Does modified Rankin Score (mRS) matter? The impact of stroke severity on carotid artery endarterectomy (CEA) outcomes.

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PII: S0890-5096(23)00146-2

DOI: https://doi.org/10.1016/j.avsg.2023.02.031

Reference: AVSG 6682

To appear in: *Annals of Vascular Surgery*

Received Date: 8 January 2023

Revised Date: 23 February 2023

Accepted Date: 25 February 2023

Please cite this article as: Cruddas L, Baker DM, Does modified Rankin Score (mRS) matter? The impact of stroke severity on carotid artery endarterectomy (CEA) outcomes., *Annals of Vascular Surgery* (2023), doi: https://doi.org/10.1016/j.avsg.2023.02.031.

Title Page:

Type of article:

Basic science research

Title:

Does modified Rankin Score (mRS) matter? The impact of stroke severity on carotid artery endarterectomy (CEA) outcomes.

Keywords:

Modified rankin score, carotid endarterectomy, stroke

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Disclaimers: None

Conflict of interest: None

Abstract

Aims

Carotid artery endarterectomy (CEA) is recommended to reduce stroke risk in patients following non-disabling ischaemic stroke (modified Rankin Score mRS<3). We reviewed CEA outcomes in patients after more devastating strokes (mRS≥3).

Methods

An observational cohort study was performed, and data was collected from 1013 CEA cases over fifteen years. Patient demographics, co-morbidities and post-operative outcomes were compared between preoperative mRS<3 (Group one) and mRS≥3 (Group two). Statistical significance was determined by $p<0.05$.

Results

Ninety-one (9%) patients were mRS ≥ 3. There was no significant difference between age, gender, and operated side. Group two had significantly higher rates of diabetes and frailty. There was no significant difference in anaesthetic type. Group two spent longer in High Dependency. Return to theatre and post-operative complications were similar. Incidence of perioperative stroke, mortality and readmission rates were not significant at 30 days post-operation between the two groups.

Conclusion

Patients with a higher mRS have more pre-operative co-morbidities but short-term perioperative complication rate is not significantly different. Patient selection should be undertaken with care.

Introduction

The Rankin Score was originally developed in 1957 as an outcome grading scale for patients following a stroke. The score was then further refined in 1988, to the modified Rankin Score (mRS). It assesses functional independence post stroke, compared to pre-stroke activities, using a single scale item, with disability categorised as: none (1); slight (2); moderate (3); moderately severe (4); and severe (5) (Table 1) [1]. No stroke symptoms are graded as 0. The score is calculated by a clinician, taking a history to assess pre- and post-stroke activity, as well as performing a neurological examination to assess for physical disability. The score combines physical performance as well as speech and mental function. The score is quick, easy to complete, and requires no formal training or equipment. The mRS has been shown to have test-test reliability, intra-rater reliability, and inter-rater reliability [2].

Some patients who experience a stroke may be candidates for carotid endarterectomy (CEA). Carotid endarterectomy is currently recommended in patients with carotid territory symptoms experienced in the preceding 6 months, with image confirmed 70-99% carotid artery stenosis, in cases where procedural stroke and death risk is <6% [3]. Level one guidance from the European Society for Vascular Surgery also recommends that revascularisation should be deferred in patients with 50-99% stenosis who suffer a disabling stroke (defined as mRS 3 or above). A number of factors must be considered when deciding a patient's suitability for intervention including age, medical co-morbidities and anticoagulation or bleeding disorder [4,5,6].

Whilst the benefits of early CEA for individuals with non-disabling, symptomatic carotid artery stenosis following stroke are established, the surgical risks and benefits of CEA in

individuals following a disabling stroke are less understood. It is likely that pre-operative mRS is one of a number of variables which impact post-operative outcomes. The aim of this study was to perform a large scale, single centre study comparing CEA outcomes in individuals with mRS <3, with those ≥3.

Methods

Data was collected from a single centre between 2007 and 2022 from the Vascular National Registry. The registry was searched for individuals who underwent a CEA. Patient demographics, co-morbidities and post-operative outcomes were recorded on a spreadsheet. This included: age; gender; co-morbidities (hypertension/respiratory diagnosis/ischaemic heart disease/heart failure/renal failure/cancer/peripheral vascular disease/smoker/atrial fibrillation/smoker/frailty); mRS; date of first symptom; date of procedure; discharge date; number of days from symptoms to surgery; number of days from surgery to discharge; discharge status; side of surgery; degree of stenosis on affected side; contralateral stenosis; if previous contralateral surgery; indication for surgery; anaesthetic used; post-operative destination; number of post-operative days on intensive care; return to theatre; post-operative complications (cardiac/respiratory/stroke/renal failure/ haemorrhage/haematoma/post-operative confusion/wound infection/nerve injury); discharge modified rankin score; discharge destination; 30-day readmission; and 30-day mortality.

Patients were categorised as mRS<3 (Group one) and mRS ≥3 (Group two). For the purpose of this study, Group one and Group two were compared in: pre-operative demographics; perioperative factors and post-operative outcomes. Paired T test was used to compare the two groups, and $p<0.05$ was deemed statistically significant.

Data was collected and reviewed by both authors.

Results

1013 CEA cases were performed during the fifteen-year period. Ninety-one individuals (9%) had a mRS≥3. There was no significant difference in age (Group one mean: 71.9; Group two mean: 73.7; p=0.445) or gender (p=0.530). Group two had a significantly higher rate of diabetes (Group one: 0.24; Group two: 0.48; p=0.015) and had a significantly higher average frailty score (Group one mean: 0.04; Group two mean: 1.82; p=0.0001).

There was no significant difference in the rate of hypertension (Group one: 0.44; Group two: 0.64; p=0.060); respiratory diagnoses (Group one: 0.13; Group two: 0.24; p=0.200); ischaemic heart disease (Group one: 0.45; Group two: 0.50; p=0.570); heart failure (Group one: 0.02; Group two: 0.11; p=0.103); renal failure (Group one: 0.07; Group two: 0.15; p=0.209); cancer (Group one: 0.02; Group two: 0.04; p=0.570); peripheral vascular disease (Group one: 0.00; Group two: 0.02; p=0.323); smoking status (never, ex-, current smoker; Group one: 0.500; Group two: 0.559; p=0.632); ASA (Group one: 2.72; Group two: 2.89; p=0.331); and atrial fibrillation (Group one: 0.16; Group two: 0.16; p=1) (Table 2).

There was no significant difference in anaesthetic type used for procedure (p=0.112) (local, regional, general, general plus regional, local infiltration, superficial cervical block and deep cervical block); side operated (p=0.408); operative technique (p=1) (direct closure, patch, eversion, bypass, stent); or post-operative destination (p=0.635) (ward, high dependency unit,

intensive care unit, home, died in theatre). There was no significant difference in rate of return to theatre (Group one: 0.04; Group two: 0.05; p=0.657).

Group two had significantly longer stays on intensive care (Group one mean: 0.76; Group two mean: 1.46; p=0.011). There was no significant difference in post-operative cardiac event (Group one: 0.00; Group two: 0.03; p=0.083); respiratory complications (Group one: 0.01; Group two: 0.03; p=0.320); stroke (Group one: 0.02; Group two: 0.05; p=0.320); renal failure (Group one: 0.00; Group two: 0.02; p=0.320); post-operative bleed (Group one: 0.13; Group two: 0.11; p=0.820); post-operative confusion (Group one: 0.00; Group two: 0.01; p=0.320). There was no significant difference between the two groups in the number of post-operative complications (Group one: 0.18; Group two: 0.25; p=0.333). Days from surgery to discharge were not significantly different between the two groups (Group one: 5.20; Group two: 6.98; p=0.159). Thirty-day mortality rates were not significantly different (Group one: 0.00; Group two: 0.00; p=0.779). Place of discharge (usual place of residence/rehabilitation/intermittent care/other hospital) was not significantly different (p=0.736). Thirty-day re-admission rates were not significantly different (Group one: 0.04; Group two: 0.00; p=0.159). At six week follow up, there was no significant difference in post-operative stroke rate (Group one: 0.00; Group two: 0.04; p=0.159) (Table 3).

Discussion

Carotid endarterectomy is performed to reduce future stroke risk in individuals with significant carotid stenosis following a transient ischaemic attack (TIA) or stroke. Operative eligibility criteria include a pre-operative mRS<3. This data sample compared pre-operative risk factors, and intra operative and post-operative outcomes for patients with mRS<3,

against those deemed higher risk, mRS≥3. Our data set included ninety-one individuals who had a mRS≥3 and had undergone carotid endarterectomy. These patients had been discussed at a neurovascular MDT, attended by neuroradiologists, vascular surgeons and stroke physicians, and the decision was made to proceed with surgery based on the balance of risks and benefits.

Results demonstrated that Group two individuals had higher rates of diabetes and higher frailty scores. Other co-morbidities were not significantly different between the two groups. Intraoperative techniques, operated side, anaesthetic used and return to theatre were also similar. Post operatively, Group two individuals were more likely to have longer stays on HDU. However, post-operative complications were not significantly different between the two groups. Death rates, days to discharge, place of discharge and readmission rates were similar between the two groups.

The study is limited by the nature of the data. All data points were considered binary. Risk factors were either present or absent, and their degree was not accounted for. For example, individuals may have similar rates of heart failure or renal failure, however, the severity was not examined. Additionally, there was a large difference in the size of the two data sets, making comparison more challenging. Some data sets were incomplete. Missing values were considered random, secondary to data availability and dependence on clinicians to enter complete data sets onto the NVR. Data was considered Missing at Random (MAR), and therefore all data available was used, and missing values ignored. Imputation and deletion were not required in this observational study, so to include as many data sets as possible,

maintain statistical power and avoid bias. In addition to incomplete data sets, the study lacks mid to long-term patient outcomes, which could be a focus for further research.

The study looked the impact of mRS and clinical stroke severity on carotid endarterectomy outcomes. Radiographic stroke size was not explored. Although this may be related to post-operative stroke, haemorrhagic transformation and therefore operative outcomes, all current guidance is focused on incidence of stroke/TIA, mRS and evidence of carotid artery stenosis, not computer tomography (CT) radiographic findings of stroke size. The purpose of this study was to re-evaluate current guidance.

Despite these weaknesses, the similar rates of post-operative complications, length of hospital stay, discharge location and mortality rates provide valuable insights.

Conclusions

Patients with a mRS≥3 are frailer and have more pre-operative co-morbidities. Surgery in patients with a mRS≥3 is not associated with increased perioperative or post-operative complications, or death. Carotid endarterectomy for patients with a mRS≥3 may be indicated although patient selection should be undertaken with care.

Acknowledgements: None

Sources of funding: None

Disclosures: None

220 **Tables**

221 Table 1 [1]: Modified Rankin Score

Score	Description
0	No symptoms
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk and attend to bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

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223 Table 2: A comparison of pre-operative risk factors

Preoperative risk factor	**Group one**	**Group two**	**P value**
Diabetes mellitus	0.24	0.48	0.015
Frailty score	0.04	1.82	0.0001
Hypertension	0.44	0.64	0.060
Respiratory diagnosis	0.13	0.34	0.200
Ischaemic heart disease	0.45	0.50	0.570
Heart failure	0.02	0.11	0.103
Renal failure	0.07	0.15	0.209
Cancer	0.02	0.04	0.570
Peripheral vascular disease	0.00	0.02	0.323
Smoking status	0.500	0.559	0.6317
ASA score	2.72	2.89	0.331
Atrial fibrillation	0.16	0.16	1

224

225 Table 3: A comparison of post-operative complications

Postoperative complication	**Group 1**	**Group 2**	**P Value**
Cardiac event	0.00	0.03	0.083

Respiratory complications	0.01	0.03	0.320
Stroke	0.02	0.05	0.320
Renal failure	0.00	0.02	0.320
Bleed	0.13	0.11	0.820
Confusion	0.00	0.01	0.320
30-day re-admission	0.04	0.00	0.159
30-day mortality	0.00	0.00	0.779
6 week stroke	0.00	0.04	0.159

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