New imaging approaches for improving diagnosis of childhood tuberculosis

In South Africa (SA), childhood tuberculosis (TB) still accounts for considerable morbidity and mortality. The incidence of TB disease and risk of progression to severe or disseminated forms are especially high in young children or those with HIV infection. Childhood TB presents most commonly as primary TB, often with non specific signs and symptoms; TB may also present as acute pneumonia. The clinical diagnosis can therefore be challenging.[1] Furthermore, due to difficulty in obtaining good-quality specimens and the paucibacillary nature of childhood TB, microbiological confirmation is only achieved in a minority of children, especially in settings where there is limited capacity for microbiological confirmation.[1]

Imaging is a major part of the diagnostic work-up for childhood TB. Chest X-rays are relatively inexpensive and widely available. However, detection of mediastinal and hilar lymphadenopathy – cardinal signs of primary pulmonary TB – is often limited, there is wide inter-observer variability in detection of nodes and pulmonary findings may be non specific. Other imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) are capable of demonstrating comprehensively the lungs and the mediastinum, but the radiation dose in CT, the need for sedation in MRI, the costs and limited availability all currently prevent their use in routine management. The merit of ultrasound for detecting features of abdominal, pleural and pericardial TB has long been acknowledged and its application in paediatrics is especially attractive as it does not involve radiation nor require sedation. Furthermore, ultrasound of the mediastinum has been shown to detect lymphadenopathy in TB patients who have a normal chest X-ray.[2]

One strategy for improving the diagnosis of childhood TB is the refinement of currently available imaging tools and use of simplified protocols tailored to the detection of TB. Point-of-care ultrasound for extrapulmonary TB (EPTB), mediastinal ultrasound and limited chest MRI are all promising new imaging approaches presently being evaluated in paediatric studies. The increasing availability of digital imaging enables telemedicine, where radiological images can be transmitted anywhere in the world allowing for expert interpretation and opinion.

Point-of-care ultrasound for EPTB – focused assessment with sonography for HIV/TB

With the availability and affordability of high-quality portable ultrasound machines, point-of-care sonography has become an integral part of many medical disciplines.[3] Physician-performed ultrasound at the patient's bedside limits the time to diagnosis and treatment decisions and reduces referrals. Abdominal nodes, hepatic or splenic hypo-echoic lesions as well as pericardial, pleural or ascitic effusions, which are likely representatives of EPTB in settings where TB is highly prevalent, are recognisable with basic ultrasound training.[4] A bedside ultrasound protocol for HIV/TB (focused assessment with sonography for HIV/TB (FASH))[5] has been developed to improve detection of EPTB in HIV-infected adults, and has now become one of the most applied modules in adult emergency rooms in SA.[6] The value of FASH in children is especially promising. It is well tolerated and non-invasive, and, because of the relatively high rate of EPTB in young children, the yield of positive ultrasound findings is high.

Mediastinal ultrasound for intrathoracic lymphadenopathy

Mediastinal and hilar lymphadenopathy are the hallmarks of primary pulmonary TB. Sensitivity and specificity for identifying lymphadenopathy, using traditional anterior-posterior and lateral radiographs in children, is relatively poor. CT studies found lymphadenopathy in up to 60% of TB patients who had normal chest X-rays,[7] but because of the significant radiation burden, CT is not a standard imaging option in children. Mediastinal ultrasound is currently being investigated as an alternative imaging test despite the anatomically limited access. Windows for mediastinal ultrasound include the suprasternal notch and parasternal intercostal spaces, which allow detection of enlarged lymph nodes in the superior and anterior mediastinum. One paediatric imaging study showed that mediastinal ultrasound detected lymphadenopathy in 67% of children with TB who had a normal chest X-ray; the mediastinal ultrasound findings were confirmed on CT.[2] Current research, investigating mediastinal ultrasound, is now being performed in larger cohorts in Cape Town and Johannesburg by two different groups.

Limited chest MRI for intrathoracic TB

MRI in children is preferred over CT because it does not involve ionising radiation. Chest MRI is only receiving attention recently because it was believed to have disadvantages in demonstrating the lungs. MRI is expensive and routine imaging requires the child to be immobile for a prolonged period, therefore requiring anaesthesia or monitored sedation. The radiation-free imaging capacity of MRI, however, remains attractive for evaluating mediastinal lymphadenopathy in children. To demonstrate the usefulness of MRI in TB imaging, new limited protocols that do not require sedation are currently being tested in a collaborative partnership between two SA universities and a private practice. Limited sequences in the form of diffusion-weighted imaging and Short Tau Inversion Recovery (STIR) are performed within 10-min slots. Unlike lymphoma in which lymphadenopathy demonstrates high signal on T2/STIR imaging, TB lymph nodes may demonstrate characteristic low signal intensity. TB-specific signal intensity has already been demonstrated in the parenchyma of TB patients on MRI.[8]

Telemedicine

Many sub-Saharan African countries have limited radiology expertise within their borders,[9] which is considered a significant contributor to patient morbidity and mortality.[10] Digital medical images and reports or opinions on these can, however, be sent electronically from an area with no radiologist to a part of the world where expertise is available. This mechanism of radiology interpretation, known as teleradiology,[9] is being increasingly adopted to successfully assist underserved areas.[9-11] An alteration in the diagnosis following a teleradiology consultation has been recorded in up to 50% of cases.[10]

Point-of-care imaging, non-invasiveness, low-risk and improved visualisation of the mediastinum are desirable goals for imaging TB in children. Although ultrasound and MRI are not new imaging modalities, refinement of protocols and novel applications may improve their diagnostic capacities for childhood TB. Bedside

ultrasound is promising also, as a monitoring tool for response to treatment.[12] Furthermore, ultrasound imaging is especially suitable for use in remote settings where no or only X-ray imaging is available. Lack of expertise on the ground for interpreting images can be overcome through simple telereading mechanisms via email or other internet-based platforms that can provide even subspecialist expertise to assist in patient diagnosis.

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