Standard for Performing and Interpreting Diagnostic CT Scans

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Each standard, representing a policy statement by the Canadian Association of Radiologists, has undergone a thorough consensus process. The standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques as described in each document.

I. INTRODUCTION

The past several years have seen major changes in CT technology. The major advances have been in the ability to perform spiral techniques, as well as the advent of multidetector systems. These advances allow rapid scanning during a breathold, tracking contrast through the various vascular phases, and increased throughput of cases. The smorgasboard of approaches now available depending on the equipment will not be fully covered, especially as this is still an evolving change. Rather general principles of CT will be stressed.

Computed tomography is a well accepted and established imaging technique which utilizes ionizing radiation to obtain cross sectional images. The applications for CT technology include:
1. Head and Neck diagnosis.
2. Evaluation of spinal disorders.
3. Assessment of the thorax.
4. Abdominal and pelvic imaging studies.
5. Imaging of the musculoskeletal system.
6. Guidance of interventional procedures.

Studies should be performed by qualified and knowledgeable physicians and/or technologists using appropriate equipment and technique. Examinations should be supervised and interpreted by appropriately trained and credentialed medical imaging specialists.

All imaging facilities should have policies and procedures to reasonably attempt to identify pregnant patients prior to the performance of any diagnostic examination involving ionizing radiation. If the patient is known to be pregnant, the potential radiation risks to the fetus and clinical benefits of the procedure should be considered before proceeding with the study. Due consideration to the radiation dose of all studies needs to be revisited from time to time.

II. QUALIFICATIONS OF PERSONNEL

Physicians involved in the performance, supervision and interpretation of CT 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 is certified by a recognized certifying body and holds a valid provincial license.

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. TECHNOLOGIST CREDENTIALS CRITERIA

The Medical Radiation Technologist must have Canadian Association Medical Radiation Technologist certification or be certified by an equivalent licensing body recognized by the CAMRT.

Under the overall supervision of the Radiologist the Technologist will have the responsibility for patient comfort and safety, for examination preparation and performance, for image technical evaluation and quality, and applicable quality assurance. The training of Technologists specifically engaged in CT shall meet with applicable and valid National and Provincial Specialty qualifications.

IV. DOCUMENTATION

Adequate documentation of CT studies should include a permanent record of the examination and its interpretation. Images should be appropriately labelled with the examination date and time, patient identification, image orientation, scan parameters, dose of I.V. contrast administered and any other information which would be necessary or useful for interpretation of the study and for comparison with previous or subsequent examinations by any qualified Radiologist. Written consultation should be included with the patients records. A scout image should be included for all examinations.

Images shall be retained on file either in electronic format or hard copies for a statutory time period consistent with clinical needs and relevant legal and local health care requirements as a permanent record. Digital recording of the case to be kept for longer time periods will be at the discretion of the Imaging Department.

Each examination must generate a written report documenting any significant abnormality that should remain with the patients imaging file.

V. EQUIPMENT AND QUALITY CONTROL

Each imaging facility should have documented policies and procedures for monitoring and evaluating the effective management, safety, and operation of imaging equipment. The quality control program should be designed to minimize patient, personnel and public radiation risks and maximize the quality of the diagnostic information.

The guidelines of the Provincial Ministries for monitoring equipment performance must be followed.
There should be review of the standards for equipment and radiation safety that are currently recognized by such national organizations as the Canadian College of Physicists in Medicine and other appropriate federal and provincial regulatory bodies.

VI. EQUIPMENT SPECIFICATIONS

A. Performance Standards

For patient imaging, the CT scanner should meet or exceed the following specifications:

1. Scan times: minimum, not more than 2 seconds.
2. Slice thickness: minimum, not more than 2- mm.
3. Interscan delay: minimum, not more than 4 seconds (may be longer if intravascular contrast material is not used).
4. Limiting spatial resolution: must be measured to verify that it meets the unit manufacturer's specifications.

B. Patient monitoring equipment and facilities for cardiopulmonary resuscitation including vital signs monitoring, support equipment, and an emergency crash cart should be immediately available. Radiologists, technologists, and staff members should be able to assist with procedures, patient monitoring, and patient support. A written policy should be in place for dealing with emergency procedures such as cardiopulmonary arrest.

VII. QUALITY IMPROVEMENT

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

Incidence of complications and adverse events should be recorded and periodically reviewed in order to identify opportunities to improve patient care. The data should be collected in a manner which complies with statutory and regulatory peer review procedures in order to protect the confidentiality of the peer review data.

VIII. GENERAL COMMENTS ON PERFORMANCE OF CT EXAMINATIONS

Although many of the operations of a CT scanner are automated, a number of technical parameters remain operator dependant. As these can significantly affect the diagnostic value of a CT examination, it is necessary to acquire thorough familiarity with the following factors which must be specified for each examination:

1. Exposure factors

Optimization of image quality requires selection of appropriate exposure factors. These may vary considerably depending on patient size, body weight and age.

2. Collimation.

Diagnostic accuracy requires appropriate selection of slice thickness. This choice will reflect clinical indications for the study as well as the, size location and orientation of structures to be imaged.

3. Slice spacing

Scans may be acquired either contiguously or non-contiguously. This choice depends on the clinical indications for the study as well as the potential for defining select regions of interest.

4. Field of view

The diameter of the field of view has a profound affect on image quality. Although it is generally sufficient to adjust and match the diameter of the field of view to the diameter of the body part to be imaged, narrow fields of view may be selected both prospectively or retrospectively, from raw imaged data (targeted reconstruction).

5. Window settings

For each image, operators must select a portion of the CT number range to be displayed using electronic windows. Window width and levels must be selected to optimize visualization of pertinent structures as well as regions of interest. Multiple window settings may be required. For example, a minimum of 2 window settings should be obtained in CT examinations of the chest: one for visualizing lung parenchyma, and one for assessing soft tissue structures in the mediastinum, hila and chest wall. In examinations of the spine, brain and other body regions, additional settings to emphasize osseous and soft tissue structures may be required as well. In general, use of these multiple window settings should be documented on the hard copy.

6. Algorithm of reconstruction

The computed software used to reconstruct the CT image can markedly affect image characteristics. Choice of the appropriate algorithm profoundly effects diagnostic accuracy. A proper understanding of high contrast/standard resolution algorithms versus high spatial resolution or edge enhancing algorithms is necessary for optimal performance of CT imaging.

7. Patient factors

In general, patients are scanned in the supine position. However changes in patient position including the use of prone and/or decubitus positioning may be of value in select cases. Phase of respiration must also be taken into consideration during imaging of the neck, chest, abdomen and pelvis. In general, images should be obtained at the same phase of respiration during the imaging of a particular body region. Scans obtained in various phases of respiration may be of some additional value in select cases.

8. Contrast media

The choice of whether or not to administer intravenous contrast will depend on the clinical indication for the study. Operators should be knowledgeable concerning various means of administering intravenous contrast including various rates and volumes of administration,and be informed regarding the timing of the various vascular phases-venous and arterial. Familiarity with bolus detection software when available is also needed.

9. On-line monitoring

Ideally each study would be monitored directly by the interpreting physician. However realities of time constraints and potential limitations on physician availability necessitate that many scans be performed without on-line monitoring. In this setting, optimization of the CTexamination requires development of an appropriate CT protocol based on careful review of clinical indications as well as all prior available imaging studies.

10. Protocols

Protocols should be prepared by region of interest and medical indication for investigation. For each area of interest or indication they should indicate the following:
a. The volume, rate and type of oral contrast material to be administered .
b. The volume and rate of administration of intravenous contrast material, and the relationship to initiating scanning.
c. Slice thickness.
d. Slice interval.
e. Superior and inferior extent of the region of interest to be imaged, generally from a level just cephalad to the structure or region of interest to a level just caudad to the structure or region of interest.

These protocols should be reviewed and updated periodically. Following are specific comments about CT examinations for particular anatomic regions and indications. These are meant to be general comments recognizing that the performance of any examination should be tailored depending on the individual characteristics of each patient, the clinical problem and the available equipment. These standards are based on the standard of practice at the time that this document was prepared. However practice patterns may change as new information becomes available and equipment is modified, so regular review of the protocols is required.

CT OF THE HEAD:

Indications

Primary indications: acute head trauma, suspicion of acute intracranial hemorrhage; detection or evaluation of calcification; immediate evaluation for postoperative surgical conditions such as assesment of tumor, hemorrhage or hemorrhagic lesions, treated/ untreated vascular lesions, shunted hydrocephalus, or shunt revision. Other primary indications are mental status change, increased intracranial pressure, headache, acute neurologic deficits, suspected intracranial infection, suspected hydrocephalus, congenital lesions (such as, but not limited to, craniosynotosis, macrocephaly, and microcephaly), evaluation of patients with psychiatric disorders, brain herniation, suspected mass or tumor, and patients presenting with symptoms of acute cerebral infarction, including those who are being evaluated for possible systemic and/ or endovascular thrombolysis.

Secondary indications: (when access to magnetic resonance (MR) imaging is not available, when MR imaging may be contraindicated, or if the supervising physician deems CT to be appropriate) diplopia, cranial nerve dysfunction, seizures, apnea, syncope, ataxia, suspicion of neurodegenerative disease, developmental delay, neuroendocrine dysfunction, encephalitis, vascular occlusive disease or vasculitis (including use of CT angiography and/ or venography), aneurysm, drug toxicity, cortical dysplasia, and migration anomalies or other morphologic brain abnormalities, and study of the skull base.

Examination Specifics

CT protocols in neuroradiology require close attention and development by the supervising physician, according to specified indications. The supervising physician should be familiar with the indications for each examination, patient history, potential adverse reactions to contrast media, exposure factors, window and center settings, field of view, collimation, slice intervals, and reconstruction algorithms. Certain indications require administration of intravenous contrast medium or intrathecal contrast (e. g., cisternography) during imaging of the brain, head, and neck. Intravenous (IV) contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. CSF contrast administration requires use of nonionic agents approved for intrathecal use.

For CT of the brain, contiguous or overlapping axial slices with a slice thickness of no greater than 10 mm in the supratentorial regions in older children and adults and no greater than 5 mm in the neonatal child are preferred. Imaging for evaluation of the posterior fossa should be with no greater than 5- mm slice thickness in the adult or pediatric patient. In the setting of trauma, images should be obtained and/ or reviewed at window settings appropriate for demonstration of soft tissue and bony abnormalities, or other abnormalities, as suspected by the physician, including subdural window widths when appropriate. For imaging of the cranial base, an axial slice thickness no greater than 3-mm with spiral techniques and 2- mm without spiral technique should be used for 2D reformatting or for 3D reconstruction.

Unenhanced studies are performed in the setting of suspected hemorrhage or stroke. If a low index of suspicion for neurosurgical disease exists (i.e. chronic headaches, dementia etc.) a screening study without contrast is sufficient. If an inflammatory process, mass or vascular malformation is suspected, an enhanced study is done. On an enhanced study, it may be difficult to differentiate blood from calcium, necessitating a repeat study without contrast.

The sella and pituitary gland should be imaged in the coronal plane with thin, contiguous slices (1-3 mm.) from anterior to the sella (tuberculum) to posterior to the dorsum. Indications include a search for a mass or hemorrhage. The scan plane should be chosen to minimize artefacts from dental amalgam. If the neck cannot be extended then reformations in the coronal plane should be done from axial images. Axial images may be necessary for confirmation of pathology seen on the coronal study or for assessment of parasellar extension of a mass. The examination should be done with intravenous contrast unless there is suspicion of hemorrhage. Images should be acquired within 10 minutes of contrast administration.

CT OF THE FACE AND NECK

Indications

Primary indications: fractures of the orbit, temporal bone, skull, and face; detection or evaluation of calcification; evaluation of the skull base for primary and secondary osseous lesions; evaluation of the temporal bone, mastoids, paranasal sinuses, larynx and salivary glands; craniocervical anomalies; evaluation of vascular structures, including CT angiography and CT venography; reconstructions for preoperative three-dimensional planning of the cranial base, vault, or dental abnormalities. Secondary indications: (when MR imaging may be contraindicated or unavailable CT may be an alternative modality, or if the supervising physician deems CT to be appropriate) evaluation of lesions involving the orbit; nasopharynx; oropharynx; oral cavity; hypopharynx; masticator; parapharyngeal, retropharyngeal, carotid and prevertebral spaces; soft tissue spaces of the face; posterolateral neck; extracalvarial region; and the thyroid and parathyroid gland where US is insufficient.

Specifications of examination

For CT of the face and neck, a slice thickness of no greater than 5- mm in children and adults. Thinner images (3- mm) may be indicated for the evaluation of infants or smaller anatomic structures. Images can be performed with either standard or bone algorithms. If bone disease is the primary diagnostic consideration, a bone reconstruction algorithm should be employed. For CT of the orbit, slice thickness no greater than 3 mm should be used for both axial and direct coronal imaging. CT of the paranasal sinuses should be performed with a slice thickness no greater than 5 mm for either axial or direct coronal imaging. Axial slice thickness no greater than 2- mm should be used for 2D reformatting or 3D reconstruction of the orbits or sinuses. For imaging of the facial bones and jaw, slice thickness no greater than 3 mm should be used in infants and no greater than 5 mm in older children and adults for either axial or coronal sections. An axial slice thickness no greater than 1.5 mm should be used for reformatting or for reconstructions. For temporal bone imaging, slice thickness should not exceed 2 mm for axial or coronal sections and should be no greater than 1.5 mm for axial slices to be used in reformatting.

A) CT OF THE ORBIT:

Indications include delineation of or exclusion of a mass. Axial 1.5-5.0 mm. contiguous slices should be done in the plane of the orbital cone (from 0o - 10o from the canthomeatal line) from the mid maxillary sinus to the mid frontal sinus. True coronal slices are useful if a mass is found, or for better delineation of muscle size or for further assessment of the optic nerves. Contrast is helpful in selected patients.

B) CT OF THE SINUSES/FACE:

Screening for endoscopic surgery:

Studies should be in the coronal plane using 3-5 mm. contiguous slices. A wide window (ie. 4000) allows a clear differentiation of bone, mucosa and air. It might be helpful for patients to be on decongestants for two days prior to the study and to blow their nose just prior to the scan.

Screening for or delineation of mass lesions:

Studies should be in the axial or coronal plane from the frontal sinus to hard palate using 5 mm. contiguous slices after a bolus injection of intravenous contrast. A soft tissue algorithm (ie. window 300-400) should be used. When a mass is evident a wide window setting for assessment of bony structures is required and true coronal images should be performed. On the true coronal slices angulation should be selected so as to avoid dental restorations.

Facial trauma:

Studies should be in the axial plane from the frontal sinus to hard palate using contiguous 3-5 mm. slices. A bone algorithm with a wide window setting (ie. 4000) is required. In addition, slices through the orbit should be imaged with a soft tissue setting. If clinically feasible, true coronals, from the nasal bone to the sphenoid sinus should be done. If the mandible is involved clinically, additional axial slices to the symphysis are required.

C) CT OF THE TEMPORAL BONE:

Temporal bone imaging is often done in addition to a study of the posterior fossa. Indications include masses in the middle or external ear, VIIth nerve paresis and hearing loss. To image the external, middle and internal ear anatomy, thin (ie. 1.5 mm) contiguous axial and coronal slices should be done through one or both petrous bones. A bone algorithm with a wide window (ie. 4000) is required.

D) CT OF THE PHARYNX, LARYNX AND NECK:

The soft tissues of the head and neck are imaged to search for or delineate masses. Studies should be performed in the axial plane from the nasion to the thoracic inlet using 5 mm. contiguous slices. A dynamic or rapid-sequence acquisition should be done in concert with a rapid pump or hand injection of contrast such that intravascular contrast is easily evident on the entire study. A true coronal study should be added when pathology involves the skull base or when the area of interest is obscured by dental restorations. Staging of laryngeal carcinoma may require additional thin (ie. 1.5 mm.) axial slices through the larynx.

CT SPINE:

Primary indications: acute trauma, acute or chronic fractures, spinal stenosis, detection or evaluation of calcification, evaluation of osseous lesions, craniocervical anomalies, congenital anomalies, primary and secondary neoplasms, as an adjunct to myelography or MR. In the cervical and thoracic regions, pain only, is a poor indication for CT, unless plain films, bone scans or clinical findings direct attention to a particular level.

Secondary indications: (when MR imaging may be contraindicated, CT may be an alternative modality, or if the supervising physician deems CT to be appropriate) evaluation of degenerative diseases of the spine, and in failed back syndrome. CT/myelography may be useful for examination of the spinal cord, roots, thecal sac and canal.

Scanning can be accomplised with contiguous 3-5 mm. axial slices in the plane of the disc spaces. An alternative method would include selective angulation in the plane of each disc space. This should extend from the pedicle above to the pedicles below each disc level to cover the entire intervertebral foramina and pars interarticulares. For reformations, overlapped cuts are recommended from images perpendicular to the table. CT with contrast is helpful in mass lesions or inflammatory processes, and in selected patients with a cervical radiculopathy.

1. Cervical: Axial images with a slice thickness no greater than 3- mm allow for optimal imaging of the cervical spine in the setting of trauma as well as in degenerative disease. Coronal and sagittal reformations can be also obtained with this slice thickness. IV contrast injection can be useful in increasing the detection of small disk herniations and can also provide better delineation of anatomic detail, particularly when beam- hardening artifact is present. IV contrast material can also be administered in conjunction with 25- 30 second spiral thin- cut acquisitions. Images should be performed and/ or reviewed with both soft tissue and bone windows. Three-dimensional volume surface reconstructions may also be obtained. Bilateral oblique reconstructions are advantageous in evaluating the intervertebral foramina. Intrathecal contrast provides excellent detail of the thecal contents including the spinal cord.

2. Thoracic spine: In the setting of trauma and specified suspected affected levels, slice thickness no greater than 3mm should be used. Sagittal, coronal, and oblique reformations can also be employed. Three- dimensional reconstructions with thin sections are also possible. Routine imaging may be performed with 3- 5 mm slice thickness parallel to the disk spaces. IV and intrathecal contrast may enhance visualization of anatomic detail. Spiral techniques can also be employed with contrast-enhanced or postmyelographic CT of the thoracic spine. Images should be performed and/ or reviewed with both soft tissue and bone windows. In the neonate, slice thickness no greater than 3-mm should be employed for routine imaging, and thinner sections may be used where appropriate.

3. Lumbar spine: In the setting of trauma, slice thickness no greater than 3- mm should be employed with sagittal, coronal, and oblique reformations as may be necessary. For routine imaging in older children and adults, contiguous or overlapping 3- 5mm thick sections should be performed parallel to the disc spaces. In the neonate, slice thickness should not exceed 3mm. Images should be performed and/ or reviewed with both soft tissue and bone windows. Three- dimensional reconstructions as well as spiral imaging may be performed as needed. Intrathecal contrast can be utilized to enhance visualization of the conus, cauda equina and adjacent anatomy.

CT OF THE EXTREMITIES:

Computed tomography is a valuable adjunct in the evaluation of a wide variety of bony and calcific musculoskeletal disorders following routine radiographic evaluation. Potential applications include the assessment of trauma, intra-articular pathology, soft tissue or bony neoplasia, osseous or joint infection and guidance of interventional procedures. As most examinations are performed for a specific clinical indication, the examination should be tailored to each problem. An edge enhancing (bone) algorithm may be utilized to optimize bone detail. Images obtained should be displayed in both soft tissue and skeletal window settings and recorded permanently on hard copy. Intravenous contrast administration while not required in many examinations may be useful in suspected soft tissue infection, evaluation of soft tissue masses, and in trauma with suspected visceral injury.

Trauma

In general, plain films should be obtained prior to CT scanning. This allows optimum planning of scan plane and slice thickness where CT is necessary to confirm the presence of bony or soft tissue injury, to evaluate fracture displacement, or to evaluate fracture healing. An imaging plane perpendicular to the fracture plane or expected fracture plane is optimal. Slice thickness should be decreased (3 mm. or less) if the scan plane cannot be perpendicular to allow for later reconstruction in a suitable plane. While a slice thickness of 10 mm. may be adequate for larger anatomic regions, in the evaluation of small osseous structures or joint incongruity slice thickness should be 5 mm. or less.

Intra-articular pathology

CT scanning may be useful in detecting intra-articular osseous bodies and capsular, ligamentous, or tendon tears about a joint. Intra-articular injection of contrast (air and/or iodinated contrast material) is often useful in assessing soft tissue disruption about a joint or intra-articular loose body. Scan thickness depends upon the joint to be imaged but is typically 5 mm. or less in large joints and 3mm or less in small joints.

Neoplasia

In neoplasms of the skeletal system, CT scanning is complementary to plain film radiography and nuclear medicine techniques. CT scanning allows visualization of bone destruction, matrix calcification/ossification and soft tissue extension. Slice thickness depends upon the size of the lesion (10mm or less) and scans obtained should include normal bone above and below the lesion. Intravenous contrast administration may aid in better defining the anatomic limits of the neoplasm. While MRI is the modality of choice in the assessment of soft tissue neoplasia CT may be valuable in characterizing the extent and distribution of the neoplasm if MRI is not readily available. Slice thickness depends on the size of the suspected lesion.

Infection

In suspected acute osteomyelitis, CT is an important complimentaty study to plain film radiographs and nuclear medicine studies. Unenhanced thin section (5 mm or less) images through the region of interest may detect subtle osseous destruction in osteomeylitis.

In chronic osseous infection, CT scanning may be useful in demonstrating disease activity by identifying sequestra, sinus tracts, or soft tissue abscesses. Unenhanced thin slices (5 mm or less) through the suspected region will often be diagnostic. Intravenous contrast may aid in identifying soft tissue extent.

CT OF THE ABDOMEN AND PELVIS:

Indications and contraindications

Indications for abdominal or pelvic CT examinations include, but are not limited to:
A. Evaluation of abdominal or pelvic pain;
B. Evaluation of known or suspected abdominal or pelvic masses or fluid collections, primary or metastatic malignancies, abdominal or pelvic inflammatory processes, and abnormalities of abdominal or pelvic vascular structures;
C. Evaluation of abdominal or pelvic trauma;
D. Clarification of findings from other imaging studies or laboratory abnormalities;
E. Guidance for interventional diagnostic or therapeutic procedures within the abdomen or pelvis;
F. Treatment planning for radiation therapy.

There are no absolute contraindications to abdominal or pelvic CT examinations. As with all procedures, the relative benefits and risks of the procedure should be evaluated prior to the performance of iodinated abdominal and pelvic CT. Appropriate contrast-enhanced precautions should be taken to minimize patient risk.

Most abdominal CT examinations are performed for specific indications and the examination should therefore be tailored accordingly (see below). A standard CT protocol should be established for those patients undergoing examinations for less specific indications such as abdominal pain. A typical screening CT examination of the abdomen and pelvis would be axial images from the level of the diaphragm to the symphysis pubis with 10 mm. slice thickness and 10-15 mm. table incrementation.

The gastro-intestinal tract should be opacified with iodinated or water oral contrast material unless medically contra-indicated, or occasionally in other circumstances. Particularly in the pelvis consideration to filling the rectum or bladder should be weighed.

During any examination of a single organ or region all scans should be obtained in the same suspended state of respiration (e.g. expiration). Axial scans should be obtained through the entire area of interest. The field of view should be optimized for each individual patient. Slice thickness should not exceed 10 mm. Table incrementation will generally not exceed 10 or 15 mm.

For many indications, the examination should be performed with intravenous contrast material, using appropriate bolus technique, where indicated and appropriately timed for the arterial or venous phase. Abnormal findings on a non-enhanced examination may require further evaluation with contrast enhancement in order to confirm a suspected pathology, characterize an abnormal finding, reassure the radiologist of the normalcy of the area in question, or stage the disease process properly.

Appropriate window settings should be used routinely to view the visceral organs, the intra-abdominal fat and muscles, the pulmonary parenchyma at the lung bases, and the osseous structures.

A) CT OF THE LIVER:

CT of the liver is performed for the detection of intra-hepatic abnormalities (e.g. rule out metastases) and for the characterization of known masses suspected to be a hemangioma or other tumor. For the detection of intra-hepatic metastatic disease a dynamic contrast enhanced examination is more sensitive than a non-contrast examination or an examination in which most of the liver images are obtained more than 3 minutes after the intravenous contrast administration. For suspected hepatoma and suspected vascular metastases, enhanced scans during the arterial phase are more sensitive than scans in the portal venous phase. Occasionally a non-contrast exam is also needed for the detection of some calcific metastases. Occasionally, delayed images are required for the complete assessment of a liver mass such as a hemangioma. Where partial hepatectomy is a consideration CT portography is performed.

B) CT OF THE PANCREAS:

CT examinations are performed for the detection and characterization of neoplasms of the pancreas, and for the detection and staging of inflammatory disease of the pancreas. The examination must be tailored accordingly.

In the assessment of pancreatic inflammatory disease, contiguous scans of 10 mm. slice thickness are generally obtained. Non-contrast scans are helpful to determine the presence of calcifications. In severe acute pancreatitis, a dynamic contrast enhanced examination (i.e. the rapid administration of intravenous contrast material, with rapid acquisition of axial images), is performed in order to maximize pancreatic parenchymal enhancement and thus to allow the detection of non-viable pancreatic tissue.

In acute pancreatitis the examination should be extended to include the entire abdomen and pelvis in order to document the presence of remote pancreatic fluid collections or other complications.

The evaluation and staging of pancreatic tumors are usually performed with contiguous scans of 5mm or less slice thickness. Usually dynamic contrast-enhanced scans are performed. Administration of adequate volumes of oral contrast is necessary to obtain proper opacification of the duodenum and adjacent loops of small bowel. Occasionally, images are obtained with the patient in the decubitus position.

C) CT OF THE BILIARY TREE:

CT for the evaluation of biliary obstruction should be performed with contiguous scans of 5 mm. slice thickness and should generally include the entire biliary tree. More cephalically located scans through the superior portions of the liver may well be helpful but can be adequately performed at 10 mm. slice thickness. For the detection of choledocholithiasis, the study may be performed without intravenous or oral contrast material.

D) CT OF THE ADRENALS:

Computed tomographic examinations performed specifically for visualization of the adrenal glands should be performed with 5 mm or thinner slice thickness and in a contiguous fashion. In the evaluation of suspected pheochromocytoma, intraveous contrast is contraindicated. If the adrenal glands are negative, the entire abdomen may be scanned using IV contrast and paying special attention to the liver for vascular metastases.

When intra-adrenal hemorrhage is a consideration, a non-contrast examination should be performed. For other indications, the examination may be performed as either a non-contrast or contrast study. In particular, intravenous contrast administration may be helpful for the evaluation of primary adrenal carcinoma. Targeted reconstruction is useful particularly in the evaluation of small adrenal lesions such as aldosterone producing tumors causing Conn's syndrome.

E) CT OF THE KIDNEYS AND/OR URETERS:

CT examination for evaluation of renal substance or renal collecting system can generally be performed with contiguous 10 mm slices. Thinner sections may be required for the evaluation of smaller renal masses. Preliminary unenhanced CT examination may be helpful for the detection of renal calcification, particularly calculi and medullary nephrocalcinosis. However, an unenhanced CT examination of the kidneys may not be adequate for the detection of small renal masses. Intravenous contrast administration is necessary for the characterization of renal masses, the staging of tumors, and evaluation of the renal veins. A combination of unenhance CT and scans in the corticomedullary and nephrographic phases may be helpful in the detection and characterization of renal masses and in staging. Contrast administration is also necessary in the assessment of ureteric obstruction or suspected ureteric mass.

F) CT OF THE AORTA:

CT examination for the assessment of the abdominal aorta is generally performed with scans of 10 mm maximum slice thickness and table incrementation of 10-15 mm. Targeted reconstruction may aid in the interpretation of suspected dissection or aneurysmal complications.

G) CT IN ABDOMINAL TRAUMA:

CT evaluation of the abdomen in the setting of blunt or penetrating abdominal trauma will necessarily be tailored depending upon the clinical status of the patient and the specific clinical question to be answered. Intravenous contrast should be administered whenever possible to optimize demonstration of hepatic, splenic and renal parenchyma as well as major vascular structures. Oral contrast should also be administered when feasible. Scans are generally performed in contiguous fashion with 10 mm. slice thickness from the level of the diaphragms to the lower poles of both kidneys. The examination should continue in 10 or 15 mm. increments to include the entire pelvis to the level of the symphysis pubis in order to facilitate the detection of unexpected bowel or mesenteric injury and to facilitate the detection of hemoperitoneum which may occasionally be subtle in the upper abdomen but appear more extensive within the pelvis.

H) CT OF THE PELVIS:

Most CT examinations of the pelvis are performed for specific indications and the examination should be tailored accordingly.

As for CT examinations of the abdomen, adequate opacification of the gastro-intestinal tract is critical. Consideration should be given in selected cases to the administration of additional contrast material per rectum in order to facilitate identification of the sigmoid colon. In female patients the placement of a tampon in the vagina will facilitate identification of the vagina and cervix. The urinary bladder may be distended with fluid or opacified with intravenously administered contrast material, on delayed scans. The bladder may also be opacified with low concentration, e.g. 5%, iodinated contrast material instilled directly into the bladder under gravity. This manouvre should especially be considered in cases of possible traumatic bladder rupture.

CT EXAMINATION OF THE CHEST:

Computed tomography is currently the imaging modality of choice, following routine chest radiography, for evaluating intrathoracic disease. Optimal performance of chest CT requires considerable knowledge of anatomy and pathophysiology, as well as intimate familiarity with computed tomographic techniques, including spiral CT.

The indications for the use of thoracic CT include but are not limited to:

1) Evaluation of abnormalities seen or suspected on a routine chest radiograph
2) Evaluation of the thorax in patients with clinically suspect pathology
3) Evaluation of symptoms inadequately assessed by more conventional imaging studies
4) Performance of CT guided biopsy and drainage procedures for parenchymal, mediastinal, and pleural processes
5) Normal chest x-ray in a patient with abnormal pulmonary function tests

Standard Chest CT

The field of view should be optimized as for all other anatomic regions. For most routine chest CT examinations, suspended inspiration is the preferred phase of respiration. Scans should be obtained through the entire area of interest. Slice thickness should not exceed 10mm (typically 7-8mm) and scan interval should not exceed 10 mm (typically 7-8mm). Images are routinely viewed on both the mediastinal setting (W 350 HU, L 40 HU) and the lung setting (W 1200 to1500 HU, L -600 to -700 HU). Mediastinal images are obtained with the standard soft tissue algorithm and the parenchymal images are obtained with the lung algorithm (if available), bone algorithm, or a lung filter applied to the standard algorithm. The administration of oral contrast is not required in the majority of cases, although it may be of value in patients with known or suspected esophageal disease. Intravenous (IV) contrast administration is generally not required when performing CT of the chest as a metastatic survey or for the assessment of diffuse parenchymal disease. IV contrast is particularly helpful in the evaluation of pulmonary lesions abutting the hila or mediastinum, and in the evaluation of mediastinal lymphadenopathy or other mediastinal pathology. The risks vs benefits for the use of iodinated IV contrast must be considered in each individual case, and contraindication guidelines must be followed.

CT Angiographic Studies

The introduction of helical CT, with the ability to image during the phase of dynamic enhancement, has greatly increased the indications for IVcontrast studies, particularly in the areas of evaluation of suspected pulmonary embolus and other vascular pathology. An unenhanced CT scan may be helpful prior to the contrast study in patients suspected of aortic dissection. A timing bolus to determine the time to maximum enhancement is generally performed. Slice thickness and pitch are calculated to cover the volume of interest in a single breath hold timed to the patients breatholding ability, with the slice thickness preferably 3 - 5 mm. In the event that the patient cannot hold their breath, the study is performed with quiet respiration. In general, the pitch should not exceed 2 in a dynamic vascular study. It is also customary to reconstruct the images at an interval equal to half the slice thickness for improved 2D and 3D reformatting.

High Resolution CT of the Chest (HRCT)

Acquisition of slices in the order of 1 - 2 mm with a 10 - 20 mm slice spacing is mandatory for assessment of diffuse parenchymal disease. A high spatial resolution or edge enhancing algorithm should be employed when performing HRCT. Targeted reconstruction with a narrow field of view is particularly useful for assessing diffuse parenchymal disease. Images taken in full expiration may be helpful for further evaluation of diseases where air trapping is suspected, and for further evaluation of the lung parenchyma when a mosaic pattern of attenuation is present or suspected on the inspiratory HRCT.

Acquisition of contiguous thin slices in the range of 1 - 3 mm is extremely helpful in the evaluation of solitary pulmonary nodules (SPNs) or masses. These should be acquired (or reconstructed) on the standard algorithm when assessing for the presence of fat or calcification within a lesion on the mediastinal setting. Targeted reconstruction with a narrow field of view is also useful in assessment of SPNs.