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CASE REPORT

Evaluation of vascular supply with cone-beam computed tomography during intraarterial chemotherapy for a skull base tumor

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Abstract A cone-beam lowers the X-ray exposure level and the contrast material dose used compared to those for the conventional angiography-computed tomography (angio-CT) technique. Herein we present a patient with a metastatic skull base bone tumor in which the subtraction image of cone-beam CT with a flat panel detector was useful for evaluating the vascular supply during superselective intraarterial chemotherapy. Although the image quality of cone-beam CT is poorer than that of conventional angio-CT, the cone-beam CT system is sufficient for clinical use.

Key words Skull bone tumor · Cone-beam CT · Interventional radiology · Flat panel detector

Introduction

A combination of radiotherapy and superselective intraarterial infusion chemotherapy is one of the effective treatments for head and neck cancers.[1–4] With this procedure, it is essential that the anticancer agent be administered effectively into the tumor vessels. Angiography is used to identify tumor vessels, but their precise identification is sometimes difficult with angiography alone in cases with poor tumor staining or if there are multiple feeding vessels. In those cases, angiography-computed tomography (angio-CT) is useful for depicting the tumor stain and feeding arteries.[5] Angio-CT, however, needs a large space for the interventional radiology (IVR) system and CT gantry. It also needs more contrast medium, exposes the patient to more radiation, and requires that the patient be moved between the angiography and CT tables.

Cone-beam CT images are reconstructed from rotational data obtained by a fluoroscopic system. This modality yields digital subtraction angiograms and CT images at the same time. The fluoroscopic system for angiography used to be equipped with an image intensifier (I.I.) system. However, spatial and contrast resolution of I.I. was not good enough to obtain cone-beam CT images useful for clinical use. Recently, an angiography system using a flat panel detector (FPD) was introduced clinically. The FPD is superior to the I.I. in various respects, such as resolution and contrast, and thus FPD improved the quality of cone-beam CT images.[6–9]

We recently applied this device clinically for superselective intraarterial infusion chemotherapy for malignant head and neck tumors. Herein we present a case of a metastatic skull base bone tumor in which the subtraction image of cone-beam CT with a flat panel detector was useful for identifying the tumor vessel during the procedure for superselective intraarterial chemotherapy.

Case

A 74-year-old man presented with a metastatic bone tumor in the right temporal bone and the clivus from an undifferentiated carcinoma of the lung (Fig. 1a). Superselective intraarterial infusion chemotherapy using an angiogram system with a cone-beam CT system fitted with

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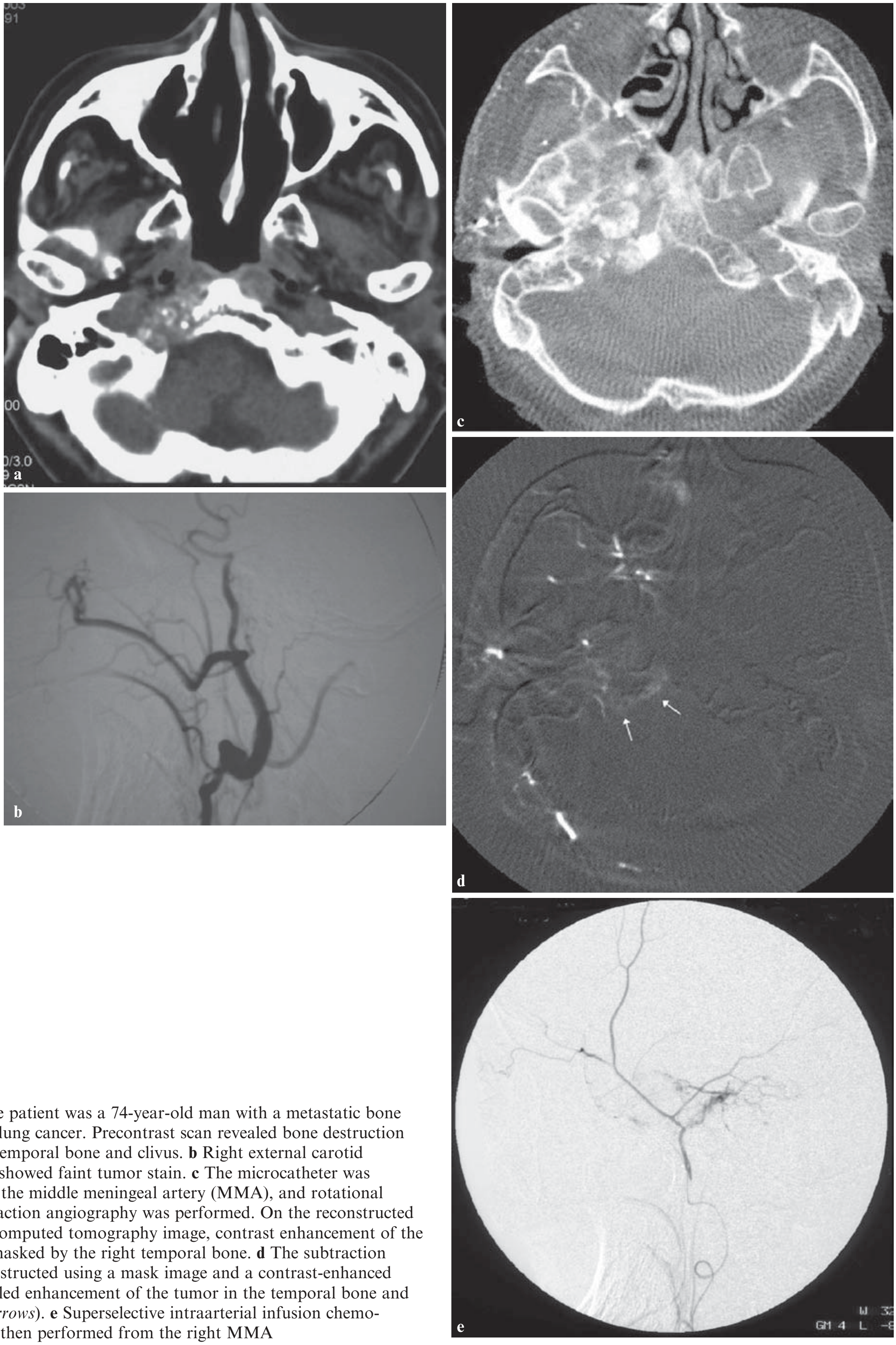

Fig. 1. **a** The patient was a 74-year-old man with a metastatic bone tumor from lung cancer. Precontrast scan revealed bone destruction in the right temporal bone and clivus. **b** Right external carotid arteriogram showed faint tumor stain. **c** The microcatheter was advanced to the middle meningeal artery (MMA), and rotational digital subtraction angiography was performed. On the reconstructed cone-beam computed tomography image, contrast enhancement of the tumor was masked by the right temporal bone. **d** The subtraction image, reconstructed using a mask image and a contrast-enhanced image, revealed enhancement of the tumor in the temporal bone and the clivus (*arrows*). **e** Superselective intraarterial infusion chemotherapy was then performed from the right MMA

a flat panel detector combined with concurrent radiotherapy was planned. The ethics committee approved the study, and the patient provided informed consent.

Right external carotid arteriography was performed to confirm the vascularization of the tumor. Tumor staining was suggested in the middle meningeal artery (MMA), but it was faint (Fig. 1b). The microcatheter was advanced into the MMA, rotational digital subtraction angiography (DSA) was performed, and cone-beam CT images were reconstructed. Although contrast enhancement of the tumor was masked by the right temporal bone, the subtracted images revealed enhancement of the tumor in the temporal bone and the clivus (Fig. 1c,d). Based on the results of cone-beam CT, intraarterial infusion chemotherapy was performed from the MMA (Fig. 1e).

Equipment details

The cone-beam CT system we used was an IVR imaging system fitted with FPD (Partire; Hitachi Medical, Tokyo, Japan), which has a ceiling-run-type C-arm panel structure. The FPD in this system used the indirect method with X-ray conversion of cesium iodide (CsI). A thin film transistor (TFT) was used for reading out. The visual field had dimensions of 40×30 cm and pixel size of 194 μm (equivalent to I.I. 16 inches). The uptake mode was $2048 \times 1536 \times 7.5$ frames per second (fps) for imaging and $1024 \times 768 \times 30$ fps for fluoroscopy.

Three-dimensional (3D)-angiography and cone-beam CT scans were performed under the following conditions: source-rotating center distance 730 mm; detector-rotating center distance 470 mm; imaging range 200°; time needed for rotary imaging 5 s/200° rotation; X-ray tube voltage 100–110 kV; X-ray tube current 10–400 mA; X-ray pulse width 5 ms.

The visual data collected were subjected to 2×2 pixel summation to yield 512×384 pixel data, which were then subjected to projective processing (correction for sensitivity, logarithmic conversion, and so on) and correction for overflow of the object beyond the visual field. Images were then reconstructed using the method of Feldkamp. Image reconstruction using complete 180°-wide data was possible for a cylindrical area with a diameter of about 235 mm and a height of about 176 mm. The pitch of reconstruction could be selected from the range of 0.1–0.5 mm. Finally, 512×512 pixel images were reconstructed. The subtraction CT images were also available using mask images obtained during DSA.

Time needed for the data transfer was 3 min, and reconstruction for 20 slices took 1.5–2.0 min. Therefore, in this case, the time needed to obtain 20 axial CT images and 20 axial subtraction images was 7 min in all.

Discussion

It is essential that, for intraarterial infusion chemotherapy to be effective, the medicine must be infused into the tumor adequately.[1–4] As the head/neck region is morphologically complex, it is difficult to judge the feeding vessels on the basis of frontal or lateral imaging alone. In those cases, angio-CT is useful for identifying tumor feeding vessels.[5]

However, the angio-CT system needs a large space for both the IVR and CT systems, and more time is needed to move patients (or the CT gantry) from the IVR system to the CT system. Moreover, performing CT scans in addition to a DSA procedure requires more contrast material and more X-ray exposure.

The cone-beam CT system can provide angiogram and cone-beam CT image data by one angio-system, which saves the space occupied in the examination room.[6–9] Because CT images are reconstructed from rotational DSA data, this system can lower the contrast material dose and X-ray exposure level during each procedure.[7,8]

The clinical usefulness of cone-beam CT has been reported for the maxillofacial area and for planning radiation therapy.[10–12] In the present case, subtraction images obtained from cone-beam CT made it possible to depict the area of the contrast-enhanced tumor and allowed us to identify the feeding vessels.

The time required to obtain transverse cone-beam CT images was about 5 min after rotational DSA imaging. Also, subtracted images could be reconstructed within a few minutes with cone-beam CT, which allowed the evaluation of intraosseous lesions. Considering the time required for the angio-CT system to move the patient or CT gantry, 5–7 min to reconstruct cone-beam CT images seems acceptable for clinical use.

Depicting the contrast-enhanced tumorous area is the most important information required from CT images during the IVR procedure. Therefore, although the image quality of cone-beam CT with FPD is inferior to that of conventional CT,[13] this system is sufficient clinically to clarify the contrast-enhanced tumor and the feeding vessels for IVR procedure.

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