Thrombectomy in Octogenarians in the Era of Stent Retriever: Is an Age Limit Necessary?

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Objective: The results of thrombectomy in people aged 80 years and above were reviewed, and the necessity of an age limit was evaluated.

Methods: Seventy eight patients who underwent thrombectomy at our hospital between July 2014 and September 2016 were divided into those aged <80 years and those aged ≥80 years, and the therapeutic results and outcome were evaluated.

Results: The patients consisted of 25 aged ≥80 years (≥80 years group) and 53 aged <80 years (<80 years group). The mean time from puncture to recanalization was 56 and 65 minutes, respectively, and thrombolysis in cerebral infarction score of 2b or better recanalization was observed in 96.0 and 88.7%, respectively, with no significant difference in either parameter. Change of the approach route was necessary in five patients aged ≥80 years (20.0%). A favorable outcome with a modified Rankin scale (mRS) score of ≤2 was observed 3 months after the onset in 44.0 and 64.2%, respectively, being slightly lower in the ≥80 years group (P = 0.151). In the ≥80 years group, the time from the onset to recanalization was a poor prognostic factor (P = 0.048).

Conclusion: In the patients aged ≥80 years, the recanalization rate, procedural time, and complication rate in thrombectomy were comparable to those in the patients aged <80 years, and no significant difference was observed in the outcome. Therefore, aggressive intervention without an age limit is considered recommendable in preoperatively activities of daily living (ADL)-independent elderly patients expected to be good candidates for simple thrombectomy. However, with the possibility of change in the approach route in mind, it is necessary to achieve recanalization more promptly in older patients.

Keywords ▶ acute ischemic stroke, mechanical thrombectomy, octogenarian

Introduction

With the arrival of the era of the stent retriever, the results of thrombectomy for acute cerebral infarction have improved, and a series of randomized control studies that demonstrated its effectiveness have been reported.1–5) In an aging society, thrombectomy is expected to be performed more frequently in elderly patients, but age is an important prognostic factor, and the outcome has been reported to be poorer in older patients.6) In the acute period of cerebral infarction, the incidence of complications during hospitalization including enlargement of infarction, hemorrhagic infarction, pneumonia, and urinary tract infection has been reported to rise in patients aged ≥80 years.7) At our hospital, thrombectomy was indicated for patients aged <80 years, in principle, before the stent retriever began to be covered by insurance in Japan, but, with the improvements in the therapeutic results after the beginning of insurance coverage, we have also performed thrombectomy more aggressively in those aged ≥80 years.

In this study, we reviewed the results of thrombectomy in patients aged ≥80 years and evaluated whether or not an age limit is necessary.

Thrombectomy at our hospital

We perform intravenous thrombolysis using alteplase (tissue plasminogen activator [t-PA]) in patients with an
indication, immediately followed by intracranial angiography. If a major artery is not recanalized, thrombectomy is performed next. Indications of mechanical thrombectomy in patients with no indication for intravenous thrombolysis with t-PA are acute cerebral infarction within 8 hours after the onset, occlusion of a major intracranial artery (internal carotid artery, M1 or M2 segment of the middle cerebral artery, and basilar artery), a National Institute of Health Stroke Scale (NIHSS) score of ≥8, and an Alberta Stroke Program Early CT score-diffusion-weighted imaging (ASPECTS-DWI) score of ≥6, and no age limit is set if the preoperative modified Rankin scale (mRS) score is 0–2.

The procedure is performed under local anesthesia in all patients. In principle, the target lesion is approached via the femoral artery, and a 9 Fr Optimo (Tokai Medical Products, Aichi, Japan) is placed in the internal carotid artery of the affected side for anterior circulation lesions. For posterior circulation lesions, an 8 Fr Roadmaster (Goodman, Aichi, Japan) is placed in the vertebral artery of either side. Then, thrombectomy is performed using the Penumbra system (Penumbra, Oakland, CA, USA), Trevo Pro clot retriever (ProVue or XP; Stryker, Fremont, CA, USA), or Solitaire FR (ev3, Irvine, CA, USA). Regarding the Penumbra system, aspiration is carried out by the direct aspiration technique (ADAPT) using Penumbra 5 MAX ACE. If the stent retriever is used, the stent is deployed after inflating the balloon of the guiding catheter, and the thrombus is retrieved by aspiration. The device is selected by the surgeon, but the Penumbra system is the first choice, in principle. If recanalization has not been achieved, the device is changed appropriately.

Subjects and Methods

The subjects were 78 patients who underwent thrombectomy at our hospital between July 2014 and September 2016. They were divided into those aged ≥80 years (older group) and those aged <80 years (control group), and the two groups were compared regarding the age, gender, mRS score before admission, risk factors (hypertension, hyperlipidemia, smoking, history of cerebral infarction/hemorrhage, and history of myocardial infarction), NIHSS score on arrival, ASPECTS-DWI, type of cerebral infarction, occluded vessels, device used, comitant use of other devices, whether or not intravenous thrombolysis with t-PA was performed, door-to-puncture time, puncture-to-placement of guiding catheter time, puncture-to-recanalization time, thrombolysis in cerebral infarction (TICI) perfusion grade, presence or absence of symptomatic intracranial hemorrhage, and mRS score after 3 months. In the older group, comparisons were also made between patients with a good outcome (mRS 0–2 after 3 months) and those with a poor outcome (mRS 3–6 after 3 months). Statistical analyses were performed using JMP 13.1 (SAS Institute Inc., NC, USA). Intergroup comparisons were made using the Student t-test and chi-square test at the P < 0.05 level of significance.

Results

Table 1 shows the age, gender, baseline mRS score, risk factors, NIHSS score on arrival, ASPECTS-DWI, type of cerebral infarction, and occluded vessels. The older and control groups consisted of 25 (mean age: 84.7 years) and 53 (69.6 years) patients, respectively. The percentage of females was slightly higher in the older group (48.0% vs. 26.4%, P = 0.103). The baseline mRS score showed no significant difference between the groups. Concerning risk factors, atrial fibrillation was observed more frequently in the older group (68.0 vs. 43.4%, P = 103), but the percentage of smokers was higher in the control group (28.0 vs. 50.9%, P = 0.096). No significant difference was observed in the ASPECTS-DWI between the two groups. The preoperative NIHSS score was slightly higher in the older group, but the difference was not significant (22.4 ± 5.1 vs. 20.2 ± 6.4, P = 0.118). While no significant difference was noted in the type of cerebral infarction or occluded vessels between the two groups, the disease type was cardiogenic embolism in all patients in the older group.

Table 2 shows the time course, contents of treatment, and angiographic and clinical outcomes. The percentage of patients treated by intravenous thrombosis with t-PA did not differ significantly between the two groups. Regarding the time course, the mean time from puncture to the placement of the guiding catheter was 26 minutes in both groups, mean time from puncture to recanalization was 56 and 65 minutes, and mean time from the onset to recanalization was 307 and 272 minutes, respectively, in the older and control groups, all showing no significant difference between the two groups. However, navigation of the guiding catheter was difficult, and the approach route was changed to the right brachial artery route, in five (20.0%) in the older group and two (3.8%) in the control group, with a significant difference (P = 0.048). The Penumbra system was used in 63 (80.8%), and a stent retriever was used in 38 (48.7%), of all patients; no significant difference was observed in the device used between the two groups.
In addition, treatment could be completed using a single device in 19 (76.0%) in the older group and 35 (66.0%) in the control group, with no significant difference between the two groups. TICI grade 2b or better recanalization was observed in 24 (96.0%) in the older group and 47 (88.7%) in the control group, TICI grade 3 recanalization was observed in 12 (48.0%) and 26 (49.1%), respectively, and no significant difference was observed between the two groups. Postoperative symptomatic intracranial hemorrhage was noted in 2 (8.0%) in the older group and 5 (9.4%)...
in the control group, with no significant difference between the two groups.

Figure 1 shows the details of the outcome. The mRS score was 0–2 after 90 days in 11 (44.0%) in the older group and 33 (64.2%) in the control group. While the percentage was slightly lower in the older group, the difference was not significant (P = 0.151). The mRS score was 6 after 90 days in 2 (8.0%) in the older group and 6 (11.3%) in the control group, with no significant difference. The cause of death was pulmonary embolism in one patient in the control group but cerebral infarction in all remaining seven patients.

Table 3 compares the patients with a good outcome and those with a poor outcome in the older group. No significant difference was noted in the patient background including the age. The preoperative NIHSS score was lower (20.3 ± 5.2 vs. 24.0 ± 6.5, P = 0.085), and the ASPECTS-DWI was higher (9.0 ± 4.0 vs. 7.4 ± 1.9, P = 0.122), in those with a good outcome. There was also no significant difference in the frequency of the use of intravenous thrombolysis with t-PA. Concerning the time course, the time from puncture to recanalization was shorter in those with a good outcome (47 ± 28 vs. 64 ± 50 min, P = 0.125), and the time from the onset to recanalization was significantly shorter in those with a good outcome (264 ± 93 vs. 341 ± 108 min, P = 0.048). No significant difference was observed in the recanalization rate or the frequency of hemorrhagic complication between the two groups.

Representative case

A representative case in which the approach route was changed is presented in Fig. 2. The patient was an 84-year-old woman who was transported 50 minutes after a sudden onset with disturbance of consciousness and right-sided paralysis. On arrival, the patient showed Glasgow Come Scale (GCS) E3V1M6 disturbance of consciousness, right-sided paralysis, severe dysarthria, and consequent speechlessness, and the NIHSS score was 19. MRI revealed infarction in the left pons (Fig. 2A), and MRA showed occlusion of the basilar artery (Fig. 2B). Since the symptoms did not respond to emergency intravenous thrombolysis with t-PA, we decided to perform thrombectomy. The patient was punctured 60 minutes after the arrival, and an 8 Fr sheath was placed in the right femoral artery. Stenosis and tortuosity were observed at the origin of the left vertebral artery (Fig. 2C), and even a 4 Fr catheter could not be passed through this site. The aorta was type 3 (Fig. 2D), and the catheter could not be advanced even to the right subclavian artery. The transfemoral approach was abandoned 40 minutes after puncture, and a 6 Fr sheath was placed by brachial artery puncture (Fig. 2E). A 6 Fr Roadmaster (Goodman) could be easily advanced to the right vertebral artery (Fig. 2F). After guiding a Marksman (Covidien, Dublin, Ireland) to the left superior cerebellar artery, Trevo (Stryker) was deployed, and thrombectomy was performed, which resulted in Thrombolysis in cerebral infarction (TICI) 3 recanalization (18 minutes after brachial artery puncture) (Fig. 2G). Right-sided paralysis, dysarthria, and disturbance of consciousness were resolved after the procedure, and the NIHSS score improved to 1 after 24 hours. Three months after the episode, the mRS score was 1, and only mild dysarthria was noted.

Discussion

In the HERMES study, in which meta-analysis of Randomized Controlled Trials (RCTs) that suggested the effectiveness of thrombectomy for acute cerebral infarction, the outcome was reported to be favorable in a significantly higher percentage of patients in the thrombectomy group than in the medical treatment group even in patients aged ≥80 years. However, in acute phase revascularization, the complication and mortality rates have been reported to be higher in older patients, and old age is considered an independent poor prognostic factor.

In this study, the percentage of patients in whom recanalization could be achieved with a single device, procedural time, and recanalization rate were all comparable between the older and control groups. While the time until placement of the guiding catheter was also comparable, the percentage of patients who required change of the approach...
Table 3  Univariate statistics for the elderly dichotomized by outcome

<table>
<thead>
<tr>
<th></th>
<th>Good outcome (n = 11)</th>
<th>Poor outcome (n = 14)</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Age y, mean ± SD</td>
<td>84.7 ± 3.8</td>
<td>84.8 ± 7.6</td>
<td>0.987</td>
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<tr>
<td>Gender, female</td>
<td>5 (45.5%)</td>
<td>7 (50%)</td>
<td>0.859</td>
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<tr>
<td>Hypertension</td>
<td>6 (54.5%)</td>
<td>10 (71.4%)</td>
<td>0.934</td>
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<tr>
<td>Atrial fibrillation</td>
<td>6 (54.5%)</td>
<td>9 (64.3%)</td>
<td>0.397</td>
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<tr>
<td>Diabetes</td>
<td>2 (18.2%)</td>
<td>3 (21.4%)</td>
<td>0.763</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>2 (18.2%)</td>
<td>0 (0%)</td>
<td>0.357</td>
</tr>
<tr>
<td>Smoking</td>
<td>1 (9.2%)</td>
<td>3 (21.4%)</td>
<td>0.775</td>
</tr>
<tr>
<td>Old cerebral infarction</td>
<td>2 (18.2%)</td>
<td>9 (64.3%)</td>
<td>0.220</td>
</tr>
<tr>
<td>Old cerebral hemorrhage</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>0 (0%)</td>
<td>1 (7.1%)</td>
<td>0.902</td>
</tr>
<tr>
<td>Preoperative NIHSS score</td>
<td>20.3 ± 5.2</td>
<td>24 ± 6.5</td>
<td>0.085</td>
</tr>
<tr>
<td>ASPECTS-DWI</td>
<td>9.0 ± 4.0</td>
<td>7.4 ± 1.9</td>
<td>0.122</td>
</tr>
<tr>
<td>IV-tPA</td>
<td>2 (18.2%)</td>
<td>4 (28.6%)</td>
<td>0.813</td>
</tr>
<tr>
<td>Time from puncture to placing guiding catheter, min, mean ± SD</td>
<td>26 ± 21</td>
<td>26 ± 24</td>
<td>0.957</td>
</tr>
<tr>
<td>Time from puncture to reperfusion, min, mean ± SD</td>
<td>47 ± 28</td>
<td>64 ± 50</td>
<td>0.125</td>
</tr>
<tr>
<td>Time from onset to reperfusion, min, mean ± SD</td>
<td>264 ± 93</td>
<td>341 ± 108</td>
<td>0.048</td>
</tr>
<tr>
<td>TICI 2b≤</td>
<td>11 (100%)</td>
<td>13 (92.9%)</td>
<td>0.902</td>
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<tr>
<td>TICI 3c</td>
<td>7 (63.6%)</td>
<td>5 (35.7%)</td>
<td>0.325</td>
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<td>Symptomatic hemorrhage</td>
<td>0 (0%)</td>
<td>2 (14.3%)</td>
<td>0.573</td>
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</tbody>
</table>

ASPETS-DWI: Alberta Stroke Program Early CT score-diffusion-weighted imaging; IV-tPA: intravenous tissue-type plasminogen activator; NIHSS: National Institute of Health Stroke Scale; TICI: thrombolysis in cerebral infarction.

Fig. 2  Diffusion-weighted images in MRI on admission show high-intensity lesions at left pons (A). MRA shows basilar artery occlusion (B). DSA of left subclavian artery shows severe stenosis at left vertebral artery origin (G). The aorta was type 3 (D). DSA of right subclavian artery shows mild tortuosity at right vertebral artery (E). DSA of right vertebral artery shows basilar artery occlusion (F). Final DSA shows successful recanalization, thrombolysis in cerebral infarction grade 3 (G).
route was significantly higher in the older group. Aging promotes twisting and meandering of arteries and may make catheter access more time-consuming, occasionally forcing change of the approach route. While the lesions could be accessed in a median time of 20 minutes from femoral artery puncture in easily accessible cases, about 30 minutes was reportedly wasted in poorly accessible cases. Difficult catheter access is considered an adverse prognostic factor and shortening of the access time is vital. At our hospital, change of the approach route is considered if more than 30 minutes is needed from puncture to the placement of the guiding catheter. In this study, the approach route was changed to the right brachial artery in all difficult-to-access patients, such as the above representative case, resulting in successful recanalization. If the lesion cannot be accessed even by the brachial artery approach, direct puncture of the common carotid artery may be an option, but its application should be evaluated carefully because of problems such as the complexity of the procedure and postprocedural subcutaneous hematoma.

The frequency of symptomatic intracranial hemorrhage was comparable (8.0% vs. 9.4%), and complications were not more frequent in older patients.

Table 4 shows the recent reports on thrombectomy in patients aged ≥80 years. TICI2b or better recanalization was achieved in 69.2%–87.9%, and symptomatic intracranial hemorrhage occurred in 9.2%–12.8% of the patients; the results at our hospital were comparable. The mRS score after 90 days was 0–2 in 17.4%–27.7% of the patients, and the mortality rate was 40.0%–47.7%; the outcome was more favorable at our hospital. In this study, thrombectomy was performed in patients with a preoperative mRS score of ≤2, and primarily older patients with a good chance of recovery were treated. In addition, all patients in the older group had cardiogenic cerebral embolism, and therapeutic intervention was made in patients expected to be treated without a complicated procedure. Under such conditions, as shown in Fig. 1, the percentage of patients with a favorable outcome (mRS score: 0–2) was slightly lower in the older group (44.0% vs. 64.2%, P = 0.151), but the difference was not statistically significant. In addition, as shown in Table 3, age was not a prognostic determinant even in the older group. Although the results in this study cannot be generalized to all elderly patients, we consider that thrombectomy should be performed at least in preoperatively activities of daily living (ADL)-independent older patients expected to be treated safely by a simple procedure without setting an age limit.

Ribo et al. investigated the relationship between the final volume of cerebral infarction after thrombectomy and the outcome and reported that a favorable outcome cannot be expected unless the infarct volume is small particularly in older patients because older patients are less likely to recover by rehabilitation and more likely to suffer complications during hospitalization. In this study, also, the time from the onset to recanalization was significantly longer in patients with a poor outcome in the older group. For improving the outcome in older patients, it is considered necessary to promptly recanalize occluded vessels and minimize the infarct volume.

This study has a few limitations. First, it is an evaluation in a small number of patients at a single institution. In addition, it is a retrospective study with a bias in patient selection. It must be noted that not all elderly patients aged 80 years and above with a mRS score of ≤2 were included as the subjects. A prospective study design is considered necessary to eliminate selection bias.

## Conclusion

In the era of stent retriever thrombectomy, the recanalization rate, procedural time, and complication rate of endovascular recanalization therapy were comparable between octogenarians and suboctogenarians. While the outcome was slightly less favorable in the older group, the difference was not statistically significant. In preoperatively ADL-independent older patients who are expected to be treatable by a simple procedure, therapeutic intervention should be made without setting an age limit. However, as change of the approach route may be required, it is
considered necessary to try to achieve recanalization more promptly as the patient is older.

**Disclosure Statement**

All authors have completed self-reporting of conflicts of interest (COI) to the Japanese Society for Neuroendovascular Therapy. There are no COI to disclose in presenting this paper.

**References**


