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A comparison of patient dose levels between 3/4 vessel conventional angiography and computed tomography angiography during examinations to investigate subarachnoid haemorrhage

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Abstract The aim of this study was to investigate and compare the levels of ionising radiation dose received by patients whilst undergoing radiological examination for Subarachnoid haemorrhage by conventional angiography (single and bi plane) and computed tomography angiography. The results obtained from previous examinations have been compared to consider which method of investigation delivers the lowest ionising radiation dose to the patient. Consideration was also given to comparing single plane angiography to bi plane angiography as empirical evidence suggested that radiologists received no formal training and only a small amount of informal training on newly installed equipment at the hospital in which the research was carried out. Would this lead to patients being inadvertently exposed to increased radiation as radiologists familiarised themselves with the equipment?

The dose received by 30 patients examined for SAH by each modality was converted to effective dose (mSv) for comparison. These results were then further compared by removing the lowest and highest recorded doses to eliminate any bias that may have been caused by skewed data. The results showed that CTA consistently delivered a lower dose to patients than single or bi plane angiography and that bi plane delivered a lower mean average dose than single plane angiography, with or without any skewed data.

Introduction

Statement of purpose

The single plane suite had been established at the site for several years and all the radiologists were familiar with the

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equipment and proficient at using it. However, empirical evidence suggests that the radiologists receive no formal training and only a small amount of informal training in the use of the newly installed equipment. If this is the case then they may be inadvertently exposing the patient to ionising radiation for longer as they familiarise themselves with the equipment, resulting in an increased dose to the patient.

Aim

To investigate and compare the levels of ionising radiation dose received by patients whilst undergoing radiological examinations for SAH by the following:

- CTA
- Conventional angiography (single plane)
- Conventional angiography (bi plane)

The purpose of this research project is to compare ionising radiation levels received by patients undergoing examination to investigate subarachnoid haemorrhage. The most frequently used radiological modalities for this examination are conventional angiography and computed tomography angiography (CTA). The reason for comparing CTA with conventional angiography is that there is evidence that CTA will become more routinely used than conventional angiography,[1,2] because, it is claimed to be a less invasive and more patient friendly procedure. However, there appears to have been little consideration given to the amount of ionising radiation received by the patients.

Subarachnoid haemorrhage

Subarachnoid haemorrhage (SAH) is an acute extravasation of blood that accumulates in the subarachnoid space, often following aneurysmal rupture, commonly in the circle of Willis. The subarachnoid space separates the arachnoid, a delicate serous membrane and the pia mater, a fine connective tissue containing numerous minute blood vessels.[3] The haemorrhages are usually defined by how they originated, i.e. the result of traumatic head injury or those that occurred spontaneously. Most SAH are aneurysmal in origin and account for approximately 85% of SAH. Although the incident rate of SAH is quite low, approximately 8–12 cases per 100,000 population every year,[4] the consequences of SAH can be very serious with approximately 50% of patients presenting with SAH dying within the first few days and many others suffering physical and/or psychological impairment.[5]

The low incident rate makes detection for general practitioners (GPs) very difficult,[5] they will most likely encounter patients with SAH once every eight years. The main clinical indication is the sudden onset of severe headache (nearly all within seconds). However, only one in eight patients presenting with sudden onset of severe headache as the only symptom will have SAH. Once at the hospital other potential diagnostic pitfalls are present, patients may present with atypical conditions such as coma, seizure, delirium or focal stroke. As a result of the uncertainty in being able to definitely diagnose SAH, early referral to hospital is very important to the patient's welfare.[5]

Literature review

Angiography is used to assess vascular abnormalities within the central nervous system (CNS), such as arteriosclerosis, aneurysms, transient ischemic attacks and SAH.[6] It is also used for interventional procedures, which are generally performed after non-invasive evaluation techniques have been employed. These interventional procedures are performed under sterile conditions within a specialised imaging suite with multi-planar imaging and digital subtraction facilities. For routine imaging angiographic X-ray tubes should have a minimum focal spot size of 1.3 mm and a magnification spot size of 0.3 mm. The procedure for SAH requires introducing a catheter into the vascular system guided by fluoroscopy, ideally into the femoral artery but the brachial or axillary arteries could be used depending on the patient's medical history. The image intensifier must be able to move around the patient to allow various tube angles without moving the patient.[6]

Reducing radiation exposure to patient and staff

Radiation exposure during fluoroscopy is directly proportional to the length of time the unit is activated.[7] Therefore radiation doses during angiography examinations can be kept to a minimum by the following:

- Not exposing the patient if not viewing the TV image.
- Pre-planning images, i.e. ensure correct patient position before imaging.
- Avoiding redundant projections.
- Operators must be aware of the 5-min time notifications.

Operator's exposure can be reduced by maintaining as much distance away from the patient as possible and warning other staff when they are about to expose, allowing them time to move away from the patient. The patient's radiation dose can be minimised by decreasing the image intensifier (II) to patient air gap.[8]

CTA is considered less invasive to the patient as the procedure does not require catheterisation but instead uses a peripheral intravenous injection via an automated pump system.[9] This requires careful timing so that the contrast is in the vascular area of interest during the CTA examination. At the hospital site chosen to conduct the research Siemens Combined Applications to Reduce Exposure (CARE Bolus) programme was used to ensure optimised contrast monitoring. A radiation dose consideration here for staff is that there is no requirement for them to be present in the room during scanning.

To keep the radiation dose as low as possible, operators must consider the image quality needed, which can be achieved by the correct use of the equipment and keeping the equipment in optimal condition.[10] The dose can be limited by selecting a low integrated tube current (mAs), a limited scan range and a high pitch.[10] To maintain the CT scanner in optimal condition, a daily calibration is required by performing a series of blank scans (i.e. scans with only air around the gantry). Also image quality and constancy must be maintained by the use of phantom measurements, all of which will help to ensure the patient receives as low a dose as possible.