posteriorly from the trachea, as well as the pneumonia in the right upper lobe.

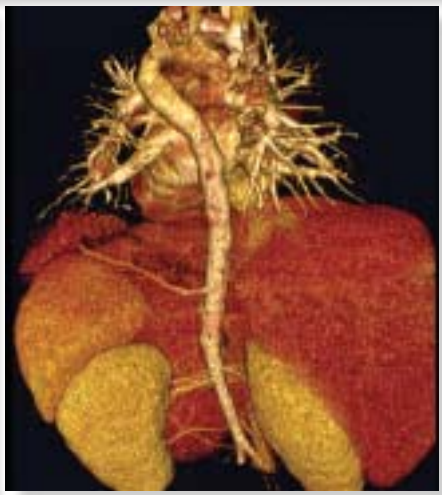
Case 2

History: 7-month-old boy with a persistent left lower lobe consolidation on CXR. Diagnosis: Extralobar sequestration of the left lower lobe. Clinical Significance: CT angiography was able to make a definitive diagnosis in this case. The aberrant vessel is clearly demonstrated by CT eliminating the need for a catheter angiogram.

Coronal and axial MPR images demonstrate an airless consolidation at the left base.



Coronal MIP image demonstrates an abnormal artery arising from the aorta and supplying the mass.

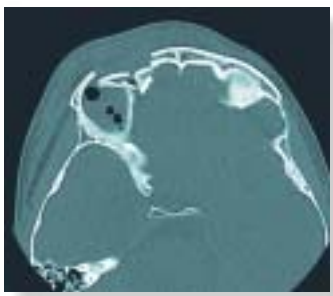


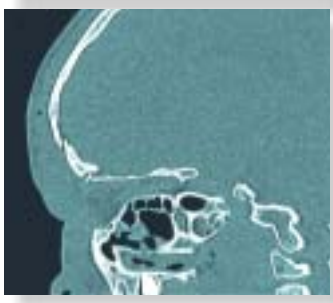
3D volume image (posterior view) again demonstrates the abnormal artery.

Case 3

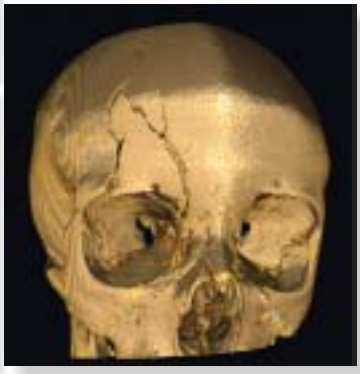
History: 9-year-old injured after a fall from his scooter. Diagnosis: Depressed fracture of the orbit and frontal bone. Clinical Significance: The 3D surface-rendered images were extremely useful to the neurosurgeon and ophthalmologist for planning the surgical repair of this fracture.

Axial and sagittal MPR images demonstrate a comminuted fracture involving the orbit and frontal bone with orbital emphysema.





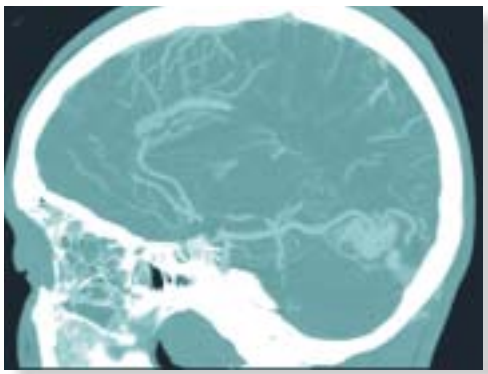
Surface-rendered image demonstrates the relationship of the fracture to the orbit and frontal bone.

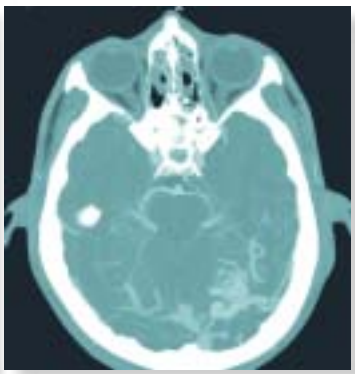


Additional surface image demonstrating the depression of the superior orbital rim.

Case 4

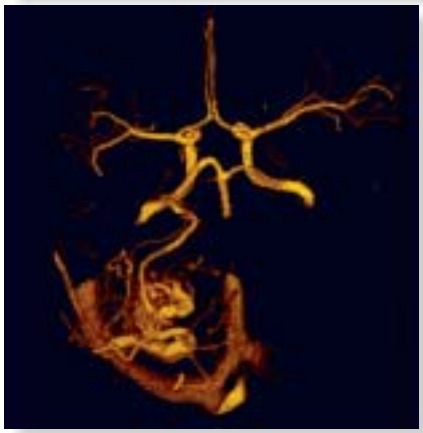
History: 17-year-old boy with headaches and a subtle abnormality in the left occipital lobe on noncontrast CT. Diagnosis: Occipital arteriovenous malformation. Clinical Significance: CT angiography was very important in this case both for diagnosis and treatment planning. CT was able to precisely delineate the arterial and venous anatomy without the need for a diagnostic angiogram. This allowed the neurosurgeons and interventional neuroradiologists to form a definitive treatment plan without having to perform an invasive study first.

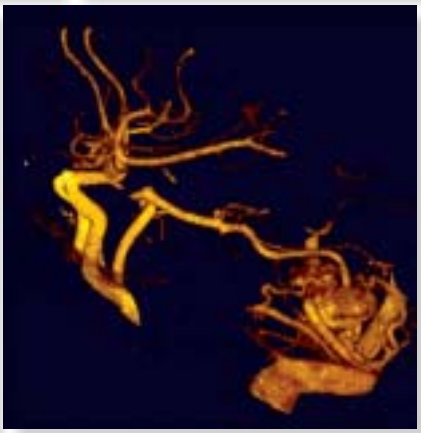




Left: Sagittal oblique thin-slab MIP image demonstrates an arteriovenous malformation in the occipital lobe. The dominant arterial supply from the posterior cerebral artery is shown.

Right: Axial thin-slab MIP image shows the nidus of the AVM with the dominant draining vein into the sigmoid sinus.





Frontal and lateral 3D volume images demonstrate the arterial feeder from the posterior cerebral artery and the venous drainage into the sigmoid sinus.

Case 5

History: 23-month-old boy with painless swelling and reduced mobility of his second metacarpal-phalangeal joint. Diagnosis: Dysplasia Epiphysealis Hemimelica (Trevor disease). This dysplasia is characterized by cartilaginous overgrowth from the epiphysis of one or more joints on one side of the body. The overgrowth is pathologically identical to an osteochondroma.

3D surface-rendered images of the hand demonstrating an osteochondroma arising from the growth plate of the second metacarpal bone. Cartilaginous overgrowth is also seen to a lesser degree in other metacarpals as well as the distal radius.

3D surface view of the isolated second metacarpal.

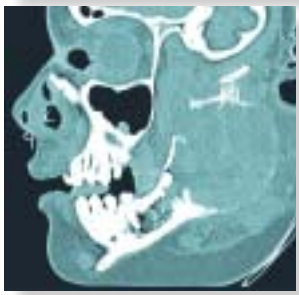
Sagittal and coronal MPR images demonstrating the osteochondroma arising from the growth plate of the second metacarpal.

Case 6

History: 15-year-old boy with a rapidly growing mass in the left mandible.
Diagnosis: Rapidly growing aneurysmal bone cyst of the mandible.
Clinical Significance: CT was the first imaging test in this patient to suggest what proved to be the correct diagnosis in this case. The CT was then instrumental in the surgical removal and reconstruction planned for the patient.

3D soft tissue surface view demonstrates a large soft tissue mass arising from the left mandible.

3D bone detail view highlights the destruction of the mandibular body and ramus.



Curved coronal MPR and oblique sagittal MPR through the mandible shows a large expansile, lytic tumor of the mandible with a very thin cortical rim.

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