CAR Standards for Specific Anatomical Areas (Vascular Ultrasound)

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These Standards have been developed by the Expert Advisory Panel on Ultrasound chaired by Dr. Shia Salem and presented for adoption to Council by Dr. Dónal Downey:
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The standards of the Canadian Association of Radiologists (CAR) are not rules, but are guidelines that attempt to define principles of practice that should generally produce radiological care. The physician and medical high-quality physicist may modify an existing standard as determined by the individual patient and available resources. Adherence to CAR standards will not assure a successful outcome in every situation. The standards should not be deemed inclusive of all proper methods of care or exclusive of other methods of care reasonably directed to obtaining the same results. The standards are not intended to establish a legal standard of care or conduct, and deviation from a standard does not, in and of itself, indicate or imply that such medical practice is below an acceptable level of care. The ultimate judgment regarding the propriety of any specific procedure or course of conduct must be made by the physician and medical physicist in light of all circumstances presented by the individual situation.

I. INTRODUCTION

These standards have been developed to provide assistance to practitioners performing ultrasound examinations and are based on the standards published by the American College of Radiology and the American Institute of Ultrasound in Medicine. In some cases, additional and/or specialized examinations may be necessary. While it is not possible to detect every abnormality, adherence to the following standards will maximize the probability of detecting most of the abnormalities that occur.

Diagnostic Ultrasound is an established, effective, diagnostic imaging technique which employs the use of high frequency ultrasound waves for both Imaging and Doppler examinations.

Extensive experience has shown that ultrasound is a safe and effective diagnostic procedure. While no demonstrable harmful effects of ultrasound have been demonstrated at power levels used for diagnostic studies, quality assurance dictates it is necessary to utilize this imaging technique in the most appropriate and indicated fashion, and that studies be performed by qualified and knowledgeable physicians and/or sonographers using appropriate equipment and techniques. Diagnostic ultrasound examinations should be supervised and interpreted by trained and credentialed physician imaging specialists.

II. SONOLOGIST'S CREDENTIALS CRITERIA

Physicians involved in the performance, supervision and interpretation of ultrasonography should be Diagnostic Radiologists and must have a Fellowship or Certification in Diagnostic Radiology with the Royal College of Physicians and Surgeons of Canada and/or the Collège des médecins du Québec. Also acceptable are equivalent foreign Radiologist qualifications if the Radiologist so qualified holds an appointment in Radiology with a Canadian University.

As new imaging modalities and interventional techniques are developed additional clinical training, under supervision and with proper documentation, should be obtained before radiologists interpret or perform such examinations or procedures independently. Such additional training must meet with pertinent provincial/regional regulations. Continuing professional development must meet with the requirements of the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada.

III. SONOGRAPHER'S CREDENTIALS CRITERIA

Sonographers should be graduates of an accredited School of Sonography or have obtained certification by the American Registry of Diagnostic Medical Sonographers (ARDMS) or the Canadian Association of Registered Diagnostic Ultrasound Professionals (CARDUP). They should be members of their national or provincial

professional organization. Continuing medical education should be mandatory consistent with the requirements of ARDMS or CARDUP.

CARDUP will have a national exam process for sonographers in place by 2004. At that time this will become the accepted standard for sonographers. As an interim measure, individual consideration of training and qualifications by a Task Force consisting of members of relevant societies can be recommended for all those whose training does not fall within appropriate guidelines.

IV. DOCUMENTATION

Adequate documentation is essential for high quality patient care and such documentation should consist of a permanent record of the ultrasound examination and its interpretation. Appropriate normal and abnormal images should be recorded for each anatomical area together with appropriate measurements. Images should be appropriately labelled with the examination date, patient identification and if appropriate image location and orientation. A written report should be included with the patient's medical record.

A permanent record of the ultrasound images and written report shall be retained. The images must be of sufficient quality to record pertinent findings and to be used for comparison with subsequent examinations and enable third party sonologists to confirm the diagnosis. The permanent record of each ultrasound examination should be retained for a statutory period which should be consistent with clinical needs and relevant legal and local health care facility requirements.

Videotape may be a useful supplement to the permanent record of an ultrasound examination. The videotape record of the ultrasound examination should be retained for the similar statutory period as the remainder of the permanent record. The videotape cassette number and counter number (name or time) must be recorded in a log book or on the printed report to allow for future access.

V. SUPERVISION AND INTERPRETATION OF ULTRASOUND EXAMINATIONS

A sonologist must be available for consultation with the sonographer on a case by case basis. Ideally the sonologist should be on site and available to participate actively in the ultrasound examination when required.

It is recognized however that the geographic realities in Canada do not permit the presence of an on-site sonologist in all locations. Adequate documentation of each examination is critical. A videotape record may be useful as an adjunct to the hard copy images in difficult cases. Despite the geographic isolation of a community the reports must be timely. Furthermore, the sonologist must be available by telephone for consultation with the sonographer and the referring physician. The sonologist should visit the facility on a regular basis to provide on site review of ultrasound procedures and sonographer supervision.

VI. QUALITY IMPROVEMENT PROGRAMS

Procedures should be systematically monitored and evaluated as part of the overall quality improvement program of the facility. Monitoring should include the evaluation of the accuracy of interpretation as well as the appropriateness of the examination.

Incidence of complications and adverse reactions should be recorded and periodically reviewed in order to identify opportunities to improve patient care.

Data should be collected in a manner which complies with the statutory and regulatory peer review procedures in order to protect confidentiality of the peer review data.

VASCULAR/ DOPPLER ULTRASOUND EXAMINATIONS

Doppler flow analysis is an ancillary or integral component of the ultrasonographic examination of many organ systems. Depending on the clinical indication or gray scale sonographic findings, colour flow Doppler, pulsed Doppler, power Doppler or continuous wave Doppler may provide information which is crucial in making the formal diagnosis. Doppler diagnoses are determined by the presence and direction of flow, and by Doppler waveform characteristics. Information obtained on Doppler interrogation should be integrated with the gray scale and clinical findings.

Doppler flow analysis combined with real-time gray scale imaging provides the basis for many noninvasive vascular studies. Standards with respect to credentials criteria, documentation, and communication should be complied with regardless of whether noninvasive vascular tests are performed in a general ultrasound laboratory or self contained vascular laboratory .The medical and technical staff should have training appropriate for the range of services provided.

Real-time gray scale imaging should be performed at the highest clinically appropriate frequency .A wide range of imaging and Doppler frequencies should be available depending on the variety of studies performed in a specific laboratory .

The following are standards for equipment characteristics and performance of specific noninvasive vascular studies which are frequently performed in ultrasound laboratories. These guidelines are based on the guidelines of the American Institute of Ultrasound in Medicine, American College of Radiology Standards, and the Essentials and Standards for Accreditation in Noninvasive Vascular Testing of the Intersocietal Commission for the Accreditation of Noninvasive Vascular Laboratories.

ULTRASOUND EXAMINATION OF THE EXTRACRANIAL CEREBROVASCULAR SYSTEM

1. EQUIPMENT

The sonographic examination of the extracranial portions of the carotid and vertebral arteries should include high resolution real-time gray scale imaging combined with analysis of the angle corrected range-gated Doppler spectrum.

Real-time imaging should be conducted at the highest clinically appropriate frequency. In the extracranial cerebrovascular system, the appropriate frequency is 5 MHz or greater, preferably with a linear array or curved array transducer. The Doppler carrier frequency should be 3 MHz or greater. Colour flow Doppler is a useful adjunct to the procedure which is helpful in visualization of the lumen and in placement of the range gate, but is not essential to the examination. Power Doppler (PD) may be helpful in searching for a narrow channel of residual flow in suspected occlusions.

2. TECHNIQUE

Examination of both sides is considered essential for a complete examination. Both imaging and Doppler information should be used to identify major vessels. Vessels should be examined throughout their course to the extent that they can be visualized.

Real-time imaging of the common carotid artery (CCA), internal carotid artery (ICA), and proximal external carotid artery (ECA), should be performed in both longitudinal and transverse planes with appropriate representative images recorded from each side In general, the vertebral artery is examined in longitudinal plane only. The extent, location, and characteristics of any atherosclerotic plaque or other vascular or perivascular abnormalities should be recorded. Imaging estimation of the degree of stenosis should be performed in the transverse plane only.

Hemodynamics should be documented by Doppler sampling throughout the entire course of the cervical carotid arteries and representative measurements recorded. The angle between the direction of motion and the applied Doppler signal (Doppler angle) should be kept between 0 and 60 degrees, and the angle correction should be applied when needed to determine flow velocity. Velocity or frequency shift measurements should be recorded proximal to stenotic lesions, at the site of maximal stenosis, and distal to the stenosis. The peak velocity /frequency shift of the highest velocity jet should be recorded. The flow direction and velocity spectrum of each vertebral artery should be recorded.

3. ANCILLARY TESTS

Continuous wave (CW) Doppler, Ocular pneumoplethysmography (OPG), and transcranial Doppler (TCD) may be used as an adjunct to duplex or colour flow Doppler studies. CW Doppler, OPG, and TCD are not sufficient for complete evaluation of the extracranial circulation without duplex or colour flow Doppler studies. TCD may be useful in evaluation of vasospasm and other conditions affecting intracranial hemodynamics.

ULTRASOUND EXAMINATION OF THE PERIPHERAL VEINS

1. EQUIPMENT

The sonographic examination of the peripheral veins should include real-time gray scale imaging with compression where appropriate, combined with range-gated Doppler flow analysis.

Real-time imaging should be conducted at the highest clinically appropriate frequency usually 5 MHz or greater. In most cases a linear array or curved array transducer is preferable. The Doppler carrier frequency should be 2.5 MHz or greater. Although not essential for examination of the deep venous system, colour flow Doppler or power Doppler may facilitate the examination.

2. TECHNIQUE

The technique depends on the indication for venous examination and anatomic location of the vein. For suspected deep vein thrombosis of the lower limb, the examination should include the common femoral, superficial femoral, proximal greater saphenous, proximal profunda femoris, and popliteal veins. Where clinically appropriate, the examination may be extended to the external and common iliac veins and the inferior vena cava and/or to the veins of the calf. In the upper limb, the examination should include the jugular, subclavian, axillary, brachial, basilic and cephalic veins. The examination may be extended to the forearm and/or innominate veins when indicated.

In patients referred for deep vein thrombosis of the lower limb, the examination should include real- time imaging in both the longitudinal and transverse planes using compression or other established, validated criteria to document venous thrombosis. Compression should be performed in the transverse plane in an effort to completely appose the anterior and posterior venous walls. Images of the common femoral, superficial femoral, and popliteal veins should be recorded with and without compression. Images of visible thrombus or noncompressible areas should be recorded, as well as any abnormalities of adjacent tissues (e.g. lymph node, hematoma, pseudoaneurysm, popliteal cyst).

Pulsed Doppler waveforms may be recorded from the common femoral, superficial femoral, and popliteal veins. Waveform augmentation with calf compression and waveform variation with respiration or valsalva may be documented.

When evaluating patients for venous insufficiency, valve function and the level and extent of flow reversal should be documented during the performance of accepted manoeuvres. Vein size, patency, and course should be documented when clinically appropriate.

Vein mapping of superficial leg or arm veins is performed to determine the patency, size and course of superficial veins to be used for vein grafting. The location of the vein may be marked on the skin overlying the vein.

ULTRASOUND EXAMINATION OF THE PERIPHERAL ARTERIES

1. EQUIPMENT

The sonographic examination of the peripheral arteries should include real-time gray scale imaging combined with analysis of the angle corrected, range-gated Doppler spectrum.

Real-time imaging should be conducted at the highest clinically appropriate frequency, usually 3.5 MHz or greater, preferably with a linear array or curved array transducer. Imaging frequencies and focal depths should be appropriate for the vessels being examined. In general, the Doppler carrier frequency should be 2.5 MHz or greater. It may be necessary to use lower frequencies above the inguinal ligament or occasionally elsewhere in the body.

Colour flow Doppler is a useful adjunct to the procedure which is helpful in visualization of the lumen and in placement of the range gate, but is not essential to the examination

2. TECHNIQUE

The course of each major artery examined should be evaluated and the presence and extent of disease should be documented. Representative longitudinal and transverse images should be recorded at prespecified levels depending on the artery being examined. Additional views should be recorded to document the extent and nature of any abnormality (e.g. aneurysm, pseudoaneurysm, dissection, stenotic lesion, etc). Any adjacent perivascular masses should also be recorded and the calibre and flow dynamics of the adjacent artery and vein documented.

Flow velocity spectra should be recorded at intervals throughout the length of the artery being examined. The sample volume (range gate) should be maintained at an appropriate size and should be directed to the centre of the artery except when evaluating post stenotic flow jets. Careful assignment of the Doppler angle is essential. The Doppler angle should be between 0 and 60 degrees to ensure maximum reliability of the velocity measurements. At any site of hemodynamically significant stenosis, the velocity waveforms should be recorded both at the site and at a point 2-4 cm. proximal (upstream) and distal to the site. The location and extent of any segment with absent flow signals should be recorded.

Arterial hemodynamics and real time data should be used to categorize the severity of stenosis or the presence of occlusion based on validated methodologies.

Pulsed Doppler or colour Doppler may be used to document the location of abnormal vascular communications. Velocity waveforms should be recorded from within vessels proximal to, in the area of, and distal to the abnormal communications. Colour Doppler is especially useful for identifying the level of such communications. Valsalva may be used to assess the severity of shunting through the abnormal communications.

In evaluating bypass grafts, an attempt should be made to sample the full length of the graft. Velocity measurements should be recorded in the artery proximal to the graft anastomosis, at the proximal anastomosis, in regions of suspected abnormalities, every 10 to 20 cm. along the graft, at the distal anastomosis, and in the artery distal to the anastomosis.

In patients who have undergone percutaneous arterial interventions, an attempt should be made to sample the site of selective intervention as well as the segment immediately proximal and distal to the site of intervention and the velocity waveforms recorded.

Segmental limb pressures, CW Doppler, and plethysmography may be used in conjunction with duplex sonography or colour flow Doppler. Accepted diagnostic criteria and techniques should be employed.

When using pressure measurements in conjunction with ultrasound for evaluating peripheral arterial occlusive disease, systolic pressures should be determined using a Doppler device and a blood pressure cuff appropriate in size for the extremity in question. Accepted diagnostic techniques and criteria should be used which may involve comparisons between upper and lower extremities (ankle to brachial ratio) or between the extremity in question and the contralateral extremity.

VISCERAL VASCULAR SONOGRAPHY

1. EQUIPMENT

Visceral vascular Doppler sonography should include real-time gray scale sonography combined with analysis of the angle corrected, range-gated Doppler spectrum. Colour flow Doppler may be extremely useful in facilitating the examination. Power Doppler may occasionally help. Although many visceral applications of Doppler ultrasound may be very difficult without colour flow Doppler, colour flow Doppler is considered complimentary but not essential.

An exception to the above equipment standards for visceral sonography is evaluation of the abdominal aorta for suspected aneurysm, which can usually be performed without Doppler.

A wide range of imaging and Doppler frequencies should be available. As with other ultrasound examinations, the highest clinically appropriate frequency should be used. In the abdomen, imaging frequencies of between 2.25 and 5.0 MHz are usually optimal. Occasionally, in thin or pediatric patients, 7.5 MHz a transducer may be appropriate.

2. TECHNIQUE

The technique employed varies depending on the vascular structure being examined. As with all range-gated Doppler techniques careful assignment of the Doppler angle is essential. The Doppler angle should be between O and 60 degrees to ensure maximum reliability of the velocity measurements.

In patients with suspected mesenteric insufficiency, the visible course of the abdominal aorta, celiac axis, hepatic, splenic, and superior mesenteric arteries should be evaluated and Doppler spectra should be obtained and documented. Evaluation in the fasting and post prandial state is usually appropriate.

Evaluation of the hepatic venous system requires visualization of the right, middle, and left hepatic veins and where possible the major branches. The inferior vena cava should also be examined. Evaluation of the portal venous system requires visualization of the main portal vein, right and left branches as well as smaller branches if possible. Evaluation of the splenic and superior mesenteric veins and porto-systemic collateral channels may also be indicated depending on clinical and sonographic findings. Real-time images of the above vessels should be recorded. Doppler spectra should be evaluated and recorded and the presence, direction, phasicity, and pulsatility of flow should be documented.

Evaluation of the renal arteries and/or veins should be accompanied by a complete sonographic examination of the kidneys. For arterial studies, flow velocity and waveforms should be recorded in the abdominal aorta, renal arteries, and intrarenal arteries. For venous studies, the renal veins and inferior vena cava should be examined. Where possible, the renal arteries and veins should be examined in their entirety.

Renal transplant studies require a complete real-time examination of the transplant and surrounding structures as well as Doppler examination of the arterial anastomosis, transplant renal artery and vein, and intrarenal arterial waveform.

In liver transplant patients, the course of the portal vein, inferior vena cava, hepatic artery, and hepatic veins should be evaluated. Pre-operatively, determination of the size and patency of the portal vein is essential. Post operatively, evaluation of the hepatic artery and portal vein are critical. The Doppler studies should be accompanied by a complete real-time examination.

Arterial and venous hemodynamics and real-time data should be used to categorize the presence or severity of disease based on validated methodologies.