ORIGINAL RESEARCH

Mechanical thrombectomy as the primary treatment for acute basilar artery occlusion: experience from 5 years of practice

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ABSTRACT

Background Most studies of the treatment for acute basilar occlusion focus on intravenous or intra-arterial thrombolysis whereas data on mechanical thrombectomy as the preferred treatment for acute basilar occlusion are scarce. In this study, data are presented on 28 patients treated with mechanical thrombectomy as the preferred treatment for basilar artery occlusion.

Methods Retrospective study comprising all patients who were treated for acute basilar occlusion at the Karolinska University Hospital from September 2005 to November 2010. Favorable outcome was defined as a modified Rankin score of ≤2 at 3–8 months after thrombectomy.

Results Of 28 patients treated with mechanical thrombectomy, the proportion reaching a favorable outcome was 57% (95% CI 37% to 75%), and if there were no signs of acute infarction prior to treatment the proportion was 73% (95% CI 50% to 89%). Only 21% died (95% CI 8% to 41%).

Conclusions The results for mechanical thrombectomy for basilar artery occlusion were superior to those presented previously for intravenous and intra-arterial thrombolysis. The study suggests that mechanical thrombectomy is a method distinct from therapies based on thrombolysis and that any randomized clinical trial on treatment for acute basilar occlusion must consider mechanical thrombectomy as a separate entity.

INTRODUCTION

There is current debate over the preferred treatment for acute basilar occlusion—intravenous thrombolysis or intra-arterial therapy, or a combination of both.[1–3] Although intravenous thrombolysis was the first therapy approved for acute ischemic stroke,[4 5] underlying randomized controlled trials mainly included occlusive disease in the anterior circulation. Support for a benefit of intravenous thrombolysis in basilar artery occlusion comes from observational studies,[6 7] and there are calls for randomized clinical trials to compare the alternatives.[1–3 7]

Endovascular mechanical thrombectomy has been shown to be both feasible and safe in acute basilar occlusion[8 9] but in most studies it has been used only when the time window for intravenous thrombolysis was closed or as a supplement to other therapies.[7 10–12] Data on mechanical thrombectomy as firstline treatment are scarce.[13 14]

We present our experience from 5 years of practice with mechanical thrombectomy as the firstline treatment for acute basilar thrombosis, and discuss the implications that the results may have for the prospects of a randomized trial.

METHODS

Setting

The study comprised all patients treated with thrombectomy for acute basilar thrombosis at the Department of Neuroradiology, Karolinska University Hospital, Stockholm, from September 2005 to November 2010. The Department of Neuroradiology is the sole provider of neuroendovascular treatment in a catchment area of approximately 2 million, and during the study period, acute endovascular stroke treatment was provided by three designated neurointerventionists on a 24/7 basis. During the study period, mechanical thrombectomy was the preferred treatment for basilar artery occlusion and there were no patients with basilar artery occlusion treated with intravenous thrombolysis only.

Patients

Patients were admitted either directly to the Karolinska University Hospital or via one of six referring hospitals within the region. Initial assessment was performed by neurologists or internists, depending on whether the patient arrived to a neurological or internal medicine emergency department. During the study period, initial assessment did not include National Institutes of Health Stroke Scale evaluation. After initial assessment at the neurological or internal medicine emergency departments, patients with symptoms of acute basilar artery occlusion were subjected to an unenhanced CT scan of the head. Evaluation of the CT scan was performed by a neuroradiologist, either directly or by telemedicine, while the physician on call was present and the patient still on the CT table. If the scan showed a hemorrhage or an acute infarction to an extent that predicted a dismal neurological outcome, there was normally no further investigation. When active treatment was considered, CT angiography was performed, either at the Karolinska University Hospital or at the referring hospital. Patients with basilar artery occlusion were acutely transferred to the neurointerventional suite for mechanical thrombectomy. Patients who received intravenous thrombolysis prior to thrombectomy were excluded from the study.

Procedure

During the study period, we used Merci retrievers (Concentric Medical Inc, Mountain View, California, USA), including the X6, L5 and L6 devices and, more recently, the V series as well as the Trevo (Concentric Medical) and Solitaire FR (ev3 Endovascular Inc, Plymouth, Minnesota, USA). Normally, a 6 F Envoy catheter (Cordis Corporation International, Johnson and Johnson Medical NV/SA, Waterloo, Belgium) was used as guide with the 7 F Guider (Boston Scientific, Natick, Massachusetts, USA) and the 8 F Merci balloon guide catheter as options. The choice of guide catheter was based on the operator's estimation of what size that particular vertebral artery was able to harbor.

As a supplement to thrombectomy, mainly to treat small distal emboli, we used intra-arterial recombinant tissue plasminogen activator (rtPA) or, if there was an underlying stenosis, balloon angioplasty and endovascular stenting (Solitaire FR, ev3 or Wingspan, Boston Scientific). The maximum dose of intra-arterial rtPA was 20 mg. Patients that were stented in conjunction with the thrombectomy received a half recommended bolus dose (0.125 mg/kg body weight) of abciximab (Reo-Pro; Eli Lilly, Sweden) but no infusion, followed by acetylsalicylic acid (Trombyl; Pfizer AB, Sollentuna, Sweden; bolus of 300 mg and then 75 mg daily for a minimum of 6 months) and clopidogrel (Plavix; Bristol-Myers Squibb AB, Bromma, Sweden; bolus of 300 mg and then 75 mg daily for a minimum of 3 months) the next day. Other adjunctive therapies included 2–5 mg of intra-arterial nicardipine (Cardene; PDL BioPharma Inc, Fremont, California, USA) during the procedure if there was a tendency to focal vasospasm as well as acetylsalicylic acid (bolus of 300 mg and then 75 mg daily) and low molecular heparin (dalteparin sodium, Fragmin; Pfizer AB, 2500 IU twice daily) after the procedure in non-stented patients to avoid re-occlusion of the basilar artery.

Assessment of baseline and outcome data, data categorization and analysis

Baseline and outcome data were retrieved from computerized medical records at the hospital. Glasgow Coma Scale (GCS) score was assessed at arrival to hospital by the stroke neurologist or the neurologist on call at the Karolinska University Hospital. Presumed etiology for the basilar artery occlusion was categorized into four groups: cardioembolic, vertebrobasilar stenosis, vertebral artery dissection and other. We used the written report from the CT scan for information on preprocedure acute infarction. All radiology reports were written by a senior neuroradiologist. The angiograms performed at the time of thrombectomy were re-evaluated by the authors (TA and ÅKS) to obtain information on pre- and postprocedure Thrombolysis in Cerebral Infarction (TICI) score. Postprocedure TICI score was categorized into two groups: 1–2a and 2b–3. Information on the modified Rankin Scale (mRS) score was usually obtained between 3 and 6 months after departure from hospital by a senior stroke neurologist. If there was no information on mRS after 3 or 6 months, we used information collected at 8 months.[15]

Favorable outcome was defined as an mRS score of ≤2. For evaluating the association between exposure variables and outcome, age, GCS and time from onset of symptoms to treatment were categorized with the intention to obtaining groups of approximately equal size.

We assessed for the presence of postinterventional hemorrhage using an unenhanced CT scan 24 h after thrombectomy. If the baseline GCS score was ≤8, with no improvement from the procedure and the attending neurologist opted for palliative treatment only, we usually abstained from further investigations. We categorized postprocedure hemorrhage into asymptomatic and symptomatic hemorrhage. Classification as symptomatic required clinical signs of deterioration which could be related to the hemorrhage.

For statistical analysis we used SAS statistical software (V.9.1; SAS Institute Inc). Ninety-five per cent CIs (95% CI) were calculated assuming a binomial distribution. For testing independence between outcome and exposure variables, we used Pearson's χ^2 tests. A p value <0.05 was considered statistically significant. Due to numerical constraints, we did not perform any statistical modeling.

As a delayed assessment of mRS may lead to an overestimation of patients with a good outcome, we assessed the potential impact of a delayed mRS assessment by performing sensitivity analyses where an extra point was added to the mRS score for all patients who were assessed at 8 months.

The study was approved by the research ethics committee at the Karolinska Institute.

RESULTS

During the study period, mechanical thrombectomy was performed on 31 patients for acute basilar artery occlusion. Of these, three were excluded because of preprocedure treatment with intravenous thrombolysis. Of the 28 patients with thrombectomy as the initial treatment, eight were women and 20 were men. At admittance, 14 of 28 had a GCS score of ≤8. The number of preprocedure acute infarcts was four out of eight among women and two out of 20 among men (p=0.038). To our knowledge, there were no patients in our catchment area with basilar artery occlusion who received intravenous thrombolysis only. Patients are presented in further detail in table 1.

There was a substantial variation in the delay between onset of symptoms and start of treatment. In 19 of 28 patients, treatment was initiated within 6 h from onset of symptoms but in one patient mechanical thrombectomy was initiated 37 h after the start of symptoms (table 2). In most patients, thrombectomy was technically successful. Before treatment, 75% of patients had complete occlusion of the basilar artery (TICI score 0). After treatment, 64% of patients had successful recanalization (TICI score 2b or 3) (table 1).

The overall proportion of patients with a favorable outcome (mRS 0–2) was 57% and the 95% CI for this proportion was 37% to 75%. There were six deaths in the cohort (21%, 95% CI 8% to 41%).

Outcome differed between men and women. Whereas 70% of men had a favorable outcome, the corresponding value for women was 25% (p=0.048, table 2). If patients with acute infarction prior to treatment were excluded however, there was no significant association between outcome and sex (p=0.69) (data not shown). Whereas there was a borderline significant association between age and outcome, none of the variables GCS, preprocedure TICI score, intra-arterial rtPA or stenting was statistically significantly associated with outcome (table 2). Likewise, the variables presumed etiology, referral from another hospital, time to treatment and time to revascularization were not statistically significantly associated with mRS score. There was a strong negative association between outcome and CT detectable preprocedure infarction (p=0.002). Among patients with no signs of acute infarction on non-enhanced CT scan before treatment, the proportion with a favorable outcome was 73% (95% CI 50% to 89%). The proportion of deaths in the same group was 9% (95% CI 1% to 29%). None of the patients with

Table 1 Patient details

	All (n (%))
All	28 (100)
Age (years)	
29–55	8 (29)
56–68	9 (32)
69–84	11 (39)
Glasgow Coma Scale	
3–8	14 (50)
9–12	6 (21)
13–15	8 (29)
Presumed etiology	
Cardioembolic	4 (14)
Vertebral artery dissection	5 (18)
Vertebrobasilar artery stenosis	10 (36)
Other	9 (32)
Referral from other hospital	
No	9 (32)
Yes	19 (68)
Preprocedure infarction	
No	22 (79)
Yes	6 (21)
Time from onset of symptoms to groin puncture (h)	
1–4	11 (39)
>4–6	8 (29)
>6	9 (32)
Range	1.5–37
Time from groin puncture to first revascularization (min)	
0–39	9 (32)
40–75	9 (32)
>75	10 (36)
Range	13–159
IA-rtPA	
No	10 (36)
Yes	18 (64)
Intra-arterial stenting	
No	24 (86)
Yes	4 (14)
Preprocedure TICI score	
0	21 (75)
I	4 (14)
IIa	3 (11)
Postprocedure TICI score	
I	1 (4)
IIa	9 (32)
IIb	14 (50)
III	4 (14)

IA-rtPA, intra-arterial recombinant tissue plasminogen activator; TICI, Thrombolysis in Cerebral Infarction.

acute infarction prior to procedure had a favorable outcome. The results are presented in further detail in table 2.

There were three cases of postprocedure hemorrhage, all asymptomatic. Two of the patients had a favorable outcome (mRS=0 and 1 within 3 months, respectively) and one patient died. The patient who died had an unsuccessful thrombectomy (TICI score 2a) and the postprocedure CT showed large acute infarcts and petechial bleeds. None of the patients with postprocedure hemorrhage had received a permanent intra-arterial stent at the time of the procedure.

We assessed mRS score for eight of the patients within 3 months, 11 of the patients between 4 and 6 months and for three patients after 8 months. When adding an extra point to the mRS score for patients who were assessed after 8 months, the proportion reaching independence was essentially unaltered—53.6% (95% CI 34% to 72%) instead of 57% (95% CI 37% to 75%)—as were all other results (data not shown).

DISCUSSION

We found that with mechanical thrombectomy as the firstline treatment for acute basilar occlusion, the proportion of patients who gained independence was 57% (95% CI 37% to 75%) and for patients with no signs of acute infarction before thrombectomy the proportion was 73% (95% CI 50% to 89%). Only 21% died (95% CI 8% to 42%), and among those without CT detectable infarctions prior to treatment, mortality was even lower (9%; 95% CI 1% to 29%).

The strengths of this study include that it is the largest study hitherto presented where mechanical thrombectomy has been used as firstline treatment for acute basilar occlusion. Another strength is the national registration number, a unique personal identifier used in all medical records and official documents that enabled complete follow-up of the patients.

The major limitation with our study was the size. Although it was the largest study on mechanical thrombectomy as firstline treatment for basilar artery occlusion, it was still only a small study. Accordingly, numbers were insufficient for statistical modeling of the data and CIs were wide. Nevertheless, it is worth noting that a previous meta-analysis on thrombolysis for basilar artery occlusion found a favorable outcome (mRS 0–2) of only 22% (17 of 76; 95% CI 14% to 33%) compared with our 57% (16 of 28; 95% CI 37% to 75%).[16] Secondly, the retrospective design with data collected from medical records made us dependent on the information available in the records. For some of the patients, this led to data on mRS being collected after 8 months. Reassuringly, however, adding an extra point to the mRS score for all patients with mRS assessed after 8 months had virtually no effect on the overall results. Thirdly, the observational design of the study was subject to all of the limitations inherent with this design.

Given the poor prognosis in basilar occlusion if the vessel is not recanalized, finding a safe and reliable treatment method is important. Unfortunately, both intravenous and intra-arterial thrombolysis leave much to be desired. In the largest study hitherto presented on the treatment of basilar artery occlusion, only 41 of 121 patients (34%, 95% CI 25 to 43) treated with intravenous thrombolysis had a favorable outcome (mRS ≤2) and 41 patients died (34%, 95% CI 25 to 43).[7] In a previous meta-analysis, the proportion of patients with a favorable outcome after intravenous thrombolysis was even lower, and ranged from three out of 16 (19%) to 12 out of 50 (24%) and mortality was 40–70%.[16] The corresponding values for intra-arterial thrombolysis were not superior.

Outcome after basilar artery occlusion is largely dependent on early recanalization.[1 17 18] Whereas both intravenous and intra-arterial thrombolysis may dissolve the thrombus, this usually takes time. In contrast, mechanical thrombectomy can rapidly restore blood flow in the basilar artery, which is the most crucial step in the procedure. Small distal emboli may then, if deemed necessary, be dissolved by relatively small amounts of adjunct intra-arterial rtPA. In addition, mechanical thrombectomy is equally efficient for thrombi located in the proximal and middle parts of the basilar artery as it is in the distal part, in contrast with what has been found for thrombolysis.[19] Another potential explanation for our results is the setting. Our department is the sole provider of neuroendovascular care in an area of approximately 2 million people, and all neuroendovascular procedures are carried out by the same three experienced specialists. Thus

Table 2 Number of patients, proportion, and p for homogeneity for modified Rankin Score (mRS) by patient and procedure characteristics

		mRS 0–2		mRS 3–5		Death		
	All	n	%	n	%	n	%	p Value
All	28	16	57%	6	21%	6	21%	
Sex								0.048
Men	20	14	70%	4	20%	2	10%	
Women	8	2	25%	2	25%	4	50%	
Age								0.049
29–55	8	4	50%	4	50%	0	0%	
56–68	9	5	56%	0	0%	4	44%	
69–84	11	7	64%	2	18%	2	18%	
GCS								0.17
3–8	14	7	50%	2	14%	5	36%	
9–12	6	3	50%	3	50%	0	0%	
13–15	8	6	75%	1	13%	1	13%	
Pre procedure infarction								0.002
No	22	16	73%	4	18%	2	9%	
Yes	6	0	0%	2	33%	4	67%	
Time from onset of symptoms to groin puncture								0.56
1–4 h	11	6	55%	2	18%	3	27%	
>4–6 h	8	3	38%	3	38%	2	25%	
>6 h	9	7	78%	1	11%	1	11%	
Time from groin puncture to first revascularization								0.63
0–39 min	9	7	78%	1	11%	1	11%	
40–75 min	9	5	56%	2	22%	2	22%	
>75 min	10	4	40%	3	30%	3	30%	
IA-rtPA								0.21
No	10	5	50%	4	40%	1	10%	
Yes	18	11	61%	2	11%	5	28%	
Intraarterial stenting								0.32
No	24	14	58%	4	17%	6	25%	
Yes	4	2	50%	2	50%	0	0%	
Pre procedure TICI score								0.73
0	21	11	52%	5	24%	5	24%	
I	4	2	50%	1	25%	1	25%	
IIa	3	3	100%	0	0%	0	0%	
Post procedure TICI score								0.08
I-IIa	10	3	30%	3	30%	4	40%	
IIb-3	18	13	72%	3	17%	2	11%	

patients receive the same high level of neuroendovascular expertise regardless of when they are treated. However, we cannot rule out the fact that our results, to some extent, may have been due to selection bias. During the study period, however, there was no competing method of treatment for acute basilar occlusion at our department. Patients that had active treatment had mechanical thrombectomy. Thus selection bias would require that, compared with patients in other studies, patients in our study with a poor prognosis more often either went undetected or were denied active treatment. However, in studies of both intravenous and intra-arterial thrombolysis, excluding patients with too large an infarction is common.[6 8 17 20] We find it unlikely that inclusion criteria would differ substantially between centers, but whether or not this is the case cannot be determined from our data. Likewise, it is unlikely that the chance of having acute basilar occlusion diagnosed in the Stockholm area should vary with prognosis, but this cannot be entirely ruled out. A final explanation is that our results could be due to chance. Even though the CI for the proportion of patients reaching a good outcome in our study excluded all results from previous studies on thrombolysis, the study was small and needs corroboration from other studies. As it is unclear to what extent our results are influenced by factors such as the volume of thrombectomy procedures performed at our department and the experience of the interventionists, future studies of mechanical thrombectomy must also take such variables into account.

Several authors argue that intravenous and intra-arterial thrombolysis for acute basilar occlusion must be tested in a randomized trial. Given our experience from 5 years of practice with mechanical thrombectomy as the preferred treatment for basilar artery occlusion, any trial with the aim of establishing best practice for basilar artery occlusion should also include mechanical thrombectomy as a separate entity.

In conclusion, we have found that patients with acute basilar thrombosis treated with mechanical thrombectomy as the primary method have a better outcome than what has been shown in previous studies of treatment with intravenous or intra-arterial thrombolysis.

Contributors All authors contributed to the conception, design, analysis, interpretation of the data, drafting of the article and revising it critically for important intellectual content. All authors gave final approval of the version to be published.

Competing interests None.

Ethics approval The study was approved by the research ethics committee of Karolinska Institute.

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Data sharing statement A more thorough description of the data than is presented above is available on request.

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