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IN SONOGRAPHY RESEARCH

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contents

Pediatric chest ultrasound: a practical approach

REFERENCE
Cox M[1,2], Soudack M[3], Podberesky DJ[4], Epelman M. *Pediatr Radiol.* 2017 Aug;47(9):1058–68.
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WHY THE REVIEW WAS PUBLISHED

Radiography, computer tomography (CT) and magnetic resonance imaging (MRI) are modalities traditionally used to image the chest region, including the lungs and mediastinum. Ultrasound is an important imaging adjunct for diagnosing and managing disease in paediatrics.

Ultrasound provides a non-ionising, relatively inexpensive and portable option for assessing some chest pathology. Children are ideal subjects as they have little subcutaneous fat and their chest wall is only partially ossified, providing a number of additional acoustic windows that are not present in adults.

Over the years, ultrasound has been expanded from heart imaging to include pleural, parenchymal, chest wall and mediastinal applications. The main disadvantage of ultrasound of the chest is that any parenchymal lesions that do not abut the pleural surface or diaphragm are unable to be imaged.

This article discusses the role of ultrasound in chest imaging. Techniques and pathologies are discussed.

WHAT THE ARTICLE LOOKED AT

Technique – Technique is discussed, pointing out the portability of ultrasound in the critically ill child and the real-time visualisation of chest pathologies. A tailored ultrasound exam to answer the clinical question is crucial. The acoustic window and transducer choice depend greatly on the size of the child.

Pathologies – Pathologies have been discussed by location i.e. chest wall, diaphragm, mediastinum, pleura and lung parenchyma.

Chest wall pathology – Palpable chest wall abnormalities, soft tissue masses including vascular malformations and infections, breast lumps and rib fractures are all easily assessed using ultrasound.

Diaphragm – M-mode sonography is used to evaluate the diaphragm. It can provide quantitative information about diaphragm excursion. Diaphragmatic paralysis can be diagnosed using ultrasound as it is a real-time modality. Ultrasound will also show masses in the chest or abdomen that could potentially affect diaphragm function.

Mediastinum – Ultrasound of the mediastinum is easily performed in infants under 12 months of age. The non-ossified portions of the rib cage and sternum provide a good acoustic window in this younger age group. Large mediastinal masses, thymus lesions and the thymus gland can be assessed. Mediastinal lymphadenopathy to some extent can be assessed. Although many cystic mediastinal lesions such as fore-gut duplication cysts, lymphatic malformations and neuroenteric cysts can be examined with ultrasound, they will still need CT and MR imaging for diagnosis. Biopsy of suitable lesions can be performed using ultrasound guidance.

Pleura and lung parenchyma – Pleura is discussed with a good description of the A-lines and B-lines. Real-time visualisation of the movement (or non-movement) of the pleura/lung is valuable in diagnosing a pneumothorax. There is no apparent movement with a pneumothorax. It is important to be acquainted with the normal M-mode of the lung parenchyma and pleural interface ('seashore sign'). The M-mode pattern seen in the setting of a pneumothorax has been referred to as a 'barcode' sign.

Pediatric chest ultrasound: a practical approach *cont.*

A chest radiograph can be insensitive for detecting small volumes of pleural fluid. Ultrasound is excellent at assessing pleural fluid as either simple or complex. Ultrasound can show a consolidated lung. Air- or fluid-filled bronchograms may be seen within a consolidated lung as branching echogenic lines, giving it a hepatised appearance. A 'dynamic air bronchogram' is indicative of pneumonia, whereas if the air bronchograms are static, it would be an indication of atelectasis. Ultrasound is extremely useful in assessing a child who has a radiographically opaque hemithorax. It will distinguish masses from lung consolidation and/or a large effusion.

Pleural tapping is easily performed with ultrasound guidance.

RELEVANCE TO CLINICAL PRACTICE

This article shows us that, in the paediatric setting, chest ultrasound is a very valuable tool in diagnosing and assessing common (and some uncommon) pathologies. With the COVID-19 pandemic currently affecting our world, lung ultrasounds would be invaluable, particularly in the paediatric population.

"Ultrasound provides complementary information to chest radiography at a fraction of the cost of CT and MR imaging, without exposing young children to ionising radiation."

Does measurement of the hepatic artery velocity improve the sonographic diagnosis of cholangitis?

REFERENCE
Tse JR, Liang T, Brooken Jeffrey R, Kamaya A. *Abdominal Radiology* 2019; 44:4004–10.
Access: doi.org/10.1007/s00261-019-02284-w

REVIEWED BY
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NOT OPEN ACCESS

WHY THE STUDY WAS PERFORMED

Acute cholangitis is a serious bacterial infection of the biliary tree, which results from a combination of obstruction of bile flow causing increased intrabiliary pressure and retrograde migration of the enteric bacteria from the sphincter of Oddi. If untreated, complications can include abscess, portal vein thrombosis, peritonitis, or death. Hence prompt diagnosis and treatment of acute cholangitis is critical for this highly morbid condition.

Clinical diagnosis is based on either the presence of Charcot's triad – fever, right upper quadrant pain and jaundice; or on the 2018 Tokyo guidelines, which is the presence of an inflammatory response (fever, elevated C-reactive protein, abnormal white cell count), evidence of cholestasis (jaundice or elevated bilirubin), and imaging evidence of obstruction (bile duct dilation). Charcot's triad has a specificity of 93%, but a low sensitivity of 36%. The main issue with the 2018 Tokyo guidelines is the low specificity of bile duct dilation on ultrasound and the fact that common bile duct (CBD) diameter may not dilate in the setting of acute, intermittent or partial obstruction.

On the other hand, hepatic artery velocity (HAV) is seen as an objective sonographic finding that can be accurately measured. The authors theorised that HAV may elevate in the setting of a structural hepatobiliary abnormality or obstruction, including cholecystitis and cholangitis. This was hypothesised as a combination of the hepatic arterial buffer response compensating for increased vascular resistance to portal venous inflow, as well as the inflammation of the biliary tree that is primarily supplied by the hepatic artery.

HOW THE STUDY WAS PERFORMED

The study was a retrospective analysis of 107 patients who underwent an abdominal ultrasound with an indication specifically to evaluate for cholangitis. The presence of acute cholangitis was determined by the clinician's assessment in the discharge summary following clinical workup and a period of observation or admission. This assessment included a review of inpatient notes, procedures, biochemical tests, microbiology tests and imaging data. Clinical data were extracted from the medical records. Ultrasound scans were evaluated to extract HAV, HAV resistive index, portal vein velocity (PVV), presence of bile duct dilation, and presence of an obstructing aetiology such as stent, stricture, or stone. An elevated proper hepatic artery velocity was defined as HAV > 100 cm/s and extrahepatic duct dilation was defined as a common bile duct diameter measuring > 7 mm.

WHAT THE STUDY FOUND

Of the 107 patients, 51 cases were excluded because the HAV was not undertaken, or the patients had an incomplete clinical workup. Of the 56 patients in the final analysis, 18 (32%) cases had cholangitis while 38 (68%) did not. There were no statistically significant differences in patient age or baseline laboratory values, including white cell count, alkaline phosphatise, alanine amniotransferase or aspartate aminotransferase.

The peak systolic HAV in patients with cholangitis was statistically significantly higher than those without cholangitis (152 ± 54 cm/s vs 91 ± 44 cm/s; $p < 0.0001$). There was no statistically significant differences in HAV resistive indices (in cholangitis 0.66 ± 0.12 vs without cholangitis 0.71 ± 0.08). The threshold of 100 cm/s was used for an elevated HAV

Does measurement of the hepatic artery velocity improve the sonographic diagnosis of cholangitis? *cont.*

because this represents approximately 2 standard deviations above the mean. Using this threshold, elevated HAV was statistically correlated with cholangitis (p = 0.0001).

There was no statistically significant difference between the average calibre of the common bile duct in patients with cholangitis (8.6 ± 3.4 mm) and those without (7.0 ± 3.7 mm; p = 0.12).

RELEVANCE TO CLINICAL PRACTICE

Hepatic artery velocity (HAV) is elevated in the majority of patients with acute cholangitis. When considered in isolation, an HAV > 100 cm/s has a high negative predictive value, but is more accurate than Charcot's triad and has similar accuracy to the 2018 Tokyo guidelines in identifying patients with cholangitis. Hence elevated HAV can be used as an alternative and more objective criteria to assess for cholangitis. ■

"... elevated HAV (> 100 cm/s) was statistically correlated with cholangitis."

Characteristics and consequences of work-related musculoskeletal pain among cardiac sonographers compared with peer employees: A multisite cross-sectional study

REFERENCE
Barros-Gomes S, Orme N, Nhola LF, Scott C, Helfinstine K, Pislaru SV, et al. *J Am Soc Echocardiogr.* 2019 Sept;32(9):1138–46.
Access: doi: 10.1016/j.echo.2019.04.416.
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REVIEWED BY
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NOT OPEN ACCESS

WHY THE STUDY WAS PERFORMED

Pain and discomfort related to scanning is an unfortunately common experience for sonographers, and particularly for cardiac sonographers. Despite the apparent prevalence of work-related musculoskeletal pain (WRMSP) in cardiac sonographers, the literature to date has been based on relatively low-level evidence. The authors sought to explore the topic further after detecting a disproportionately high rate of WRMSP in cardiac sonographers during an earlier study focused on other healthcare workers. The research in this particular study was undertaken to ascertain the prevalence and consequences of WRMSP specifically in cardiac sonographers.

HOW THE STUDY WAS PERFORMED

The study was undertaken across 10 clinical sites and participant engagement was electronic survey based via the Disabilities of the Arm, Shoulder, and Hand Outcome Measure (QuickDASH) questionnaire, which is a well-established and comprehensive survey format. The study sought to determine if WRMSP was experienced in the current year of the survey resulting from work activities. The study population comprised of cardiac sonographers as the study group and a control group of various cardiology departmental employee groups who did not perform any form of sonography.

WHAT THE STUDY FOUND

Of the study cohort, 86 per cent of 111 cardiac sonographers experienced WRMSP, which was much higher compared to the control group (46 per cent of the 305 control subjects). In addition to higher prevalence, the severity of WRMSP was higher in the cardiac sonographer group and they missed more days of work. Additionally, results persisted when adjusted for various subject characteristics. Neck, shoulder and back pain were the most common pain areas for cardiac sonographers, and these areas were more painful for cardiac sonographers compared to control subjects. Interestingly, carpal tunnel syndrome (CTS)-like symptoms were reported at a fourfold higher level in cardiac sonographers compared to controls but rates of formal CTS diagnosis were not statistically different between the groups.

RELEVANCE TO CLINICAL PRACTICE

This study complements previously published similar research that cardiac sonographers get a lot of pain, discomfort and injury compared to workers not performing ultrasound. This research did not address the specific question of whether the highly specific and repetitious probe manipulation performed by cardiac sonographers induces WRMSP at a higher rate or with more severity than occurs for sonographers performing general, vascular and/or obstetric and gynaecological ultrasound. This research should act as a clarion call to investigate innovative preventive strategies for cardiac sonographers in the workplace. ■

"WRMSP in cardiac sonographers is much more prevalent and severe compared with peer employees."

Ultrasound evaluation of adult-acquired flatfoot deformity: Emphasis on the involvement of spring ligament

REFERENCE
Sirlyn Q. AJUM 20. 83–90. 10.1002/ajum.12050.
Access: onlinelibrary.wiley.com/doi/abs/10.1002/ajum.12050

REVIEWED BY
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NOT OPEN ACCESS

WHY THE STUDY WAS PERFORMED

Adult acquired flatfoot deformity (AAFD) incorporates a flattened longitudinal foot arch, a valgus heel and an abducting and supinating forefoot. It has a progressive nature and may require surgical intervention.

The tibialis posterior tendon (TPT) is known as the dynamic stabiliser of the longitudinal medial arch of the foot and the spring ligament as the primary static stabiliser. This study was performed due to a new understanding that disruption of the spring ligament complex also occurs with TPT dysfunction in patients with AAFD.

HOW THE STUDY WAS PERFORMED

Eight cases of AAFD were investigated with ultrasound. All cases had progressive flattening of the arch, chronic pain, swelling of the medial ankle and moderate to severe pes planovalgus deformity. All had shown no improvement in symptoms with orthoses.

A tailored ultrasound examination of the medial ankle was performed. The patient was in a lateral oblique position with knee flexed and foot on its lateral margin. In transverse, the TPT was followed from the musculotendinous junction to its insertion on the navicular. Continual angling of the transducer is required to avoid anisotropy. The TPT is then assessed in the longitudinal plane. A variant of normal, in a small proportion of the population, is an os tibiale externum; an intratendinous ossicle at the tuberosity of the navicular.

To assess the spring ligament, slightly abduct and pronate the foot from the above position. Image by placing the transducer parallel to the plantar surface of the foot. Place one end of the transducer over the sustentaculum tali and the other end over the talar head. You will see the ligament deep to the distal fibres of the TPT, bridging the sustentaculum tali of the calcaneus and navicular bone.

It is important when scanning to minimise excessive transducer pressure to avoid compression of an intrasubstance tear or synovial sheath fluid. Also be aware there may be an intratendinous ossicle at the tuberosity of the navicular.

WHAT THE STUDY FOUND

The condition of the TPT was found in all eight cases to show tendinosis to tenosynovitis to complete rupture. In all cases the spring ligament showed partial to complete tear.

The study concluded that in chronic AAFD, TPT is always abnormal and commonly associated with spring ligament failure. The author reports ultrasound to have a high specificity and sensitivity for detection.

RELEVANCE TO CLINICAL PRACTICE

For all patients presenting for assessment of chronic AAFD, it is important to assess both the TPT and spring ligament. Misdiagnosis or failure to recognise involvement of the spring ligament may lead to adverse clinical outcomes. Without proper diagnosis and treatment, surgical intervention may become necessary. ■

New quantitative digital image analysis method of histological features of carotid atherosclerotic plaques

REFERENCE
Zheng H[1], Gasbarrino K[1], Veinot JP2, Lai C[2], Daskalopoulou SS[3]. *Eur J Vasc Endovasc Surg*. 2019 Nov;58(5):654–63.
Access: doi: 10.1016/j.ejvs.2019.07.015.
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REVIEWED BY
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NOT OPEN ACCESS

WHY THE STUDY WAS PERFORMED

Information on the stability and composition of carotid artery plaque is important for building the patient's overall clinical picture. Non-invasive characterisation of carotid lesions until now, however, has been via visual assessment only, which is obviously susceptible to subjectivity and inter-observer reliability. The aim of this study was to develop a fully quantitative method of analysing histological samples of carotid plaques that produce more accurate assessments than the currently used semi-quantitative techniques.

HOW THE STUDY WAS PERFORMED

Carotid artery plaque histological samples from 40 individuals who underwent carotid endarterectomy were analysed. The current gold standard semi-quantitative method was first used to grade the histological samples from 1–4 in terms of plaque stability (1 being stable, 4 being definitely unstable) based on ten features: intraplaque haemorrhage, thrombus, new vessel formation, calcification, cap rupture, proportion of fibrous tissue, lipid core size, foam cells, overall inflammation and infiltration of inflammatory cells.

Fully quantitative analysis of the same samples was also performed using the Zeiss Axio Imager M2 system that looked at all the ten parameters that the semi-quantitative method did, but also at the amount of fibrous tissue within the fibrous cap. The number of macrophages and lymphocytes within the cap were also quantified separately from each other, something the semi-quantitative method isn't capable of doing, as each of these two molecules play important and independent roles in initiating the inflammatory response within the plaque. The quantitative method also evaluated total plaque area and the thickness of the fibrous cap.

WHAT THE STUDY FOUND

The semi-quantitative method found that there were statistically significant differences between all the measured parameters besides calcification, intraplaque bleeding and neovascularisation across the four stability groups. Fibrous cap thickness was seen to be greater in stable plaques compared to unstable ones and the size of the lipid core was statistically larger in more vulnerable lesions. Plaque and cap inflammation and an increased number of foam cells were also seen to be associated with the unstable plaques. The quantitative method produced very similar results on the ten parameters measured by the previous method. The other important plaque characteristics analysed by the quantitative method – erosion length and infiltration of macrophages and lymphocytes – were also seen to be significantly upregulated in definitely unstable plaques.

RELEVANCE TO CLINICAL PRACTICE

While the ultrasonic assessment of atherosclerotic plaque and vulnerability remains to operate on a subjective and very much so qualitative basis, the complementary laboratory-based techniques used in this study highlight variables that could be tested in a quantitative, fully objective style with ultrasound. Measurement of the concentration of certain cell types within the plaque is beyond the capabilities of ultrasound; however, parameters such as cap thickness, intraplaque bleeding and level of calcification could all be quantified in one form or another sonographically, which may allow for a new perspective on plaque stability without the need for histology post carotid artery surgery. ■

> "Fibrous cap thickness was seen to be greater in stable plaques compared to unstable ones and the size of the lipid core was statistically larger in more vulnerable lesions."

Diagnosis of fetal defects in twin pregnancies at routine 11–13-week ultrasound examination

REFERENCE
A Syngelaki, B Cimpoca, E Litwinska, R Akolekar, K H Nicolaides. *Ultrasound Obstet Gynecol*. 2020 Apr;55(4):474–81.
Access: doi: 10.1002/uog.21938.

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AVAILABLE VIA THE EBSCO HOST ON SONOGRAPHERS.ORG

WHY THE STUDY WAS PERFORMED

The study was performed to understand the effectiveness of routine 11–13-week ultrasound scans in detecting fetal anomalies antenatally for twin pregnancies (both monochorionic (MC) and dichorionic (DC)). The study was performed in light of similar studies performed on singleton pregnancies.

In addition, the nuchal translucency (NT) and crown-rump length (CRL) markers are measured in routine 11–13-week ultrasound screening in twin pregnancies with a fetal anomaly. This is to evaluate whether there is thickened NT and/or huge discrepancy in CRL between the two fetuses when compared to normal twin pregnancies.

HOW THE STUDY WAS PERFORMED

The study performed a retrospective analysis of the data collected through a prospective approach over the duration of 17 years (from 2002 to 2019), gathered from four participating units (i.e. a private fetal medicine outpatient clinic and three hospitals with maternity units) offering routine ultrasound examinations in the United Kingdom.

The selection criteria for the study are as follows:

1. Two live fetuses in twin pregnancies (both MC and DC) while presenting for the routine ultrasound scan at 11–13 weeks.
2. Only twin pregnancies with confirmed pregnancy outcomes are included.
3. Twin pregnancies with chromosomal anomalies detected antenatally or postnatally are excluded.
4. Referred cases for assessment (with suspicions of fetal anomalies in twin pregnancies) from other hospitals to the above four participating units are excluded.

Below is a list of research parameters adopted to investigate the effectiveness of the routine 11–13-week ultrasound scan in fetal anomalies:

1. The routine 11–13-week ultrasound scan is performed according to standardised scanning protocols.
2. The routine 11–13-week ultrasound scans are performed by highly skilled sonographers who have achieved the Fetal Medicine Foundation (FMF) Certificate of Competence in first trimester screening or trainees under the above personnel's supervision.
3. The duration allocated to a routine 11–13-week ultrasound scan for twin pregnancies is 60 minutes.
4. Follow-up scans during second and third trimester are performed according to standardised scanning protocols to assess fetal morphology and fetal growth respectively.
5. The final diagnosis of twin pregnancies is confirmed by postnatal examination by paediatricians, in the case of live birth.
6. In the event of a miscarriage, stillbirth or elective termination of the twin pregnancies, the final diagnosis is confirmed by the findings in the last ultrasound performed antenatally.

WHAT THE STUDY FOUND

There is a total of 6366 twin pregnancies, with 1387 MC (21.8%) and 4979 DC (78.2%).

The findings are as follows:

1. There are higher rates of fetal anomalies in MC (2.8%) than DC (1.3%) twins, diagnosed antenatally or postnatally.
2. The routine 11–13-week ultrasound scan detected 36.5% of confirmed fetal anomalies: 52.6% in MC and 27.1% in DC.
3. The study had achieved similar results in the detection of fetal anomalies in DC twin pregnancies during first trimester when compared to the studies performed on singleton pregnancies. The study confirmed that a routine 11–13-week ultrasound scan of twin pregnancies, following a standardised scanning protocol and performed by highly skilled sonographers, is effective in detecting fetal anomalies that could be classified into three (3) groups.
    a. Always detectable
    b. Never detectable
    c. Sometimes detectable.
4. The study also reported the findings below when comparing twin pregnancies with a fetal anomaly to normal twin pregnancies.
    a. Thickened NT (≥ 95th or ≥ 99th percentiles)
    b. Discrepancy in CRL (≥ 10% or ≥ 15%) between the two fetuses.

    The presence of one or both markers above are associated with an increased risk for fetal anomalies; however, both of them are poor predictive indicators in screening due to high false-positive rate.

STRENGTHS AND LIMITATIONS OF THE STUDY

The study has a large sample size of twin pregnancies collected through a duration of 17 years.

The limitations of the study are as follows:

1. Despite the large sample size, the study has only managed to identify the first-trimester detection of overall fetal anomalies (into three groups) but not capable of significant detection on the individual fetal anomaly that is dependent upon the sampling population (in this case, the UK sampling population).
2. The evolution of standardised scanning protocols for a routine ultrasound scan at 11–13 weeks.
3. The final confirmation of fetal anomalies is challenging because asymptomatic anomalies could be missed during neonatal examination, neonates are assumed chromosomal normal based on normal morphology, and lastly, since postmortem is not routinely performed on all cases, in the setting of a miscarriage, stillbirth or elective termination, the final diagnosis of fetal anomalies is based on the findings of the last antenatal ultrasound scan.
4. About 30% of the patients did not deliver in the participating hospital, which caused difficulties in the accuracy of the final confirmation of fetal anomalies postnatally.

RELEVANCE TO CLINICAL PRACTICE

It is important to raise awareness of the benefit of a routine 11–13-week ultrasound scan, performed to a high standard by highly skilled sonographers following a standardised systematic scanning protocol.

With noninvasive prenatal testing (NIPT) more readily available and conducted around the same period (around 11–13 weeks), it is important not to forego the practice of the routine 11–13-week ultrasound scan for fetal anomalies' detection and screening.

The study focused on twin pregnancies, which are high risk pregnancies, to further confirm the effectiveness of a high quality routine 11–13-week ultrasound scan in the first-trimester detection of fetal anomalies (similar to the findings in singleton), and the usefulness and limitation of two markers as screening indicators, namely thickened NT and huge intertwin discrepancy in CRL.

"The main limitation of this and most previous studies investigating the effectiveness of routine ultrasound examination in the prenatal diagnosis of fetal defects relates to ascertainment of such defects."