Effect of Neurointerventional Embolectomy on Cerebral Infarction

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Abstract

Objective: To investigate the therapeutic effect of neurointerventional embolectomy in cerebral infarction cure with digital subtraction angiography (DSA).

Method: 90 patients with acute cerebral infarction were divided into a thrombolysis group and an embolectomy group, with 45 cases in each. In the thrombolysis group, recombinant tissue plasminogen activator was used for intravenous thrombolysis, while the embolectomy group was treated with DSA neurointerventional embolectomy. The recanalization rate was compared between the two groups by scoring patients' neurological function before one week and after the treatment. The rating method complied with the National Institutes of Health Stroke Scale (NIHSS). The recurrence of stroke, myocardial infarction, and mortality in both groups was compared, which were recorded by follow-up visits within 6 months after the treatment.

Result: For the embolectomy group, the complete recanalization rate and recanalization rate were significantly higher than the rates in the thrombolysis group (P < 0.05). After the treatment, NIHSS scores in both groups were obviously lower than the scores before, with statistical significance (P < 0.05). Moreover, the embolectomy group has lower NIHSS scores than the thrombolysis group (P < 0.05) after the operation, but no distinct difference (P > 0.05) was found before. The follow-up visits revealed that the recurrence rate of stroke in the embolectomy group was lower compared with the other (P < 0.05), however, there was no distinct difference in the incidence of myocardial infarction and mortality (P > 0.05).

Conclusion: DSA neurointerventional embolectomy can effectively open the stenotic and occluded vessels, improve the clinical therapeutic performance, and reduce the risk of stroke recurrence in patients in the long term.

Keywords: Digital Subtraction Angiography (DSA); neurointerventional; Embolectomy; Cerebral Infarction

1. Introduction

Cerebral infarction is a kind of bad tissue, which exists in the brain as a result of occlusion or stenosis in the arteries for the convey of blood and oxygen. Normally, the blockage can be caused by a thrombus, an embolus or atheromatous stenosis of one or more arteries (Adams, Victor, & Ropper, 2009). Cerebral infarction can thus cause many risks, such as hypertension, diabetes, and obesity (Hankey, 2006). In clinical, cerebral infarction has a high incidence rate, and its risk of death significantly elevates as age increases. One of the main causes of cerebral infarction is vascular stenosis due to atherosclerosis (Fiorella et al., 2012; Fjetland et al., 2013; Hirsch, 2019), which is difficult to treat by conservative pharmacotherapy alone. Interventional therapy is a method to deliver the guidewire, catheter, etc. into the lesion site and perform the local operation by means of imaging for precise
Neurointerventional surgery is an operation that is achieved through an extremely small hole in the skin. Through this miniature portal, tiny catheters, needles or tubes are placed and guided to their intended targets in the brain, head/neck, or spine. The field employs sophisticated imaging technologies to precisely guide its devices into highly sensitive neural structures. So far, there are already some cases prove that this is a minimally invasive approach in the treatment of brain vascular and spinal conditions (Blackham et al., 2012). Especially for the digital subtraction angiography (DSA) technology, which is a new X-ray imaging system combining conventional angiography and computer image processing, is already applied for the treatment of cerebral infarction.

This study investigates the clinical efficacy of DSA neurointerventional embolectomy in the treatment of ischemic cerebrovascular disease.

2. Materials and Methods
2.1 General Information
Ranging from January 2014 to December 2017, patients (n = 90) with cerebral infarction admitted to our department were selected and two groups are divided according to the therapies: thrombolysis and embolectomy. Each group contains 45 cases. There were 30 males and 15 females aged 45-74 in the thrombolysis group, with a mean age of 67.29 ± 7.32. The time from onset to treatment ranges from 5 to 15 h, and the average was 8.91 ± 2.47 h. 45 patients had limb motor dysfunction among whom 24 had combined aphasia and 1 had combined consciousness disorder. There were 28 males and 17 females in the embolectomy group, aged 42-80, and the mean age was 69.46 ± 7.47. The time from onset to treatment was 5-14 h and the average time was 8.27 ± 2.79 h. 45 patients had limb motor dysfunction among whom 26 had combined aphasia and 2 had combined consciousness disorder. When selecting the patients, we confirmed that no distinct difference existed between the two groups (P > 0.05).

2.2 Inclusion and Exclusion Criteria
Inclusion criteria: the patients included in this study should meet the diagnostic criteria for cerebral infarction in the Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke, 2018; the symptom should be confirmed by cranial CT and/or MRI. Exclusion criteria: patients with liver and kidney failure, coagulation dysfunction, the use of Aspirin and/or heparin, peptic ulcer bleeding and other hemorrhagic diseases, and neurological deficit or mental illness due to other causes should be excluded. Informed consent was signed by every patient or the family prior to enrollment.

2.3 Method
2.3.1 Treatment Method
In the thrombolysis group, recombinant tissue plasminogen activator (rt-PA) was used for the intravenous thrombolysis, which was performed at 0.9 mg/kg, the dose should be less than 90.0 mg. The embolectomy group was treated with DSA neurointerventional embolectomy. Under locoregional anesthesia with lidocaine, the right femoral artery was punctured using a Seldinger procedure (Maus, Brehm, Tsogkas, Henkel, & Psychogios, 2019; Nayak, Ladurner, & Killer, 2010; Tatum et al., 2013). Then the arterial sheath was inserted. The microcatheter was positioned to the vicinity of the vascular lesion. After confirmation of the embolization site by DSA, a microwire was placed to guide the microcatheter to the distal embolization via the embolic position. The Solitaire stent was placed at the embolization site along the microcatheter, which would deploy spontaneously when the microcatheter was retracted. Then the stent was withdrawn into the catheter, and both the stent and catheter were withdrawn under negative pressure to remove the thrombus. In both groups, cranial CT was applied 24 hours after surgery to exclude intracranial hemorrhage.

2.3.2 Efficacy Evaluation
(1) The recanalization rate was compared between the two groups. Complete recanalization: complete vascular patency and restoration of blood perfusion of the ischemic lesion. Partial recanalization: the vessel is partially patent, and blood perfusion is restored to less than 50% of the ischemic lesion. Vessel non-passage: No significant changes in vessels or movement of thrombi, and blood perfusion of the ischemic lesion was not restored (de Leciñana et al., 2013). Recanalization rate (%) = (number of complete recanalization case + number of partial recanalization case) / (total) × 100%. (2) Before and one week after the treatment, the neurological function of each patient was evaluated using the NIHSS
(Tatum et al., 2013), (3) six-months followed-up visits were carried out for each patient. The postoperative stroke recurrence, myocardial infarction, and mortality were compared between the two groups.

2.4 Statistics
SPSS 13.0 software was used to analyze the data. The data in accordance with normal distribution and homogeneity of variance were represented as ($\bar{x} \pm s$), and the independent sample mean values $t$-test was used for comparisons between groups; The enumeration data was expressed in rates, $\chi^2$-test method was applied for the comparison between both groups; difference is determined as significant if $P < 0.05$.

3 Result
2.1 Comparison of the Recanalization Rate
The complete recanalization rate and the recanalization rate were higher in the thrombectomy group than in the thrombolysis group ($P < 0.05$), as shown in Table 1.

Table 1. Comparison of the Recanalization Rates Between the Two Groups After the Treatment

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of cases</th>
<th>Complete Recanalization (number / %)</th>
<th>Partial Recanalization (number / %)</th>
<th>Vessel Non-Passage (number / %)</th>
<th>Recanalization Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombolysis</td>
<td>45</td>
<td>7 / 15.56</td>
<td>15 / 33.33</td>
<td>23 / 51.11</td>
<td>48.89</td>
</tr>
<tr>
<td>Embolectomy</td>
<td>45</td>
<td>17 / 37.781</td>
<td>16 / 35.56</td>
<td>12 / 67.00</td>
<td>73.331</td>
</tr>
</tbody>
</table>

1Compare with the thrombolysis group, $P<0.05$

2.2 Comparison of NIHSS
Before the treatment, no obvious difference existed in NIHSS scores between both groups ($P > 0.05$). One week after the treatment, the NIHSS scores were significantly lower than those before ($P < 0.05$) in both groups, and the NIHSS score in the embolectomy group was obviously different ($P < 0.05$) than that in the other group, as shown in Table 2.

Table 2. Comparison of NIHSS Scores Before and After the Treatment Between the Two Groups (Score, $\bar{x} \pm s$)

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of cases</th>
<th>NIHSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before Treatment</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>45</td>
<td>24.51±2.39</td>
</tr>
<tr>
<td>Embolectomy</td>
<td>45</td>
<td>24.48±2.54</td>
</tr>
</tbody>
</table>

1Compared with pre-treatment scores, $P < 0.05$; 2Compared to the thrombolysis group, $P < 0.05$.

2.3 Comparison of Follow-Up Visit Result
Forty and 42 cases were followed up in the thrombolysis group and the embolectomy group. The recurrence rate of stroke in the thrombectomy group was lower ($P < 0.05$) in the case of the embolectomy group. The differences in the incidence of myocardial infarction and mortality between both groups were not significant ($P > 0.05$), as shown in Table 3.
**Table 3. Comparison of Follow Up Results**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of cases</th>
<th>Recurrent Stroke (number / %)</th>
<th>Myocardial Infarction (Number / %)</th>
<th>Mortality (Number / %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombolysis</td>
<td>40</td>
<td>11 / 27.5</td>
<td>1 / 2.5</td>
<td>2 / 5.00</td>
</tr>
<tr>
<td>Embolectomy</td>
<td>42</td>
<td>3 / 7.141</td>
<td>1 / 2.38</td>
<td>1 / 2.38</td>
</tr>
</tbody>
</table>

1Compare with the thrombolysis group, P < 0.05.

**3 Discussion**

Cerebral infarction, either recognized as ischemia apoplexy, is caused by various reasons for regional impaired blood supply to the tissue in brain, giving rise to brain tissue necrosis of hypoxic-ischemic lesions and clinical manifestations of neurological deficits. Cerebral infarction has different sub-categories, such as cerebral thrombosis and lacunar infarction according to different pathogenesis. Cerebral thrombosis is the most common type of cerebral infarction, accounting for about 60% of all cerebral infarction, so commonly referred to as cerebral infarction actually refers to cerebral thrombosis. The incidence, fatality, and disability rates of cerebral infarction are all high (Mordasini et al., 2010). The formation of atherosclerosis is associated with various factors such as vascular endothelial dysfunction, inflammatory response, and oxidative stress. Cerebral infarction is mostly related to thrombosis at the vascular lesion or extraneous embolus shedding. Therefore, early removal of thrombus and restoration of blood perfusion of local brain tissue is the key to rescue dying brain cells and alleviate neurological deficits in patients.

Digital subtraction angiography (DSA) is a new X-ray imaging system, which is a combination of conventional angiography and computer image processing. Common angiographic images have a lot of anatomical information, such as bones, muscles, blood vessels and air-containing lacunae, which overlap with each other, and it is difficult to observe a structure or tissue in detail. Equipment and technology of DSA have been quite mature which could realize the fast three-dimensional rotating real-time imaging, real-time subtraction function, can also dynamically observe the morphology and hemodynamics of blood vessels and their lesions from different orientations. For interventional techniques, especially endovascular techniques, DSA is indispensable. DSA has replaced the conventional angiography because there is no overlap between bone and soft tissue, which makes the vessel and its lesion display more clearly. The images processed by DSA make the images of vessels clearer and safer for interventional procedures. DSA makes it possible to observe the thrombus from multiple angles, and the false-negative results caused by large vessel occlusion and vessel curvature can be eliminated by arbitrarily adjusting the angles. Clinical studies have shown that timely thrombolytic therapy in the early stage of cerebral infarction can significantly improve clinical efficacy and improve the prognosis of patients.

This study showed that NIHSS scores of patients using embolectomy therapy were significantly lower than the thrombolysis group, suggesting that embolectomy is an effective method to treat cerebral infarction. Embolectomy directly removes the thrombus, which is more thorough than thrombolysis and can better restore the blood supply of diseased vessels and promote the recovery of the function of the corresponding brain tissue. Alternatively, embolectomy operation was applied locally, reducing the dose compared to systemic administration in thrombolysis, which is in favor of reducing the risk of bleeding. This study also showed that the recanalization, neurological recovery, and follow-up visit results of the embolectomy group were superior to those of the thrombolysis group. It should be noted that DSA neurointerventional embolectomy is an invasive operation, and the patients’ blood vessels have pathological changes caused by atherosclerotic plaque formation. The operation should be slow and gentle to avoid iatrogenic factors leading to plaque detachment or vessel wall injury, which may further cause hemorrhage or new infarction, and aggravate the patients’ condition.
References: