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Abstract We wished to measure the absorbed radiation dose during fluoroscopically controlled vertebroplasty and to assess the possibility of deterministic radiation effects to the operator. The dose was measured in 11 consecutive procedures using thermoluminescent ring dosimeters on the hand of the operator and electronic dosimeters inside and outside of the operator's lead apron. We found doses of 0.022-3.256 mGy outside and 0.01-0.47 mGy inside the lead apron. Doses on the hand were higher, 0.5-8.5 mGy. This preliminary study indicates greater exposure to the operator's hands than expected from traditional apron measurements.

Keywords Vertebroplasty · Radiation dosimetry

Introduction

Vertebroplasty is an effective interventional radiological procedure consisting of the percutaneous injection of a tissue cement, usually methyl methacrylate, into weakened vertebral bodies [1, 2, 3, 4]. The principal indications are osteolytic metastasis and myeloma, painful or aggressive haemangioma, and osteoporotic vertebral collapse with debilitating pain despite appropriate medical treatment. In most institutions the procedure, especially the injection of the cement, is performed under continuous fluoroscopic control to access filling and avoid leakage, which could result in major complications. The radiation risk to the radiologist is therefore high; the absorbed dose might cause deterministic dosedependent damage. There are reports on radiation exposure to the operator in neurodiagnostic and interventional procedures [5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19], but to our knowledge none is available concerning vertebroplasty procedures. Our aim was therefore to measure the absorbed radiation dose during fluoroscopically controlled vertebroplasty and to evaluate the possibility of deterministic radiation effects to the operator.

Materials and methods

Over a period of 3 months, 11 patients, six women, five men, mean age 68 years, underwent fluoroscopically guided vertebroplasty for pain due to metastases. They had been referred from the oncology department and were fully informed about the procedure, which has been approved by our ethics committee. Clinical assessment included immediate and follow up studies of the patient's pain, general condition and neurological status.

Radiation dose in vertebroplasty

The patients were under general anaesthesia and placed prone on the table of the biplanar fluoroscopy unit (BV 3000, Philips, The Netherlands). Imaging was performed with digital subtraction angiography (DSA) equipment fluoroscopic control of needle placement and cement injection into the vertebral body. The interventions were performed by an experienced neuroradiologist with personal experience of more than 300 vertebroplasties. The needle was positioned aiming towards the vertebral body by using fluoroscopic landmarks. An anteroposterior projection was used until the needle passed through the posterior cortex of the vertebral body; thereafter the lateral projection was used. Using biplane fluoroscopy speeds up the procedure. Then contrast medium was injected through the needle to obtain a phlebogram. Methyl methacrylate, (18 cc powder) and barium (2 cc) were mixed with 5 ml of liquid polymer, giving a mixture with a polymerization time of up to 8 min. This mixture was injected under lateral fluoroscopic control.

Measurements were made on the operator's hand, using a lithium fluoride thermoluminescent dosimeter ring and on the chest with two electronic dosimeters, one inside and one outside the lead apron.

Results

Total fluoroscopy times were between 10 and 60 min. Tube dosage was 14.5-170.3 mGy (mean 170.3 mGy). Measurements on the operator were 0.022-3.256 mGy outside and 0.01-0.47 mGy inside the lead apron, and 0.5-8.5 mGy on the hand.

Discussion

This preliminary study indicates significant exposure to the hands of the operator during percutaneous vertebroplasty, which may be underestimated by traditional

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apron measurements. It is important to reduce this exposure of the hands by reducing the time the hands are in the radiation field or using devices which can be manipulated with the hands outside it. During vertebroplasty the operator often needs to manipulate the needle under fluoroscopic control to insure proper placement. This can induce radiation damage to the skin after repeated interventions.

Overall the introduction of digital fluorography has significantly reduced radiation dose to the patient [9]. It is important to be aware that high doses per image in digital fluorography does not necessarily improve image quality [10]. Increased filtration can further reduce radiation dose, as has been demonstrated in proctography [8]. Kuon et al. [13] demonstrated that additional security measures could drastically reduce radiation exposure in interventional cardiology. Zweers et al. [17] found that in TIPS, the use of dedicated fluoroscopy exposure factors, with a relatively high tube voltage and lower tube current resulted in a significant dose reduction to patients and staff. Some of these interventions could also be performed on open MRI systems to avoid ionising radiations.

Clearly these results need to be confirmed in larger series under different conditions, including improved filtering and reduced radiation-dose protocols, but they underline the importance of radiation protection for the personnel involved in these procedures which are being performed increasingly frequently.

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