Emergency radiology: a vital aspect of radiology

Health & Medicine, Nursing

Introduction

Emergency Radiology is a subspecialty of radiology whose growth over the years as paralleled that of emergency medicine, and as such is defined as the imaging and imaging management of the injured and acutely ill. This peer review aims at looking at emergency radiology with a special focus on which intervention is best for some selected systems of the body.

Optimization of Emergency Department Diagnostic Imaging

The increased use of diagnostic imaging has led to increased cost and Emergency department length of stay, up to 50% of diagnostic imaging may be medically unnecessary and the increasing use of pathology nor an improvement in patient-centered outcomes. CT use has increased patients exposure to contrast media and the associated risk of contrast induced nephropathy. While exposure to ionizing radiation has been shown to confer an increased cumulative lifetime risk of cancer.

History of Emergency Radiology

In the past two decades, emergency radiology has emerged as one the newest and fastest growing subspecialty in radiology. In the past, emergency radiology was majorly based on radiography and fluoroscopy. Many patients were unable to have completion of imaging examinations done in the emergency department. Patients with diagnostic uncertainty were admitted in the hospital for preparation of fluoroscopic procedures or for angiographic examinations.

Several factors have made a significant change in the practice of emergency radiology. The introduction of emergency computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound has revolutionized the practice of emergency radiology. Presently, emergency radiology has grown to be most hospitals acute diagnostics imaging center. The emergency radiology division of today is unique in its physical design, equipment, staffing, information systems and operations. Multi-detector CT scanners has enabled total body trauma scans including CT angiograms of the head, neck and extremities.

Future trends in emergency radiology will include response to an aging population; health care reform; new imaging modalities such as cardiac CT; the need for radiation dose reduction and increasing demand for MRI2.

Maxillofacial Trauma

Facial skeleton can roughly be divided into three areas; the lower third or mandible, the upper third, which is formed by the frontal bone and the middle third, an area extending downwards from the frontal bone to the level of the upper teeth of the patient is edentuluous, the upper alveolus. Fractures of the facial skelton are but one component of a spectrum of “ maxillofacial injuries” and they are associated with varying degrees of involvement of the overlying soft tissues and such neighboring structures as the eyes, nasal airways, paranasal sinuses and tongue. They can vary in severity from a simple crack in the upper alveolus to a major disruption of the entire facial skeleton.

The contemporary causes of facial fractures of the facial bones are in order of frequency; inter personal violence, sporting injuries, falls, road traffic accidents and industrial trauma. The classifications of facial fractures is divided broadly according to the pattern of injury. Thus, the mandible and the mid-facial skeleton has their own individual classification. The extensive discussion on the classification would not be addressed on this review.

Management of facial trauma has to be seen in the context of the treatment of injuries in general, and the first priority is obviously ensuring survival. The emergency treatment of even the simplest maxillofacial injury involves securing an airway and an assessment of cervical spine and head injuries, all of which are of vital importance in the general management of a patient whose injuries do not necessarily involve the face and jaws.

Diagnostic Imaging of the Head and Neck Trauma

The overall management of patients with facial bone fractures has been considerably influenced by advances in radiology and imaging during recent years. It is important that all doctors working in the accident and emergency departments undersand some basic principles concerning appropriate requests for radiographs of patients with facial injuries. Thus, we delve into the various imaging modalties available for facial trauma and their indications.

Plain Radiography

Plain X-rays still provide the foundation of imaging. They may be sufficient in their own and will provide a guide and indication for the use of other facilities such as computed Tomography (CT) and Magnatic Resonance Imaging (MRI).

The occipitomental projection with various modifications is the most useful view of the facial bones (Sidebottom et al., 1996). The following plain views of the facial bones may be in diagnosis:

- Upper Third
    - Mofied cadwell projection;
    - Lateral projection
- Middle Third
    - Occipitomental
    - Waters view
    - Lateral projection
    - Occlusal view of the maxilla
    - Periapical view pf involveds or damaged teeth
- Mandible
    - Posterior anterior projections
    - Oblique lateral projection
    - l Rotated posterior anterior projection
    - Occlusal views of the mandible
    - Periapical views of involved or damaged teeth

Tomography

Tomographs are radiographs generated from machines which allows the X-rays film and the tube to move in contralateral directions. Rotational panoral tomography of the mandible is now almost universally available and is rountinely used in suspected fractures of the mandible. Other traditional indications for tomographs of the facial region, for example suspected

damage to the orbital walls or the craniomandibular articulation have now been largely superceeded by CT.

Computed Tomography

Although CT scannners are now widely available, the majority of facial bone fractures can be diagnosed from conventional radiographs and tomograms. The indications for CT evealuations are as follows:

1. Suspected fracture of the upper third of the face
2. Extensive frctures of the middle third
3. Orbital trauma.

3-D CT Imaging

The digital data generated by CT imaging can be used by appropriate computer software to genate a screen image in three-dimemnsional format. As technology improves these images are not only improving in quality but can be produced on affordable computer hardware.

Magnetic Resonance Imaging (MRI)

In many countires (MRI) is expensive and restricted in its availability. It has little application in the diagnosis of acute facial trauma. There is no doubt, however, that it is helpful in the evaluation of cerebrospinal fluid leaks and can be useful in the more accurate diagnosis of injuries to the temporo-mandibular joint and orbital contents.

Spine Trauma

True spinal emergemcies are rare and represent a potential loss of function if not treated properly. Early diagnosis is the key to preventing significant morbidity in th form of permanent disability. The recognition of red flags,

followed by a thorough neurologic exam and appropriate imaging should prompt a thorough examination with a heightened sense of urgency regarding the workup for serious forms of pathology. Spinal emergencies threaten a loss of function if not treated properly.

Spinal Cord Compression

Spinal cord compression (SCC) is a medical emergency that requires immediate imaging assessment and appropriate treatment to prevent or minimize neuroligc sequelae that could be potentially devastating. It can manifest with a wide range of clinical presentations, course and degrees of severity. To confirm a clinically suspected SCC, it is mandatory to perform an imaging work up. The role of an imaging is fundamental to establish a radiological diagnosis, to distinguish intrinsic spinal cord disease from extrinsic cord compression, to define mechanical spine stability, to provide further radiological information and to guide treatment if necessary.

Diagnostic Imaging for Spinal Cord Compression

Imaging approaches rely on clinical features and examinations. The appropriate use of each available imaging modality is based on the clinical setting, the complexity of spine anatomy and the relative capabilities or limits of each technique.

Plain Film Radiography

Plain film represents the most accessible and less expensive imaging modality in spinal disorders, acquired on posterior-anterior views and lateral views, additional views are required in specifc conditions. Plain films evaluate osseous structures and the vertebral alignment but, especially in

situations where a SCC is suspected, have severe sensitivity limits and from a firstline diagnostic imaging tool for spine related condtions in the past, are nowadays progressively abandoned in favor of more advanced and accurate imaging modalities.

Multi Detector CT (MDCT)

MDCT is unparalled in its capabltiy to detect bone abnormalities, it ensures fast acquisition times and it is progressively widely available on the territory. Mdct can also depict significant soft tissues abnormalities. The limitations of this technique remains inability to provide accurate information on spinal cord lesios and ligamentous injury.

Magnetic Resonance Imaging (MRI)

MRI is the best imaging modality to assess soft tissues, ligaments disks and spinal cord. Any patient with suspected SCC should undergo an MRI examination as soon as possible to reveal the location and severity of spinal cord lesion. The presence of SCC needs to be distinguished from non compressive spinal cord abnormalities. Therefore, we look for masses or other pathological processes that exert extrinsic mass effect on the spinal cord. If a mass causing dislocation, deformation or compression is noted, attention to the presence of high t2 signal abnormality is necessary. Notably, the presence of an ill defined t2 signal and swelling of the spinal cord parenchyma aboveand below the compression can sugget the presence of edema, suggesting acute compressive myelopathy.

Advanced MRI Techniques

This includes the diffusion-weigthed imaging (DWI), Diffusion Tension Imaging (DTI) and tractography. These technqiues are still in the experimental phases.

Myelo CT

Myelo CT is reserved to selected areas when MRI is not feasible or results are unclear, and can render additional information compared with MDCT. with an accurate visualization of the intradural extramedullary compartment. Myelo CT is less sensitive to metallic artifacts especially in cases of implants hardwares6, 7.

Traumatic Abdominal Emergencies

In multiply injured patients, abdominal injuries carries 19%-43% and are responsible for similar rates of death in the early hours after trauma as severe head injuries. Rapid diagnosis and treatment of patients with suspected blunt abdominal injuries is a difficult and challenging task for the trauma surgeon, because physical examination in trauma patients is often unreliable and non-specific. On one hand, morbidity and lethality of abdominal trauma is highly dependent on timely interventions. On the other hand, missed abdominal injuries are one of the leading avoidable causes of death in multiple traumatized patients, thus raising the need for rapid and valid diagnostic evaluation. The introduction of ultrasound and computed tomography has improved the diagnostic approach to patients with suspected abdominal and pelvic injuries.

Diagnostic Imaging of Abdominal Trauma

Ultrasound

Abdominal ultrasound has been widely accepted as the first step in radiological assessment. Ultrasound is of a particular value in deciding whether immediate surgical exploration is indicated for intraperitoneal hemorrhage in the hemodynamically unstable patients in addition, it is repeatable, non-invasive, non-radiating and inexpensive. In emergency radiology, there are two main trends in using ultrasound in the evaluation of blunt abdominal trauma. The first trend is the use of ultrasound mainly as a rapid and reliable diagnostic for free intra abdominal fluid. This method is termed ‘ focused assessment sonography for trauma” (FAST).

The second trend is widely accepted as the standard abdominal ultrasound should be performed by a well trained operator and should involve boh a full abdominal exploration with the particular attention to the peritoneal pouches for any internal solid organ indication of hemoperitoneum and a systemic solid organ analysis to detect any solid organ injuries.

Computed Tomography

If the patient is hemodynamically stable, CT is widely accepted as the imaging modality of choice for the detection of abdominal and pelvic injuries. With CT evaluation, a comprehensive and complete survey of the injuries obtained, which allows categorizing trauma patients according to the pattern and severity of their lesions and could help determine the pattern of their treatment. In the past, the time required for CT, including transport to and from the radiology department and interpretation of the CT image, exceeded 60 mins. With the evolution of MDCT scanners, the time needed for image

acquisition has been markedly reduced. Other important advanges of MDCT include thin-collimated submillimeter isoropic imaging enabling high quality reconstructions in any desired plane and improved contrast bolus exploitation allowing precise separation of multiple phases of enhancement which is especially useful in the evaluation of vascular diseases.

Magnetic Resonance Imaging (MRI)

As a third evolving imaging modality, magnetic resonance imaging offer some distinct advantages over CT; including lack of radiation exposure and less nephrotoxic contrast agent application. Due to several technical restrictions inherent in MRI including cludign the need for special equipment, emnt for anesthesia, lengthy examination times and the lack of rapid availability of MRI in the emergency setting, MRI has currently only a minor role in the evaluation of patients with suspected abdominal trauma.

Pelvic Injuries

Pelvic trauma includes a great mix of polymorphous lesions, differing from each other by their anatomical aspect, their context and the following therapeutic implications:

1. Isolated bone tear needing no particular treatment
2. Acetabular fractures with the major functional prognosis
3. High-energy trauma with pelvic ring disruption, vital lesions and hemorrhage implying emergency hemostais.

Pelvic ring fracture amount to 1. 5% of all joint fractures. The three basic mecansim lead to pelvic ring disruptions. They are based on the direction of the force imparted to the pelvis at the time of injury. They include:

1. Anterior compression
2. Lateral compression
3. Vertical shear

Diagnostic Imaging of Pelvic Trauma

Plain Films

The AP view of the pelvis is the basic incidence for pelvic trauma. It allows identification of ischio-illia line, illio-pectinal line (“ illio[pubic line), as well as anterior and posterior or acetubalr walls.

Computed Radiography

Computed Tomography has become an outstanding tool in pelvic imaging. Its technological improvements (helicoidal and multi-detector technologies)have recently increased its potential.

Because of its performance, CT indications tends to increase, for Hnter et al, they may be detailed as follows:

1. Acetabular Fractures
2. Dislocation of hip
3. All potential or recognized sacral fracture
4. All potential or recognized sacro-illiac injuries
5. Any question off stability in pelvic fractures

Magnetic Resonance Imaging (MRI)

Some studies have shown the superiority of MRI under particular circumstances such as the detection of intra-articular splinters, appreciation of the femoral head, and detection of hidden fractures mainly in the elderly; however its use remains minor with pelvic trauma in their acute phase.

Conclusion

Trauma is a major public health concern throughout the world and probably the most serious facing the world. The various improvement in imaging techniques has considerably increased the confidence of surgeons in management of both operative and non operative patients. Thus, emergency radiology has become a vital aspect of radiology and every emergency team should have their emergency radiology department close to themselves.

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