

# Intra-arterial Thrombectomy with Stent Retriever for Acute Ischemic Stroke – a Retrospective, Single-centered Study from Brazil

## *Trombectomia intra-arterial com Stent Retriever para o acidente vascular encefálico isquêmico agudo - estudo retrospectivo em único centro no Brasil*

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### Abstract

**Objective** To report our initial experience with intra-arterial thrombectomy (IAT) with stent retriever for acute ischemic stroke.

**Methods** We conducted a retrospective review of patients with acute ischemic stroke who underwent IAT from September 2010 to August 2016.

**Results** Forty-one patients were included; mean age was 57 years (range: 29–85), and 54% were women. There were 32 anterior circulation occlusions, and 11 posterior circulation occlusions. The mean value of the National Institutes of Health Stroke Scale (NIHSS) upon admission (available in 9/41 patients) was 14 (range: 6–20). Nineteen patients had favorable outcomes (modified Rankin Scale [mRS]: 0–2 at 6 months), and 22 had unfavorable outcomes (mRS: 3–6 at 6 months). The mortality rate was 37% (15/41). Favorable outcomes were associated with revascularization within the first 360 minutes of the onset of symptoms ( $p = 0.000001$ ), and satisfactory revascularization (thrombolysis in cerebral infarction [TICI] scale: 2b or 3) ( $p = 0.0018$ ).

**Conclusion** It is of paramount importance to educate stroke teams on the benefits of IAT for acute ischemic stroke and the population on identifying stroke and seeking immediate care following symptom onset.

### Keywords

- ▶ endovascular treatment
- ▶ intra-arterial thrombectomy
- ▶ mechanical thrombectomy
- ▶ ischemic stroke

### Resumo

**Objetivo** Relatar nossa experiência inicial com trombectomia intra-arterial (TIA) com uso de *stent retriever* em acidente vascular encefálico isquêmico (Avei) agudo.

**Métodos** Análise retrospectiva de pacientes com Avei submetidos a TIA de setembro de 2010 a agosto de 2016.

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**Palavras-chave**

- ▶ tratamento endovascular
- ▶ trombectomia intra-arterial
- ▶ trombectomia mecânica
- ▶ acidente vascular encefálico isquêmico

**Resultados** Foram incluídos 41 pacientes; a idade média foi 57 anos (intervalo: 29–85), e 54% dos pacientes eram mulheres. Trombos ocluindo vasos da circulação anterior foram encontrados em 32 casos, e 11 na circulação posterior. A média do valor da Escala de Acidente Vascular Encefálico do National Institutes of Health (NIH) na admissão (disponível para 9 dos 41 pacientes) foi 14 (intervalo: 6–20). Um total de 19 pacientes teve resultados favoráveis (Escala de Rankin modificada [ERm]: 0–2 em 6 meses), e 22 tiveram resultados não favoráveis (ERm: 3–6 em 6 meses). A mortalidade foi de 37% (15/41). Resultados favoráveis foram associados com revascularização dentro dos primeiros 360 minutos de instalação dos sintomas ( $p = 0.000001$ ) e revascularização satisfatória (escala de trombolise em infarto cerebral [TEIC]: 2b ou 3) ( $p = 0.0018$ ).

**Conclusão** É de suma importância educar as equipes de acidente vascular encefálico sobre os benefícios da TIA para AVEI agudo, e a população, na identificação do AVEI, para que seja buscado atendimento imediato após o início dos sintomas.

**Introduction**

In 1995, the first effective therapy for acute ischemic stroke – recombinant tissue-type plasminogen activator (r-tPA) – was demonstrated by the National Institute of Neurological Disorders and Stroke (NINDS) trial.<sup>1</sup> Since then, major advances in acute ischemic stroke care have occurred, including the use of intra-arterial thrombectomy (IAT). Between 2014 and 2015, 5 prospective, randomized trials (MR CLEAN, ESCAPE, EXTEND-IA, SWIFT PRIME, REVASCAT) have showed the efficacy of IAT with stent retrievers in large artery occlusions.<sup>2–6</sup> Here we report our initial institutional experience with IAT for a series of patients with acute ischemic stroke.

**Methods**

A retrospective review of patients with acute ischemic stroke who underwent IAT at a hospital in the city of Curitiba, Brazil, from September 2010 to August 2016 was conducted. We analyzed this cohort's epidemiological characteristics, site of occlusion, stroke etiology, use of r-tPA, and the time interval between: a) symptom onset and groin puncture; b) symptom onset and revascularization; and c) groin puncture and revascularization.

Endovascular procedures were performed under general anesthesia in 36 patients, 2 of whom required general anesthesia following sedation due to agitation, confusion or uncooperativeness. Five patients underwent the procedure under sedation. Forty-four Solitaire AB stent retrievers (ev3 Inc., Irvine, CA, US) were utilized, and the average stent retriever attempts in the cohort was 4.4 (1 to 9). Two patients underwent ipsilateral carotid stenting concurrently with distal thrombectomy due to subocclusive atherosclerotic stenosis.

The clinical outcomes were measured by the modified Rankin Scale (mRS) at the time of the procedure, and at 1 and 6 months thereafter. Favorable outcomes were defined as mRS 0 to 2 at 6 months, and unfavorable outcomes, as mRS 3–6 at 6 months. The degree of post-procedural revascularization was measured by the thrombolysis in cerebral infarction (TICI) grading system.<sup>7</sup> Revascularization was considered satisfactory for TICI 2b and 3, and unsatisfactory for TICI 0, 1 and 2a.

The data was presented in frequency tables, in addition to descriptive measures. Binomial testing was applied to perform the test of proportions. The Fisher exact test was used to verify the relationship between two dichotomous variables. The Mann-Whitney test was used to verify the relationship between the dichotomous variables and the continuous variables. The level of significance was 5%.

**Results**

A total of 41 patients were included in the study. The mean age was 57 years (ranging from 29 to 85); 54% were women. The National Institutes of Health Stroke Scale (NIHSS) score upon admission, available only for nine patients, was on average 14 (ranging from 6 to 20). Eleven patients previously received an intravenous r-tPA, while two received an intra-arterial r-tPA concurrently with IAT. The remaining 28 patients did not receive an r-tPA because of contraindications. The mean time from symptom onset to groin puncture was 242 minutes; from symptom onset to revascularization, the mean time was 398 minutes; and from groin puncture to revascularization, it was 155 minutes. Thirty-two patients (78%) were found to have occlusion in the anterior circulation, whereas 11 (22%) had it in the posterior circulation. Twelve patients (29%) had unsatisfactory revascularization (TICI 0, 1, or 2a) and 29 patients (71%) had satisfactory revascularization (TICI 2b or 3). Regarding the clinical outcomes, 19 patients (46%) had favorable outcomes (mRS 0, 1, or 2 at 6 months), and 22 patients (54%) had unfavorable outcomes (mRS 3, 4, or 6 at 6 months). The average mRS scores at the time of the procedure and at 1 and 6 months thereafter were 3.21, 3.12 and 3.02 respectively. These numbers are summarized in **Table 1**. In the same period, 164 patients received intravenous r-tPA alone, and the neurological outcome was worse: 61 deaths (37.2%) during the first week due to the direct effect of cerebral infarction and 24 due to late clinical complications (14.63%). Of the 79 (48%) survivors, only 35 (21.35% of the total) scored mRS 0–2 at 6 months. There were no patients admitted to our department with acute stroke within 3 hours who received conservative treatment.

**Table 1** Characteristics of the studied patients ( $n = 41$ )

Mean age $\pm$ SD (years)	57.39 (29–85) $\pm$ 16.53
Male sex (n/%)	19/46%
Mean NIHSS score (available for 9 patients) mean/range	14 (6–20)
Treatment with IV r-tPA (n)	11
Treatment with IA r-tPA (n)	2
Mean time from symptom onset to groin puncture/range (minutes)	242.56 (60–480)
Mean time from symptom onset to revascularization/range (minutes)	397.56 (190–770)
Mean time from groin puncture to revascularization/range (minutes)	155 (35–490)
Anterior circulation strokes (n/%)	32 (78%)
Posterior circulation strokes (n/%)	9 (22%)
TICI score:	
unsatisfactory (0,1, 2a)	12 (29.26%)
satisfactory (2b, 3)	29 (70.74%)
mRS at 6 months after IAT:	
favorable (0–2)	19 (46%)
unfavorable (3–6)	22 (54%)

Abbreviations: IA, intra-arterial; IV, intravenous; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale; r-tPA, recombinant tissue-type plasminogen activator; SD, standard deviation; TICI, Thrombolysis in Cerebral Infarction scale;

Concerning stroke etiology, we were able to have it determined in 36 patients (88%); the etiology in the remaining 5 patients was not identified despite thorough work-up. The most frequent cause was cardiogenic ( $n = 14$ ): 6 patients had atrial fibrillation, 4 had patent foramen ovale, and 4 had other heart diseases (Chagas disease, severe congestive heart failure, late postoperative period of mitral metal valvuloplasty and Down syndrome). Other etiologies included atherosclerosis ( $n = 12$ ), artery-to-artery embolism (significant stenosis in the cervical vessel ipsilateral to the clot;  $n = 5$ ), dissection of cervical vessels (1 traumatic and 2 spontaneous;  $n = 3$ ), and thrombophilia ( $n = 2$ ). Hemorrhagic transformation occurred in 7 patients (17%).

Fourteen patients (34%) died as result of stroke, and an additional patient died at 7 months due to an oncological cause. Among the 32 (78%) patients with anterior circulation occlusions, 10 (31%) died; among the 9 (22%) patients with posterior circulation occlusions, 5 (56%) died. No statistical difference between the groups was identified ( $p = 0.17$ ). The likelihood of dying in patients who suffered hemorrhagic transformation was higher (6/7, 86%) than in patients in whom hemorrhagic transformation did not occur (9/34, 26%) –  $p = 0.006$ . Patients who were older than 70 years of age were more likely to die (6/11, 56%) in comparison to those younger than 70 years of age (9/30, 30%); however, this association was not statistically significant ( $p = 0.14$ ). Pa-

**Table 2** Clinical outcomes as per mRS at 6 months

	Favorable (mRS 0–2)	Unfavorable (mRS 3–6)	
Mean time from symptom onset to revascularization			Fisher exact test, $p = 0.000001$
< 360 minutes	17 (89%)	2 (11%)	
> 360 minutes	2 (9%)	20 (91%)	
TICI			Fisher exact test, $p = 0.0018$
Satisfactory (2b, 3)	18 (62%)	11 (38%)	
Unsatisfactory (0,1, 2a)	1 (9%)	11 (90%)	

Abbreviations: mRS, modified Rankin Scale; TICI, Thrombolysis in Cerebral Infarction scale.

tients older than 80 years of age were more likely to die (3/4, 75%) than patients younger than 80 years (12/37, 32%); similarly, this association was not statistically significant ( $p = 0.13$ ). Men were found to be more likely to die than women (10/19 [53%] versus 5/22 [23%] respectively;  $p = 0.048$ ).

The odds of better clinical outcomes at 6 months (as per mRS) declined in those patients for whom the time from symptom onset to revascularization was longer (–**Table 2**). Among the 19 patients in whom revascularization was achieved within the first 360 minutes of symptom onset, favorable outcomes (mRS of 0, 1 or 2 at 6 months) were observed in 17 patients (89%). Among the 22 patients in whom revascularization was achieved after the first 360 minutes of symptom onset, favorable outcomes were observed in 2 patients (9%). Notably, the 360-minute cut-off point was determined by statistical analysis. The association between revascularization within the first 360 minutes of symptom onset and improved clinical outcomes was statistically significant ( $p = 0.000001$ ).

The odds of better clinical outcomes were also associated with more efficient revascularization (as per TICI score) (–**Table 2**). Among the 29 patients in whom revascularization was satisfactory (TICI 2b or 3), favorable outcomes (mRS of 0, 1 or 2 at 6 months) were observed in 18 patients (62%). Among the 12 patients in whom revascularization was unsatisfactory (TICI 0, 1, or 2a), a favorable outcome was observed in 1 patient (9%). The association between efficient revascularization and improved clinical outcomes was also statistically significant ( $p = 0.0018$ ).

Improved outcomes were also associated with shorter time from symptom onset to groin puncture as patients with favorable outcomes had groin puncture at a mean time of 205 minutes; the mean time for patients with unfavorable outcomes was of 275 minutes ( $p = 0.0168$ ). Better outcomes were also associated with a shorter time from groin puncture to revascularization (mean time of 75 minutes in patients with favorable outcomes versus 223 minutes in patients with unfavorable outcomes;  $p = 0.000002$ ). Specifically regarding r-tPA, either intravenous or intra-arterial, there was no association between its use and the clinical outcomes.

## Discussion

Since 1995, when the first effective therapy for acute ischemic stroke was demonstrated by the NINDS trial,<sup>1</sup> major advances in the management of ischemic stroke have occurred. Intra-arterial stroke therapy was introduced early,<sup>8</sup> especially for severe strokes (that is, large artery occlusions leading to severe outcomes or death); however, it was not until 2012–2013 that trials using first-generation thrombectomy devices were published.<sup>9–11</sup> Their results did not show any benefit of IAT over the standard treatment.

In 2015, the American Heart Association published guidelines<sup>8</sup> for the management of acute stroke based on the benefits of IAT consistently reported by large randomized trials.<sup>2–6</sup> The numbers needed to treat in these trials ranged from 3 to 5. The authors concluded that thrombectomy in acute ischemic strokes secondary to proximal occlusions surpassed any therapy. Since then, endovascular therapy became the state-of-the-art intervention in stroke patients who meet predefined criteria.<sup>12</sup>

In the series presented herein, the total mortality rate was 37% ( $n = 15/41$ ). Among patients with anterior circulation occlusions, the rate was 31% ( $n = 10/32$ ), whereas in patients with posterior circulation occlusions it was 56% ( $n = 5/9$ ). The total mortality rate in our study was slightly higher than the rate in the literature.<sup>12</sup> We believe this is related to the fact that, in our series (differently from the large trials mentioned before), patients with both anterior and posterior circulation occlusions were included. In this study, we identified the following predictive factors for death: a) age ( $> 70$  years and  $> 80$  years,  $p = 0.14$  and  $0.13$  respectively); b) gender (men were more likely to die,  $p = 0.048$ ); and c) occurrence of hemorrhagic transformation ( $p = 0.006$ ).

Improved clinical outcomes at 6 months (mRS 0, 1 or 2) were associated with revascularization within the first 360 minutes of the onset of symptoms ( $p = 0.000001$ ), and with satisfactory revascularization (TICI 2b or 3) ( $p = 0.0018$ ). Better outcomes were also associated with shorter time from symptom onset to groin puncture ( $p = 0.0168$ ) and shorter time from groin puncture to revascularization ( $p = 0.000002$ ). There was no association between the use of r-tPA, either intravenous or intra-arterial, and the clinical outcomes.

A limitation of our study was that NIHSS scores were available for a minority of the studied patients ( $n = 9/41$ ). This happened because of the retrospective nature of the paper, and due the fact that most patients in this series were cared for before strict protocols and guidelines on IAT for acute stroke were published.

Based on our results and on the results from other major trials in the literature, we would like to stress the paramount importance of educating stroke teams (as well as neurologists caring for patients with stroke) on the significant benefits of IAT in patients with acute ischemic stroke due

to proximal large vessel occlusions presenting within 6 to 8 hours of the onset of symptoms. In the same context, it is essential to educate the population on preventing and identifying stroke as well as seeking immediate emergency care following symptom onset.

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### Disclosure

None of the authors have any disclosures to report. The work described is consistent with this journal's guidelines for ethical publication.

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