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Meta-analysis of diagnostic significance of sixty-four-row multi-section computed tomography angiography and three-dimensional digital subtraction angiography in patients with cerebral artery aneurysm

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ABSTRACT

Objective: Imaging methods are essential in evaluating cerebral artery aneurysms and they have evolved with recent technical advances. Sixty-four-row multi-section computed tomography (64-MSCT) angiography and three-dimensional digital subtraction angiography (3D-DSA) are two of the most popular methods. We sought to systematically explore and find out which one would be better in imaging cerebral artery aneurysm, and try to investigate the potential use and value of 64-MSCT angiography and 3D-DSA in cerebral artery aneurysm.
Method: Followed by a predefined comprehensive literature search, we carefully searched both English and Chinese electronic databases for potentially relevant studies following our meta-analysis. Two reviewers independently assessed the methodological quality of the included eligible trials based on quality assessment of studies of diagnostic accuracy studies (QUADAS). Pooled summary statistics for sensitivity, specificity, positive and negative likelihood ratios (positive LR and negative LR), and diagnostic odds ratio (ORs) with their 95% confidence intervals (CIs) were utilized.
Results: Final meta-analysis of 923 cerebral artery aneurysm cases were incorporated from eight cohort studies and selected for statistical analysis. Pooled sensitivity and specificity of 64-MSCT angiography in the diagnosis of cerebral artery aneurysm were 0.97 (95% CI, 0.96–0.98) and 0.91 (0.88–0.94), respectively. The pooled positive LR was 7.68 (95% CI, 3.34–17.67); and the pooled negative LR was 0.04 (95% CI, 0.03–0.05). The pooled diagnostic OR was 263.69 (95% CI, 121.19–573.77). The area under the SROC curve was 0.9934 (standard error [SE] = 0.0031). No significant evidence of publication bias was detected ($P > 0.05$).
Conclusion: The main finding of our meta-analysis revealed that 64-MSCT angiography relative to the 3D-DSA may have a high diagnostic accuracy for the cerebral artery aneurysm. Thus, 64-MSCT angiography may be an effective tool for the early detection of cerebral artery aneurysm.

1. Introduction

Cerebral artery aneurysm, also named intracranial cerebral aneurysm, is widely known as one of the most common and serious cerebrovascular events [1]. A previous report in this field has demonstrated that chronic inflammation might have a negative influence on degeneration in the cerebral artery aneurysm wall, which will increase the potential risk of rupture rate of an aneurysm [2]. Furthermore, ruptured cerebral aneurysms, which vary with its morphological features and patient's medical history, is one of the leading causes of morbidity and fatality in patients with subarachnoid hemorrhage [3]. In the United States, a recent epidemiologic study has shown that among a population of 100, approximately 2 people might be affected by cerebral artery aneurysms, and approximately 15,000 patients will die of complications from ruptured cerebral artery aneurysms each year [4]. In addition, it has been reported that the incidence of cerebral artery aneurysm varies greatly across gender, with a higher prevalence in women and conversely a lower prevalence in men [5]. Meanwhile, investigations have found that the recurrence rate of cerebral artery aneurysms is higher than expected, which becomes a considerable challenge [6]. As for the etiology of cerebral artery aneurysms, it has been widely accepted to be induced by interaction between ambient and genetic factors [7]. A number of studies have shown that various factors such as chronic inflammation, hypertension, hemodynamic stress, arteriovenous malformations, and excessive alcohol consumption may be significantly related with an increased risk of cerebral artery aneurysms [1,5,8]. As we all know, a rapid radiological imaging evaluation of ruptured cerebral artery aneurysms can play an important role to the successful treatment of cerebral artery aneurysms [9]. To date, researchers have paid more attention to

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spiral computed tomography and digital subtraction angiography, two popular and useful imaging methods, which are extensively used in neurovascular imaging [10,11].

Sixty-four-row multi-section computed tomography (64-MSCT) angiography, also named x-ray computed tomography angiography (CTA), can reconstruct tomographic images in a variety of directions in the human body via three-dimensional horizontal scan with the help of computer-processed x-rays [12]. The whole practical process is achieved by digital geometry processing, which forms and produces a three-dimensional image of the scanned object from a series of two-dimensional radiographic images [13]. The usage of CTA has dramatically increased over the last two decades, especially in the United States, Europe, and Asia, and the main target crowd is children and adults [14,15]. This excellent technique is prevalent and widely applied in medical imaging for diagnostic and therapeutic goals [16]. For example, with regard to the application, 64-MSCT angiography can provide more accurate and detailed data for analyzing the internal and external structures of organs and tissues of the patients examined, such as patients with gastric cancer and perihilar cholangiocarcinoma [17,18]. Up to now, a great number of researchers have shown that CTA with the remarkable performance of rotational time of 0.6 s and slice thickness of 0.625 mm may be an alternative method for diagnosing and treating intracranial aneurysms [19,20]. To be more specific, imaging acquisition of 64-MSCT angiography requires only 1 minute or even less, and 64-MSCT is well tolerated by the majority of patients with high-risk acute subarachnoid hemorrhage [21]. The main characteristics of 64-MSCT angiography are that it can depict intracranial aneurysms at different locations and with high sensitivity and specificity; then, its unique advantages include non-invasivity, simplicity, rapidity, and better visualization, which are the prime determinants for it to become the preferred and first-intention diagnostic technique [22].

On the other hand, three-dimensional digital subtraction angiography (3D-DSA), used in a bony or dense soft tissue environment, is regarded as a fluoroscopy technique assisted by radiology to obtain vascular images [23]. The operating process is to form a pre-contrast image from radiological equipment; then, images are acquired after injecting contrast medium into the blood vessels and removing distracting structures from the first image [24]. Therefore, it was widely accepted that DSA primarily aims to image blood vessels with high image quality (<3 mm), results that are not possible using CTA imaging [25]. Although 3D-DSA is still considered as the gold standard for arterial imaging, especially for intracranial aneurysms, it is used less and less commonly and may be substituted by 64-MSCT angiography [26]. The reasons are that it is invasive, time-consuming, expensive, and stressful for patients with intracranial aneurysms [27]. Hence, previous large studies demonstrated and concluded that 64-MSCT angiography is a more appropriate and feasible alternative to diagnose intracranial aneurysms with significant advantages in the reduction of contrast medium dose and x-ray exposure time [21]. Yet inconsistent results were also found in other relevant documents [22,28]. In the current meta-analysis, the purpose of this study was to explore the utility of 3D-DSA and 64-MSCT angiography in describing the imaging characteristics of patients with cerebral artery aneurysms and have a potential judgment on which imaging detection method is more available and reliable to the present diagnosis of cerebral artery aneurysm.

2. Materials and methods

2.1. Literature search

The following computerized bibliographic databases were applied to identify relevant articles related to the association of 64-MSCT angiography with cerebral artery aneurysm diagnosis, with no restrictions on language or data collection: PubMed, Embase, CINAHL, and Science Citation Index, the Cochrane Library, Current Contents Index, Chinese Biomedical, the Chinese Journal Full-Text, and the Weipu Journal. ("Multi-slice computed tomography angiography" or "Multi-slice CT angiography" or "MSCTA" or "MS-CTA" or "64-section multidetector CT angiography" or "MSCT" or "multislice computed tomography coronary angiography" or "64-section CT angiography" or "64-MSCT angiography" or "64-section CT scanner") and ("intracranial aneurysm" or "intracranial aneurysm" or "intracranial aneurysms" or "Anterior Communicating Artery Aneurysm" or "Anterior Communicating Artery Aneurysms" or "Basilar Artery Aneurysms" or "Basilar Artery Aneurysm" or "Middle Cerebral Artery Aneurysms" or "Posterior Cerebral Artery Aneurysm" or "Posterior Cerebral Artery Aneurysms" or "Berry Aneurysm" or "Berry Aneurysms" or "Brain Aneurysm" or "Brain Aneurysms" or "Cerebral Aneurysm" or "Cerebral Aneurysms" or "Giant Intracranial Aneurysm" or "Giant Intracranial Aneurysms" or "Intracranial Mycotic Aneurysm" or "Intracranial Mycotic Aneurysms" or "Anterior Cerebral Artery Aneurysm" or "Anterior Cerebral Artery Aneurysms" or "Posterior Communicating Artery Aneurysm" or "Posterior Communicating Artery Aneurysms") were entered in the database searches as medical subject heading terms and text words with a highly sensitive search strategy. Manual searches were used to screen other eligible studies.

2.2. Study selection

After reading the abstracts, full papers were retrieved and assessed for their suitability with the following inclusion criteria: (1) only those cohort studies conducted within a human population to explore the relationship between 64-MSCT angiography and the diagnostic value of cerebral artery aneurysm were incorporated; (2) the diagnosis and management of patients with cerebral artery aneurysm should be confirmed by its clinical etiology and manifestations, and the combined diagnosis from the laboratory and imaging methods observing the occurrence and extent of subarachnoid hemorrhage (SAH) via CT or cerebral angiography, and magnetic resonance imaging [29,30]; (3) articles must be published in a peer-reviewed journal especially providing with original data. Corresponding major exclusion criteria were those experimental articles or trails that: (1) did not satisfy the above inclusion criteria designed in the current study; (2) abstracts, reviews, case report, letters, meta-analysis, or proceedings; (3) duplication publications or studies with overlapping data; and (4) subgroup analysis of the included trials.

2.3. Data extraction and quality assessment

We used a standard reporting form to extract data from each included study, and the following descriptive information were collected: surname and initials of the first author, year of submission, country and racial descent, total numbers of included cases, gender information, mean age and floating range, demographic variables, 2×2 table information, and confirmation of diagnosis. Diagnostic results data were also counted in the research including the true positive (TP), false positive (FP), false negative (FN), and true negative (TN) information results in four-fold (2×2) tables for cerebral artery aneurysm diagnosis. The quality of involved studies was assessed independently by two authors based on a tool for the quality assessment of studies of diagnostic accuracy studies (QUADAS) [31]. Fourteen assessment items were implicated in the QUADAS criteria. Each of these items was scored as "yes" (2), "no" (0), or "unclear" (1). QUADAS scores ranged from 0 to 28; and a score of $\geq$22 indicates good quality.

2.4. Statistical analysis

The association of the diagnostic significance of 64-MSCT angiography with cerebral artery aneurysm was judged by the positive likelihood ratio (positive LR) and negative likelihood ratio (negative LR) combined with its 95% confidence interval (95% CI). Data were first extracted to quantify heterogeneity among studies with Cochran's *Q*-