学 位 論 文 の 要 旨

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学　位　論　文　名　Magnetic Resonance Imaging Based Evaluation of Diagnostic Accuracy of Dual-energy Computed Tomography for Intracranial High Density Areas After Mechanical Thrombectomy

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論 文 内 容 の 要 旨

INTRODUCTION

Mechanical thrombectomy (MT) is an effective neuroendovascular treatment for acute cerebral infarction caused by large cerebral vessel occlusion. However, hemorrhagic complications such as subarachnoid hemorrhage and intraparenchymal hemorrhage will occur at a certain rate. On the other hand, extravascular leakage of the contrast medium is observed after MT due to the disruption of the local blood-brain barrier from acute cerebral ischemia. Since both conditions are depicted as similar high density area in subarachnoid spaces or brain parenchyma on conventional single-energy CT (SECT) scans. It has been difficult to distinguish hemorrhagic complications from contrast agent leakage. Dual-energy CT (DECT) has two different X-ray energies to image the target and obtains different X-ray absorption values from the same object. Thereby, DECT can provide a high discrimination ability with respect to the object being imaged and is expected to have clinical utility in differentiating blood, contrast media, and calcification. Recent reports described DECT may be useful to distinguish the hemorrhagic complications from contrast leakage after endovascular treatment. There are few reports to compare the diagnostic accuracy of DECT with MRI. The purpose of our study was to validate the diagnostic accuracy of DECT for hemorrhagic complications and leakage of contrast after MT by MRI.

MATERIALS AND METHODS

We retrospectively analyzed patients with acute cerebral infarction caused by large cerebral vessel occlusion and treated with MT at National Hospital Organization Hamada Medical Center

between January 2019 and May 2020. Indication for MT was based on the Japanese Guideline for the Management of Stroke 2021. Thrombectomy was performed by a stent retriever or aspiration catheter or both. SECT and DECT examination were performed immediately after the treatment on a DECT system (Aquilion One GENESIS Edition, Canon Medical Systems, Tochigi, Japan). MRI was performed with a clinically dedicated system at 3.0 T (MAGNETOM Skyra, Siemens AG Medical Group, Erlangen, Germany) using a circular polarized head coil. Postoperative SECT, DECT and MRI were evaluated by an experienced radiologist on blinded clinical data. The diagnosis of hemorrhagic complications was confirmed by T2*-weighted gradient-echo sequence (T2*GRE) taken within 24 hours after MT. All DECT imaging findings were comparatively referred to T2*GRE and evaluated for the hemorrhagic lesions or the contrast medium leakage. The location and size of the intracranial hemorrhage (ICH) and symptomatic ICH were diagnosed based on the Heidelberg classification of bleeding. All patients who underwent DECT and follow-up MRI were included in the analysis. Patients were divided into positive and negative DECT groups, and hemorrhage and no hemorrhage groups, and the predictive values were calculated. A statistical analysis was performed with EZR. This study was approved by ethics committee of National Hospital Organization Hamada Medical Center (No. 0415), and Shimane University Faculty of Medicine (No. 20221019-2).

RESULTS AND DISCUSSION

MT was conducted in 73 patients during the study period, and 58 patients were subjected to this study. The patient characteristics were as followed. The mean age was 77.1 ± 13.2 years, and 22 (43%) were male. The mean National Institutes of Health Stroke Scale (NIHSS) was 21.2 ± 8.8 and diffusion weighted imaging - Alberta Stroke Program Early CT Score (DWI-ASPECTS) was 7.0 ± 2.2. The main occlusion site of large cerebral vessel was M1 part of middle cerebral artery in 35 patients (60.3%). The intravenous recombinant tissue plasminogen activator (rt-PA) was administered in 27 (47%) of patients. 53 (91%) of patients were accomplished successful recanalization with the cerebral vessels of the Score of Thrombolysis in Cerebral Infarction (TICI) 2b or 3 by MT. The mean time from the onset to the recanalization was 323 ± 206 min, and from the puncture to the recanalization was 68.5 ± 33.4 min. There were 19 (32.8%) cases of ICH associated with the MT, and symptomatic ICH in this study was one patient (1.7%). High density area was detected on SECT in 22 of 58 patients. Of these, 11 were DECT-positive and 11 were DECT-negative. Among the 11 DECT-positive, ten were diagnosed with hemorrhage. On the other hand, among the 11 DECT-negative, four were diagnosed with hemorrhage. Whereas there were All 36 cases that showed no high density area on SECT, and DECT-negative. But five of them were eventually diagnosed as hemorrhage. The diagnostic accuracy of DECT with T2*GRE was a sensitivity of 52.6% (9/19), specificity of 97.4% (38/39), positive predictive value of 90.9%

(10/11), negative predictive value of 80.9% (38/47) and accuracy rate of 82.8% (48/58).

ICH is the most common complication associated with MT. The incidence was previously reported to be 5.7% in symptomatic ICH and 41% in asymptomatic ICH. And recurrent postoperative vessel occlusion is also another serious complication associated with MT. In past study, the incidence of recurrent occlusions after MT was 1.8%, the average time to recurrence was 2 days, and anticoagulants were not initiated in 74% of recurrent cases. Although it is desirable to initiate anticoagulants as soon as possible after MT to avoid recurrent occlusions, early administration of anticoagulants may make worse the ICH. Therefore, it is very important to make an accurate differential imaging diagnosis between postoperative hemorrhage and contrast agent. DECT has advantages as a post-MT imaging method because it can be performed in a short time and is less burdensome to patients. Recently, a systematic review stated of hemorrhagic events and contrast medium after MT with DECT. Their review article stated a sensitivity of 77% and specificity of 100% for DECT, indicating its excellent diagnostic ability. But most of their reference images for DECT that were used to diagnose of ICH were follow-up SECT images. SECT might have a difficulty to detect small hemorrhages that may be disappear in a short period. In our study, the sensitivity was 52.6%, specificity 97.4%, positive predictive value 90.9%, negative predictive value 80.9%, and accuracy rate 82.8%, which are not inferior to previous reports except sensitivity. Especially the specificity was high, suggesting that DECT is effective in detecting ICH immediately after MT. Whereas, we considered following two reasons for the lower sensitivity. First, it is the higher diagnostic accuracy of MRI for bleedings compared to SECT. T2*GRE can depict micro hemorrhagic changes immediately after MT that cannot be detected by SECT. We believe that our study may have supplemented hemorrhagic lesions that could not have been detected in previous studies. Second, it is the interval of DECT and MRI. Even if there is no immediate postoperative hemorrhage on DECT, delayed micro-ICH could occur late and be detected on MRI. So, the interval may affect the diagnostic accuracy of DECT that was performed immediately after MT.

CONCLUSION

This study revealed the high specificity of DECT for the diagnosis of hemorrhagic complications after MT for acute stroke based on MRI evaluation. It was also demonstrated that the selection of reference images and the interval between DECT and reference images affect the diagnostic accuracy of DECT.