Outcomes of Endovascular Thrombectomy Versus Decompressive Craniectomy in Diabetic Patients with Stroke

Analysis for RCOP NIS Surg18

Ali Salman

## Preamble:

* **Reference Papers:**
  + [Khattar et al. (2020)](https://doi.org/10.1016/j.wneu.2020.03.022)
  + [Gravbrot et al. (2022)](https://doi.org/10.1016/j.jocn.2022.04.027)
  + [Thuemmler et al. (2023)](https://doi.org/10.1016/j.clineuro.2023.107747)
* **Study Objective**: Investigate the influence of Endovascular Thrombectomy (ET) vs. Decompressive Craniectomy (DC) on inpatient admissions with Stroke and Diabetes.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a principal ICD-10 diagnosis code of Stroke and a history of Diabetes, with an ICD-10 procedure code of ET or DC.
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($) [adjusted to 2020 dollars, using CPI data by the U.S. Bureau of Labor Statistics]
* **Statistical Analysis**: Multiple logistic and linear regression to determine the independent association of ET vs. DC on outcomes, adjusted for:
  + Demographics: Age, sex, race, insurance, residential income, residential region, hospital location/teaching status, and hospital census region.
  + Medical History: Diabetes mellitus present.
  + Comorbidities: Charlson comorbidity index, atrial fibrillation, coronary artery disease, heart failure, chronic kidney disease, hypertension, hyperlipidemia, and peripheral vascular disease.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **Overall**, N = 20,420 | **Endovascular thrombectomy**, N = 20,135 | **Decompressive craniectomy**, N = 285 | **p-value** |
| --- | --- | --- | --- | --- |
| Age, y | 70 (13) | 70 (12) | 62 (14) | <0.001 |
| Sex |  |  |  | 0.4 |
| Female | 9,635 (47%) | 9,485 (47%) | 150 (53%) |  |
| Male | 10,785 (53%) | 10,650 (53%) | 135 (47%) |  |
| Race |  |  |  | <0.001 |
| White | 12,425 (63%) | 12,315 (64%) | 110 (41%) |  |
| Asian or Pacific Islander | 835 (4.3%) | 800 (4.1%) | 35 (13%) |  |
| Black | 3,465 (18%) | 3,410 (18%) | 55 (20%) |  |
| Hispanic | 2,105 (11%) | 2,040 (11%) | 65 (24%) |  |
| Native American | 60 (0.3%) | 60 (0.3%) | 0 (0%) |  |
| Other | 720 (3.7%) | 715 (3.7%) | 5 (1.9%) |  |
| Charlson comorbidity index | 5.23 (2.02) | 5.24 (2.02) | 4.44 (1.76) | 0.004 |
| Healthcare insurance |  |  |  | 0.003 |
| Private | 4,650 (23%) | 4,555 (23%) | 95 (33%) |  |
| Medicaid | 2,025 (9.9%) | 1,965 (9.8%) | 60 (21%) |  |
| Medicare | 13,250 (65%) | 13,120 (65%) | 130 (46%) |  |
| Other | 475 (2.3%) | 475 (2.4%) | 0 (0%) |  |
| Residential income |  |  |  | 0.4 |
| $1 - $51,999 | 6,395 (32%) | 6,275 (32%) | 120 (42%) |  |
| $52,000 - $65,999 | 5,320 (26%) | 5,250 (27%) | 70 (25%) |  |
| $66,000 - $87,999 | 4,650 (23%) | 4,590 (23%) | 60 (21%) |  |
| $88,000 or more | 3,730 (19%) | 3,695 (19%) | 35 (12%) |  |
| Residential region |  |  |  | >0.9 |
| Large metro | 11,335 (56%) | 11,170 (56%) | 165 (58%) |  |
| Micropolitan | 2,985 (15%) | 2,945 (15%) | 40 (14%) |  |
| Small metro | 6,035 (30%) | 5,955 (30%) | 80 (28%) |  |
| Hospital location/teaching status |  |  |  | 0.3 |
| Rural | 125 (0.6%) | 120 (0.6%) | 5 (1.8%) |  |
| Urban, non-teaching | 1,730 (8.5%) | 1,695 (8.4%) | 35 (12%) |  |
| Urban, teaching | 18,565 (91%) | 18,320 (91%) | 245 (86%) |  |
| Hospital census region |  |  |  | 0.2 |
| Midwest | 4,040 (20%) | 3,995 (20%) | 45 (16%) |  |
| Northeast | 3,115 (15%) | 3,075 (15%) | 40 (14%) |  |
| South | 9,060 (44%) | 8,950 (44%) | 110 (39%) |  |
| West | 4,205 (21%) | 4,115 (20%) | 90 (32%) |  |
| Atrial fibrillation | 7,260 (36%) | 7,210 (36%) | 50 (18%) | 0.005 |
| Coronary artery disease | 7,020 (34%) | 6,980 (35%) | 40 (14%) | <0.001 |
| Heart failure | 6,050 (30%) | 5,990 (30%) | 60 (21%) | 0.15 |
| Chronic kidney disease | 4,600 (23%) | 4,535 (23%) | 65 (23%) | >0.9 |
| Hypertension | 18,485 (91%) | 18,230 (91%) | 255 (89%) | 0.8 |
| Hyperlipidemia | 13,895 (68%) | 13,765 (68%) | 130 (46%) | <0.001 |
| Peripheral vascular disease | 1,920 (9.4%) | 1,905 (9.5%) | 15 (5.3%) | 0.3 |

## Outcomes Table:

| **Characteristic** | **Overall**, N = 20,420 | **Endovascular thrombectomy**, N = 20,135 | **Decompressive craniectomy**, N = 285 | **p-value** |
| --- | --- | --- | --- | --- |
| Died during hospitalization | 2,430 (12%) | 2,395 (12%) | 35 (12%) | >0.9 |
| Length of stay (days) | 6 (3, 11) | 6 (3, 10) | 18 (9, 28) | <0.001 |
| Inflation-adjusted total charge ($) | 158,666 (96,695, 261,431) | 156,942 (96,252, 258,165) | 338,350 (195,205, 563,325) | <0.001 |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Treatment procedure |  |  |  |
| Endovascular thrombectomy | — | — |  |
| Decompressive craniectomy | 0.98 | 0.41, 2.34 | >0.9 |
| Age, y | 1.02 | 1.01, 1.03 | 0.003 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.95 | 0.77, 1.18 | 0.6 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.81 | 0.46, 1.44 | 0.5 |
| Black | 1.10 | 0.81, 1.49 | 0.6 |
| Hispanic | 1.00 | 0.71, 1.41 | >0.9 |
| Native American | 0.00 | 0.00, 0.00 | <0.001 |
| Other | 1.39 | 0.86, 2.25 | 0.2 |
| Charlson comorbidity index | 1.09 | 1.02, 1.16 | 0.015 |
| Healthcare insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.26 | 0.84, 1.87 | 0.3 |
| Medicare | 0.94 | 0.71, 1.25 | 0.7 |
| Other | 1.82 | 1.03, 3.25 | 0.041 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 1.18 | 0.91, 1.54 | 0.2 |
| $66,000 - $87,999 | 1.13 | 0.85, 1.50 | 0.4 |
| $88,000 or more | 1.04 | 0.75, 1.43 | 0.8 |
| Residential region |  |  |  |
| Large metro | — | — |  |
| Micropolitan | 1.21 | 0.86, 1.69 | 0.3 |
| Small metro | 1.13 | 0.90, 1.42 | 0.3 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 1.67 | 0.21, 13.6 | 0.6 |
| Urban, teaching | 1.57 | 0.19, 12.7 | 0.7 |
| Hospital census region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.85 | 0.59, 1.23 | 0.4 |
| South | 0.93 | 0.70, 1.23 | 0.6 |
| West | 1.25 | 0.89, 1.74 | 0.2 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.00 | 0.81, 1.24 | >0.9 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 0.95 | 0.76, 1.20 | 0.7 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.12 | 0.88, 1.43 | 0.3 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 0.96 | 0.72, 1.28 | 0.8 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.66 | 0.48, 0.90 | 0.009 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.69 | 0.56, 0.85 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 0.75 | 0.52, 1.08 | 0.12 |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Treatment procedure |  |  |  |
| Endovascular thrombectomy | — | — |  |
| Decompressive craniectomy | 10 | 5.3, 16 | <0.001 |
| Age, y | -0.05 | -0.09, 0.00 | 0.029 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.1 | 0.40, 1.8 | 0.002 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.90 | -0.60, 2.4 | 0.2 |
| Black | 3.4 | 2.2, 4.6 | <0.001 |
| Hispanic | 2.0 | 0.48, 3.5 | 0.010 |
| Native American | -3.2 | -6.8, 0.40 | 0.081 |
| Other | 2.3 | -0.22, 4.7 | 0.074 |
| Charlson comorbidity index | 0.77 | 0.54, 1.0 | <0.001 |
| Healthcare insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 5.8 | 3.3, 8.3 | <0.001 |
| Medicare | -0.58 | -1.5, 0.36 | 0.2 |
| Other | 0.08 | -2.0, 2.2 | >0.9 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.85 | -1.8, 0.14 | 0.093 |
| $66,000 - $87,999 | -0.63 | -1.7, 0.39 | 0.2 |
| $88,000 or more | -1.0 | -2.0, -0.02 | 0.046 |
| Residential region |  |  |  |
| Large metro | — | — |  |
| Micropolitan | -0.39 | -1.4, 0.64 | 0.5 |
| Small metro | -0.30 | -1.1, 0.54 | 0.5 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 3.6 | 1.6, 5.5 | <0.001 |
| Urban, teaching | 3.4 | 1.9, 5.0 | <0.001 |
| Hospital census region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.3 | 0.01, 2.6 | 0.048 |
| South | 0.88 | 0.11, 1.6 | 0.025 |
| West | 0.65 | -0.39, 1.7 | 0.2 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | 0.08 | -0.55, 0.72 | 0.8 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -0.88 | -1.6, -0.15 | 0.018 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.1 | 0.20, 1.9 | 0.016 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -1.1 | -2.3, 0.06 | 0.062 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -1.2 | -2.7, 0.21 | 0.093 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -2.0 | -2.8, -1.1 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -1.4 | -2.4, -0.41 | 0.006 |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Treatment procedure |  |  |  |
| Endovascular thrombectomy | — | — |  |
| Decompressive craniectomy | 152,980 | 77,897, 228,063 | <0.001 |
| Age, y | -1,003 | -1,737, -268 | 0.008 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 14,945 | 1,327, 28,563 | 0.032 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 25,060 | -11,826, 61,946 | 0.2 |
| Black | 33,374 | 13,573, 53,175 | <0.001 |
| Hispanic | 69,152 | 34,764, 103,540 | <0.001 |
| Native American | -85,999 | -147,902, -24,095 | 0.007 |
| Other | 114,560 | 49,616, 179,504 | <0.001 |
| Charlson comorbidity index | 11,200 | 6,923, 15,477 | <0.001 |
| Healthcare insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 62,951 | 25,219, 100,683 | 0.001 |
| Medicare | -10,861 | -28,623, 6,901 | 0.2 |
| Other | 15,334 | -41,423, 72,090 | 0.6 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -18,123 | -35,528, -719 | 0.041 |
| $66,000 - $87,999 | -14,530 | -36,412, 7,353 | 0.2 |
| $88,000 or more | -25,743 | -49,635, -1,852 | 0.035 |
| Residential region |  |  |  |
| Large metro | — | — |  |
| Micropolitan | -47,488 | -67,412, -27,563 | <0.001 |
| Small metro | -39,182 | -57,129, -21,235 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 110,667 | 65,900, 155,434 | <0.001 |
| Urban, teaching | 71,879 | 46,563, 97,194 | <0.001 |
| Hospital census region |  |  |  |
| Midwest | — | — |  |
| Northeast | 53,303 | 26,256, 80,349 | <0.001 |
| South | 33,044 | 17,313, 48,776 | <0.001 |
| West | 112,980 | 87,429, 138,532 | <0.001 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | 7,014 | -6,598, 20,627 | 0.3 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -18,494 | -31,880, -5,109 | 0.007 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 10,776 | -4,878, 26,430 | 0.2 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | -15,736 | -36,442, 4,970 | 0.14 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -14,138 | -41,153, 12,877 | 0.3 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | -37,048 | -53,013, -21,082 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | -8,643 | -33,961, 16,675 | 0.5 |