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Application of DynaCT in interventional neuroradiology

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Summary

Background: DynaCT (Angiographic CT) is a new imaging technique that with the use of the angiographic apparatus allows the researchers to obtain images of the human body comparable to standard CTs. Owing to this, only one procedure gives us the possibility to evaluate the vascular system together with the surrounding soft tissues

Material/Methods: DynaCT, similarly to the 3D DSA method, involves the use of a C-arm rotating around the patient during the acquisition process. Like in CT, the acquired data may be processed into secondary reconstructions: multiplanar (MPR), maximum-intensity projections (MIP) and volume rendering (VR).

Results: Neuroradiologically obtained images allow for an assessment of such brain structures as: ventricular system, subarachnoid cisternae and, to a lesser degree, brain tissue. In case of examinations with intra-arterial contrast administration we get precise images of the vascular system together with cranial bone structures and soft tissues, comparable (from the qualitative point of view) to those obtained during the angioCTs using multi-slice scanners. In case of angioplasty, DynaCT with contrast administration provides us with information on the exact location of a stent inside a vessel. Similarly, in patients with aneurysms embolised with stents, this technique enables the visualization of the stent position in relation to the neck of the aneurysm. Owing to DynaCT, it is possible to quickly evaluate the complications which may appear during endovascular procedures, especially the intracranial bleeding.

Conclusions: DynaCT provides us with information that facilitates the process of qualification for the surgical or intravascular treatment. It also allows for a fast evaluation of possible complications which may appear during endovascular procedures, without wasting time for patient's transfer to the CT room.

Key words: DynaCT • interventional neuroradiology

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Background

DynaCT (Angiographic CT) is a novel technique of diagnostic imaging that is still an optional mode in every state-of-the-art angiographic apparatus. It can be used to obtain the images of the human body similar to the ones received in standard computed tomography (CT). With a standard angiographic examination it is possible to visualise only the structures of a very high density, (such as bones), as well as the contrast medium inside the lumen of the blood vessels. Very often, to find the final diagnosis, to qualify the patient to the right treatment procedure, or to evaluate the performed intravascular interventional procedure, it is necessary not only to perform a precise evaluation of the vascular system, but also to visualise the surrounding soft tissues. The DynaCT technique enables us to obtain such information without carrying out a separate CT examination.

The aim of the work was to present the DynaCT technique on the basis of own experiences.

Material and Methods

The name DynaCT was introduced by Siemens company which was the first to introduce this method to its angiography equipment of Axiom Artis family. The state-of-the-art angiography systems have a free-rotation option used in

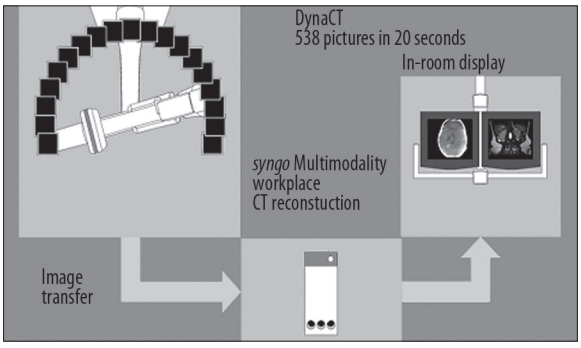

Figure 1. Technique of DynaCT examination (from SIEMENS manual).

angiography with 3D reconstruction, as well as flat detection panels that replaced the electronic image intensifier.

The DynaCT method, similarly to 3D angiography, uses the technique of an automated C-arm rotation around the patient, with a concomitant data acquisition. While the time of the C-arm rotation (by 220°) during rotation angiography amounts to 5 seconds, this is 20 seconds for the DynaCT examination of the head. During those 20 seconds there is one acquisition performed every 0.4°, and the total number of projections amounts to 538. A high number of projections is required to obtain a proper contrast resolution of the brain image. In case of examinations of other body areas, with larger differences in tissue density, the rotation time amounts to 10 seconds and the number of acquisitions is accordingly lower. The radiation dose absorbed by patients during such a study is comparable to the dose absorbed during the CT examination [1]. The obtained image data are then sent to a satellite control desk, where they are processed and (as in CT) used for reconstructions – multiplanar (MPR), maximum-intensity projections (MIP) and volume rendering (VR) (Figure 1).

The DynaCT examination, similarly to the CT study, may be performed as a plain CT scan or after contrast administration applied intraarterially through a catheter inserted into a specific vessel, and thus to a given vascular area. Owing to that, it is possible to obtain a very good contrastation of the vascular system, but on a limited area. In order to avoid the artifacts of hardening of the radiation beam (due to a high density of the contrast medium), the contrast is diluted with the saline, up to the concentration of 15–30%.

The concentration of the contrast medium used in the examinations evaluating the intravascular stent position is even lower. The contrast medium filling the vascular lumen shows precisely its anatomy; and thanks to the low concentration of that contrast medium, there is no blurred image of the wire tube, which allows for a precise evaluation of its location in the vascular lumen.

From the year 2006 until June 2009, in the Laboratory of Angiography and Interventional Radiology of the Clinical Hospital in Cracow, we performed 130 examinations with DynaCT technique. In 50 cases, the examination was carried out with intraarterial administration of the contrast medium: to obtain some additional information supplementing the diagnostic data in 48 cases and to follow the aneurysm embolisation with the use of a stent in 2 cases.

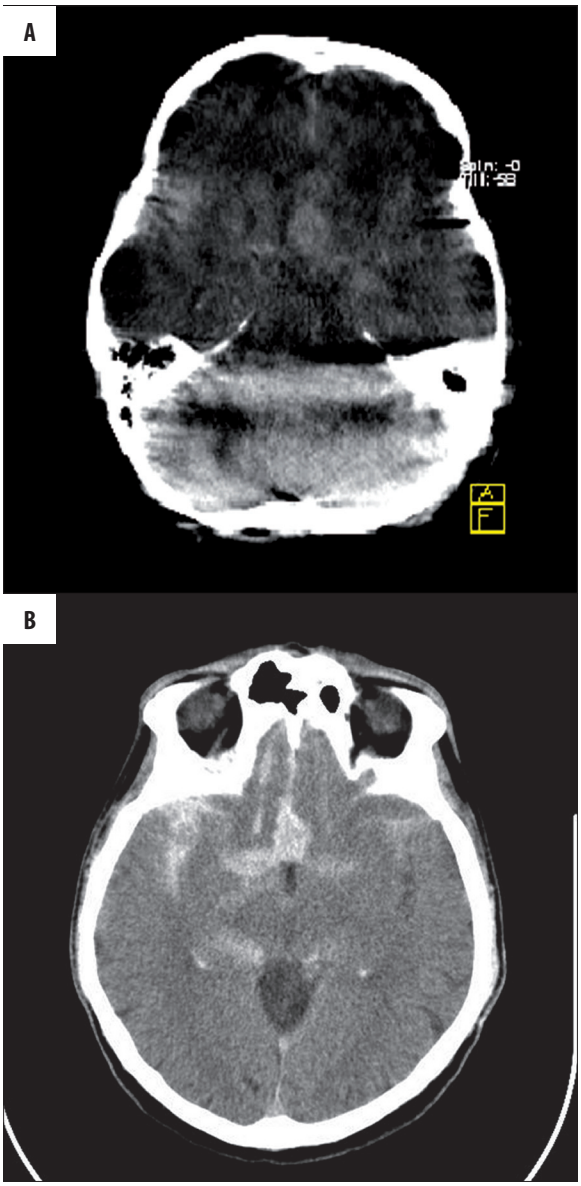

Figure 2. Comparision of DynaCT (**A**) and computer tomography (**B**) examinations in patient with subarachnoid hemorrhage.

The remaining 80 examinations were performed without contrast administration after intravascular embolisation of the aneurysms and haemangiomas of the brain vessels.

Discussion

In neuroradiological procedures, the DynaCT images allow for a sufficiently precise evaluation of the most important brain structures. There is a visible distinction between the white and grey matter, and the basal ganglia. It is also possible to assess the ventricular system in detail – the width of the ventricles, presence of dislocations, and the width of the subarachnoid cisternae. Spatial resolution of the images is the same as in the basic computed tomography – 512×512, while the contrast resolution is distinctly lower. It is impossible to measure the degree of radiation absorption in the Hounsfield scale. That is why, in comparison to the CT, this method is not suitable to evaluate the early symptoms of brain ischaemia.

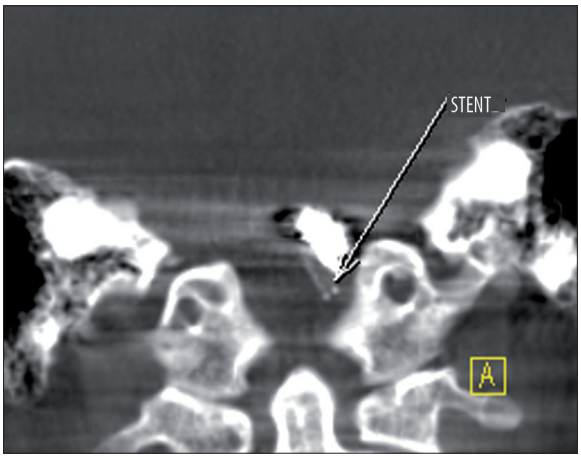

Figure 3. Dyna CT – MPR reconstruction, vertebral artery aneurysm after stent-assisted coiling.

Examinations with intraarterial contrast administration provide us with precise images of the vascular system, together with surrounding soft tissues and cranial bone structures, qualitatively comparable to the images obtained in angio-CT examinations with the use of multi-slice CT scanners. The data obtained in such a way facilitate the diagnosis of the type of vascular pathology and enable patient's qualification for the surgical or intravascular treatment. This makes the time of the full diagnosis shorter in patients with the diseases of brain vessels who are often hospitalised due to intracranial bleeding, in life-threatening condition.

One of the most important applications of the DynaCT technique is the evaluation of intravascular interventional procedures with respect to the haemorrhagic complications that may appear during such procedures. Extravasated fresh blood in cranium is equally well visualised with the angiographic CT, as with the computed tomography. It is possible to quickly evaluate: the intensity of the bleeding, the presence of haematoma in brain tissue and the mass effect connected with it, as well as the presence of blood in the ventricular system and subarachnoid space (Figure 2). A precise analysis of the width and potential dislocation of the ventricular system, as well as the degree of brain oedema is also possible. However, the evaluation of the structures within the posterior cranial cavity is still difficult at this level of DynaCT advancement, due to the artifacts from bones, more marked than on CT. The possibility of quick evaluation of the complications following interventional procedures, without transporting the patient to the CT room, substantially shortens the time of introduction of proper activities and considerably improves the security of the patient [2].

In angioplastic procedures, the DynaCT examination with contrast medium administration allows for localisation of the implanted stent within the blood vessel. Stents, currently used in interventional neuroradiology, are made of nickel titanium, which is invisible during fluoroscopy. There are only spots of marker visible at each end of the stent, or some single threads weaved into the metal tube. The result of the procedure is observed in angiography as a widened lumen of the blood vessel, while in DynaCT it is

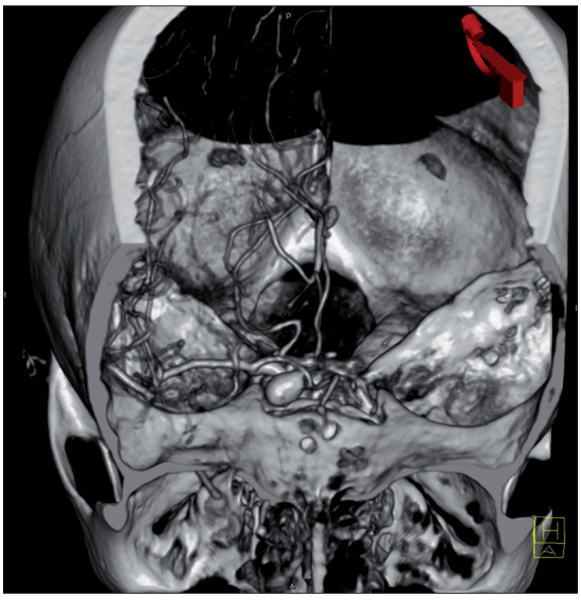

Figure 4. Dyna CT – VR reconstruction, internal carotid artery aneurysm.

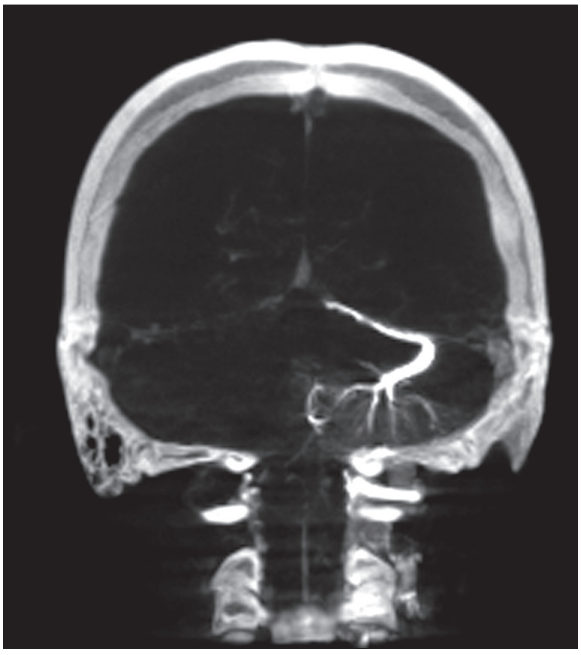

Figure 5. DynaCT – MIP reconstruction, venous malformation of the cerebellar hemisphere.

also possible to evaluate the exact location and the degree of mesh expansion in relation to the vascular wall [3–6].

Similarly, in aneurysm embolisation with the use of stent, the examination allows for stent localisation in relation to the aneurysm (Figure 3). This is particularly important in aneurysms with wide necks, located within vascular ramifications, when it is possible to evaluate (with high precision) the degree in which the neck of the aneurysm is filled with the stent mesh, which is equal to the degree in which the lumen of the vessels coming of the base of the aneurysm is protected. It is also possible to quickly and precisely detect stent dislocation in relation to the aneurismal

sack and to make decision on further treatment process [7–9].

DynaCT is also used as a method supplementing angiography in the diagnostics of brain aneurysms located in the cranial base, within the internal carotid artery, where the choice of the right treatment method requires not only the assessment of the morphology of the aneurysm, but also the evaluation of its location in relation to the bony structures (Figures 4,5).

Conclusions

With DynaCT, the interventional neuroradiology received an additional, very useful imaging diagnostic tool. By applying this tool, we may perform a quick evaluation of the interventional procedures and obtain information facilitating treatment planning, without transfering the patient to the CT room, which increases patient's safety.

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