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The Benefit of Endovascular Thrombectomy for Stroke on Functional Outcome Is Sustained at 12 Months

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Endovascular thrombectomy · Acute ischemic stroke · 12-month functional outcome · Quality of life

Abstract

Background and Purpose: The short-term benefits of endovascular thrombectomy (EVT) for acute ischemic stroke (AIS) have been widely documented, yet there is limited evidence to show that this is sustained in the long term. We aimed to determine whether the benefit of EVT on functional outcome at 3 months is maintained at 12 months and the factors correlating with functional independence and quality of life. ***Methods:*** Data for analysis came from a prospective registry of consecutive patients undergoing EVT at a single Comprehensive Stroke Center (Oct 2018–Sep 2019). A phone interview was conducted for 12-month patient outcomes. Functional outcome was assessed by the modified Rankin Scale (mRS). Quality of life was determined by return to usual place of residence, work, or driving and calculation of a health utility index using the European Quality of Life-5 Dimensions questionnaire (EQ-5D-3L). ***Results:*** Of the 151 patients who underwent EVT during the study period, 12-month follow-up was available for 145 (96%). At 12 months, 44% (n = 64) of patients were functionally independent (mRS 0–2) compared to 48% at 3 months. Mortality at 12 months was 26% compared to 17% at 3 months. Significant predictors of functional independence at 12 months were younger age and lower baseline National Institutes of Health Stroke Scale. Better quality of life significantly correlated with return to usual place of residence and driving. ***Conclusion:*** Three-month functional independence was sustained at 12 months, indicating that EVT remains beneficial for patients with AIS in the longer term.

Introduction

The benefit of endovascular thrombectomy (EVT) in acute ischemic stroke (AIS) due to large vessel occlusion (LVO) is well established [1–5]. There is limited evidence

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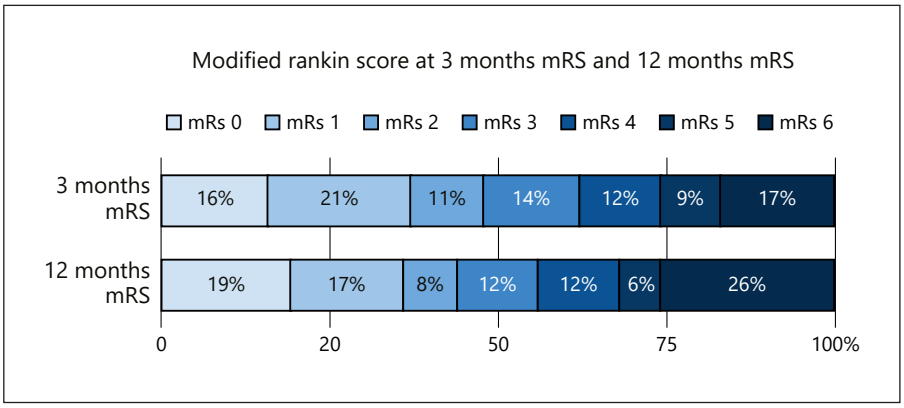

Fig. 1. Three- and 12-month mRS outcome. Shown is the distribution of scores on the mRS at 3 months and 12 months. A score of 0 is defined as having no symptoms, 1 as having no significant disability despite symptoms, 2 as having slight disability but able to look after one's own affairs without assistance, 3–5 as moderate to severe disability, and 6 as death. mRS, modified Rankin Scale.

regarding longer-term functional and quality of life (QOL) patient outcomes. The MR CLEAN [1] and REVASCAT [3] follow-up trials report that the proportion of patients with functional independence at 12 months and 2 years is comparable to 3-month outcomes [6, 7]. An observational cohort study [8] also found a sustained longer-term benefit.

Most studies have focused on functional independence using the mRS score which does not assess patient QOL. QOL can be measured using the European Quality of Life-5 Dimensions questionnaire (EQ-5D-3L) to calculate a health utility index (scores range from −0.329 to 1, higher scores indicating better health) and the EQ-visual analog scale (EQ-VAS) [9]. These tools broadly examine a patient's return to "usual activities" but do not specifically assess the impact of stroke on a patient's ability to return to their usual place of residence, work, or driving. The frequency of subsequent vascular events is also unclear.

This study aimed to determine the 12-month outcomes including functional independence, mortality, and QOL in patients with AIS due to LVO undergoing EVT. It was hypothesized that the observed benefit of EVT on patient functional independence at 3 months would be sustained at 12 months.

Materials and Methods

Study Design

Data for analysis came from a prospective EVT registry of consecutive patients presenting to a Comprehensive Stroke Center (CSC) from October 2018 to September 2019 (n = 151). Registry data included age, gender, baseline National Institutes of Health Stroke Scale (NIHSS) score, vascular risk factors, premorbid mRS, stroke etiology, lesion location, procedural data, symptomatic intracranial hemorrhage, and 3-month functional outcome. The study obtained ethical approval from the South Western Sydney Local Health District Human Research Ethics Committee (2019/ETH04094). Verbal informed consent was obtained from participants or next of kin.

Data Collection

Three-month stroke survivors or next of kin were contacted by phone to determine 12-month outcome. Functional outcome was assessed by using mRS. QOL was determined by the EQ-5D-3L and the EQ-VAS. Additional collected data included new-onset atrial fibrillation (AF) or vascular events (stroke and myocardial infarction), place of residence, requirement of a government-funded support Home Care Package (HCP), return to work, and driving.

Statistical Analysis

Twelve-month functional outcomes were dichotomized into functionally independent (mRS 0–2) and poor (mRS 3–6). Descriptive statistics were calculated for registry data outlined in the study design. ANOVA and multivariate logistic regression were used to determine significant correlations between 12-month functional outcome and patient demographics and stroke characteristics. Linear regression analysis was used to determine correlations between place of residence, HCP, return to work, and driving with health QOL outcome measures (EQ-5D-3L health index and EQ-VAS). A 2-sided p value of ≤0.05 was considered statistically significant. Statistical analysis was conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corporation, Armonk, NY, USA).

Results

One hundred and fifty-one patients with AIS due to LVO underwent EVT during the study period. Six patients uncontactable at 12 months were excluded. Overall, 145 patients were included in the study of which 107 underwent 12-month interviews. One hundred and forty patients (140/145; 97%) had a premorbid mRS 0–2. Baseline demographics and prevalence of stroke risk factors are shown in Table 1.

Table 1. Baseline characteristics of the patient cohort

	Study group at baseline (n = 145)	mRS 0–2 at 12 months (n = 64)	mRS 3–6 at 12 months (n = 81)	p value
Age				
Median (IQR)	72 (62–80)	69 (59–77)	76 (65–83)	
Mean±SD	70.0±13.3	66±13	73±13	0.001*
Range	35–96	35–89	41–96	
Gender				
Male	82 (57)	34 (53)	48 (59)	0.459
Female	63 (43)	30 (47)	33 (41)	
Baseline NIHSS score				
Median (IQR)	18 (11–22)	15 (9–18)	19 (15–26)	
Mean±SD	17±8.1	14±7	20±8	<0.001*
Range	0–42	0–33	2–42	
Risk factors				
Hypertension	106 (73)	37 (58)	69 (85)	<0.001*
Diabetes	41 (28)	14 (22)	27 (33)	0.128
Atrial fibrillation	71 (49)	31 (48)	40 (49)	0.910
Current smoker	37 (26)	21 (33)	16 (20)	0.073
Premorbid mRS				
mRS 0–2	140 (97)	62 (97)	78 (96)	0.850
mRS > 2	5 (3)	2 (3)	3 (4)	
Lesion location				
Anterior (ICA/MCA)	130 (90)	57 (89)	73 (90)	0.835
Posterior (PCA/basilar)	15 (10)	7 (11)	8 (10)	
Symptomatic ICH	7 (5)	0	7 (9)	0.016*
3-month mRS				
mRS 0–2	69 (48)	58 (91)	11 (14)	<0.001*
mRS 3–6	76 (52)	6 (9)	70 (86)	
Mortality at 3 months	25 (17)			
Mortality at 12 months	38 (26)			

All data are represented as n (%), mean ± SD, median (IQR), or range. ICA, internal carotid artery; ICH, intracranial hemorrhage; MCA, middle cerebral artery; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; PCA, posterior cerebral artery. * Statistically significant ($p < 0.05$).

At 3 months, 69/145 (48%) were functionally independent (mRS 0–2) compared to 64/139 (46%) at 12 months (shown in Fig. 1). Eighty-four percent of functionally independent patients at 3 months remained independent at 12 months. Twenty-five patients (17%) died at 3 months and a further 13 died between 3 and 12 months (12-month mortality: 26%). Of these 13 additional deaths, 5 patients had an mRS 0–2 and 8 were mRS 3–5 at 3 months. Forty-four of 53 patients with an excellent functional outcome (mRS 0–1; 83%) at 3 months remained unchanged at 12 months. Seventeen of 51 patients with an mRS 3–5 at 3 months (33%) had further functional decline or death at 12 months.

A comparison of 12-month outcomes for the 107 survivors based on their functional outcome is shown in Table 2. At 12 months, 5/107 (4.6%) patients had a new stroke/transient ischemic attack, 1 patient had a myocardial infarction, and 2 patients were diagnosed with AF. Seventy-six percent of patients returned to their usual place of residence, but of these, 15 (14%) required a government-funded HCP (all mRS 3–5). Thirty-two patients were working before stroke, and of these, 10 had returned to work (all mRS 0–2). Sixty patients were able to drive a motor vehicle before stroke and 31 returned to driving at 12 months (all mRS 0–2).

The median EQ-5D-3L index score at 12 months was 0.863 in patients with an mRS 0–2 and 0.624 in the mRS 3–5 subgroup. The median EQ-VAS score was 80 in patients with an mRS of 0–2 and 50 in the mRS 3–5 subgroup.

Univariate analysis of baseline data showed that significant predictors of functional independence (mRS

Table 2. Comparison of 12-month outcome for functionally independent (mRS 0–2) and poor functional outcome survivors (mRS 3–5)

12-month outcomes	Study group (n = 107)	mRS 0–2 subgroup (n = 64)	mRS 3–5 subgroup (n = 43)	p value
New stroke/TIA	5 (5)	2	3	0.355
New AF	2 (2)	2	0	0.380
New MI	1 (1)	0	1	0.220
Place of residence				
Home	82 (76)	61	21	
Nursing home	20 (19)	2	18	<0.001*
Others	5 (5)	1	4	
Change in place of residence	26 (24)	3	23	<0.001*
Care packages	15 (14)	0	15	<0.001*
Working	10 (9)	10	0	0.006*
Working before	32 (30)	21	11	0.423
Driving	31 (29)	31	0	<0.001*
Driving before	60 (56)	41	19	0.042
EQ-5D-3L index value, median	0.768	0.863	0.624	<0.001*
EQ-VAS score, median	75	80	50	<0.001*

All data are represented as n (%), n, or median. AF, atrial fibrillation; EQ-VAS, EQ-visual analog scale; EQ-5D-3L, European Quality of Life-5 Dimensions-three-level; MI, myocardial infarction; mRS, modified Rankin Scale; TIA, transient ischemic attack. * Statistically significant ($p < 0.05$).

Table 3. Predictors of 12-month functional independence (mRS 0–2) and factors associated with better quality of life (EQ-5D-3L index score)

Predictors of functional independence	Multivariate logistic regression OR (95% CI)	p value
Younger age	1.040 (1.009–1.076)	0.012*
Lower baseline NIHSS score	1.120 (1.059–1.184)	<0.001*
No hypertension	4.743 (1.865–12.061)	0.001*
Factors associated with better quality of life	**Multivariate linear regression 95% CI**	**p value**
Unchanged place of residence	0.032–0.135	0.002*
No home care package	0.036–0.163	0.002*
Return to work	−0.005–0.157	0.066
Driving	0.049–0.157	<0.001*

Effect of age is per year and NIHSS score per point reductions. CI, confidence interval; EQ-5D-3L, European Quality of Life-5 Dimensions-three-level; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio. * Statistically significant ($p < 0.05$).

0–2) at 12 months were younger age, lower baseline NIHSS, normotension, and 3-month functional independence (Table 1). Multivariate logistic regression showed that younger age, lower baseline NIHSS, and normotension remained significant predictors of functional independence (Table 3). Multivariate linear regression analysis showed that the significant predictors of a favorable EQ-5D-3L index score at 12 months were unchanged place of residence, return to work and driving, and lack of need for a government-funded support HCP (Table 3).

Discussion

This EVT outcome study showed that functional independence (mRS 0–2) was sustained at 12 months. Percentage of patients with functional independence at 12 months (46%) was similar to that at 3 months (48%). Mortality increased from 17% at 3 months to 26% at 12 months. Significant predictors of functional independence at 12 months were younger age, lower baseline NIHSS, and normotension. A better QOL was seen with return to usual place of residence and driving. A poorer QOL correlated with the need for a government-funded support HCP.

Patients with an excellent functional recovery (mRS 0–1) at 3 months were highly likely to maintain this level of recovery at 12 months. Patients with a higher mRS at 3 months (mRS ≥2) were more likely to functionally decline over time. Stroke recurrence or new cardiovascular events were low in this study and do not adequately explain this finding. One possible explanation for the lower rate of functional independence at 12 months is that patients undergo inpatient rehabilitation early after their stroke during which time limitations on their daily activities may not be obvious [6]. Once patients move home where there is less assistance, small changes in functional ability become more evident which may result in a decline in their mRS category. Another explanation may involve a natural deterioration of function due to increasing age and underlying cerebrovascular disease. Other unstudied factors such as depression and fatigue may also play a role.

The literature reports similar sustained long-term functional outcomes in patients after EVT as found in our study. A long-term follow-up study [7] of the REVASCAT [3] trial found similar proportions of patients with mRS 0–2 at 3 and 12 months (43.7 vs. 44%). Long-term outcomes [6] in the MR CLEAN trial [1] also found the proportion of functionally independent patients (mRS 0–2) at 2 years in the EVT group (37.1%) to be comparable to that at 3 months (32.6%).

These studies also assessed QOL outcomes using the EQ-5D-3L. The median EQ-5D-3L index score was 0.46 at 12 months in the REVASCAT follow-up and 0.48 at 2 years in the MR CLEAN follow-up. These results differ from the median EQ-5D-3L score of 0.77 at 12 months seen in our study, despite all studies having a similar baseline stroke severity (NIHSS 17 or 18). Other factors may be contributing to the disparity seen in 12-month health QOL such as geographic differences in standard of living, healthcare, carer support, and economic prosperity.

There are no prior studies directly addressing the impact of EVT on return to usual place of residence, work, or driving. These were important factors in determining QOL in our patients. Of interest, only two-thirds of patients who were functionally independent at 12 months (mRS 0–2) returned to work or driving.

A limitation of this study was its sample size and observational design. The 12-month assessment was not blinded by 3-month and baseline data, introducing potential bias. The study is from a single center which may not be representative of other populations. The strength of this study is that it offers real-world data from a high-volume center registry, including patients who otherwise may be excluded from randomized control trials. A high proportion of 12-month follow-up data was also available.

Conclusion

This study found that the functional independence seen in the short term following EVT for AIS is sustained at 12 months. Mortality increased from 17% at 3 months to 26% at 12 months. The significant predictors of long-term functional independence were younger age, lower baseline NIHSS score, and normotension. Better QOL correlated with functional independence at 12 months, return to usual place of residence, and driving. Further studies are warranted on the impact of EVT on the patients' return to their previous lifestyle.

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Statement of Ethics

The study obtained ethical approval from the South Western Sydney Local Health District Human Research Ethics Committee (2019/ETH04094). Verbal informed consent was obtained from participants or next-of-kin.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

B.P. was involved in data collection, data analysis, and manuscript preparation (first and all subsequent drafts). D.C. was involved in study design, data collection, data analysis, and manuscript preparation. M.P. was involved in study design and manuscript preparation. A.C., N.M., and J.W. were involved in data collection and manuscript preparation. C.C.S. was involved in study design, data collection, data analysis, manuscript preparation, and ethics application.

Data Availability Statement

The data that support the findings in this study are available from the corresponding author upon reasonable request.

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