Malignant Middle Cerebral Artery Infarction and Role of Decompressive Hemicraniectomy

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Objectives

- Natural history of malignant MCA infarction (MMI)
- The trials on role of decompressive hemicraniectomy (DHC)
- Pathophysiology of MMI
- Predictors of MMI
- Optimal timing for DHC

“Malignant” MCA stroke

- Approximately 10% of strokes:
  - Massive, hemispheric
  - Brain edema, herniation, shift
  - Hemiplegia, eye/head deviation, aphasia/ neglect
  - Decline in level of consciousness within day(s)
  - Up to 80% mortality

European RCTs on DHC

DESTINY 2007

- 32 patients (18-60)
- Infarct >2/3 MCA territory
- NIHSS > 18 (ND) 20 (D)
- DHC 12-36 hours

DECIMAL 2007

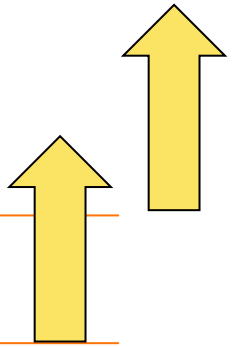
- 38 patients (18-55)
- Infarct >1/2 MCA territory
- NIHSS >16
- DHC <36 hours

HAMLET 2009

- 64 patients (18-60)
- Infarct >2/3 MCA territory
- NIHSS >16 (ND) 21 (D)
- DHC <96 hours

MRS

- 0 – No symptoms at all
- 1 – No sig disability despite symptoms; able to carry out all usual duties
- 2 – Slight disability; unable to carry out all previous activities, but able to look after own affairs w/o assistance
- 3 – Moderate disability; requiring some help, but can walk without assistance
- 4 – Moderate-severe disability; can't walk w/o assistance, unable to attend own bodily needs w/o assistance
- 5 – Severe disability; bedridden, incontinent and requiring constant nursing care and attention
- 6 – Dead



Early decompressive surgery in malignant infarction of the middle cerebral artery: a pooled analysis of three randomised controlled trials

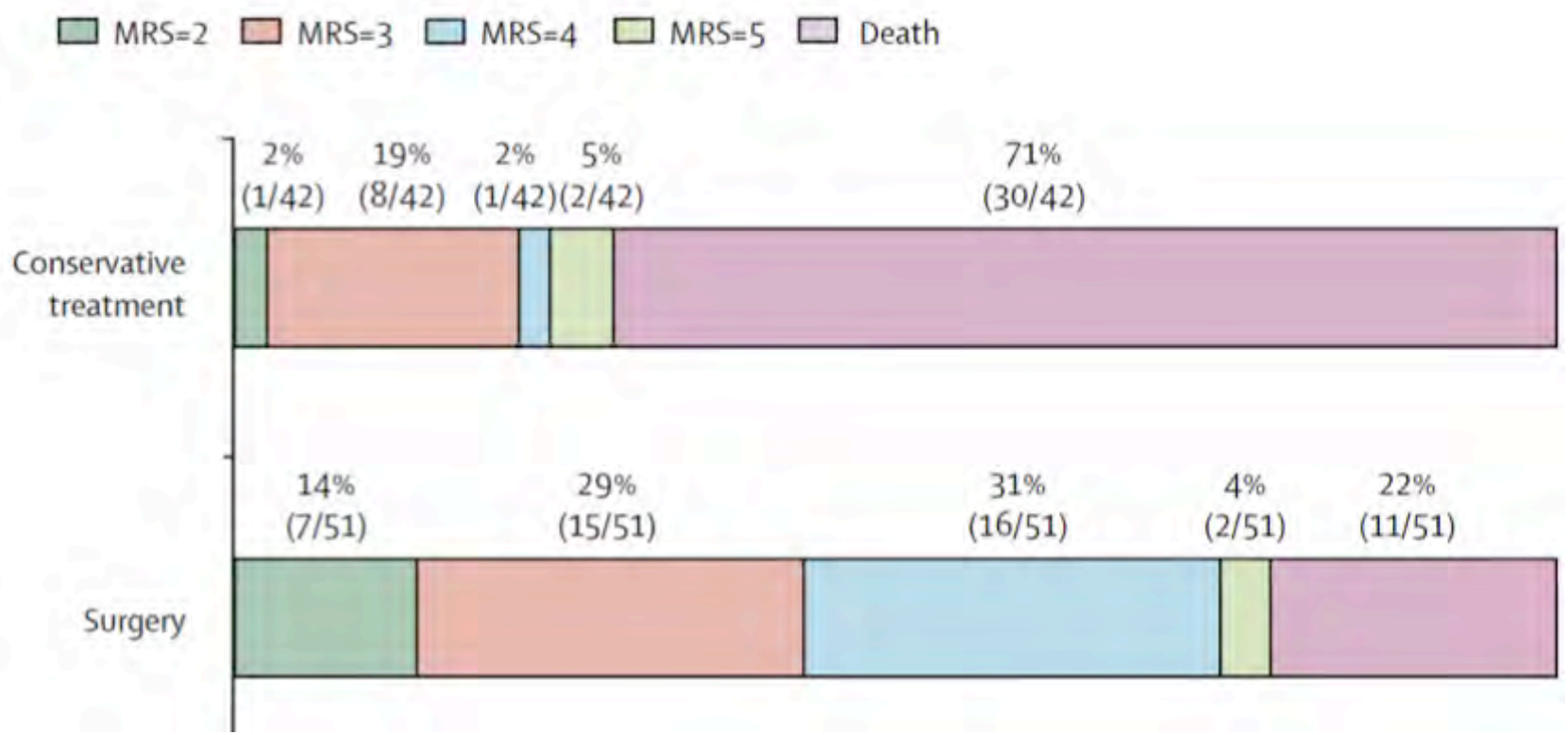
Lancet Neurol. 2007 Mar;6(3):215-22.

Katayoun Vahedi, Jeannette Hofmeijer, Eric Juettler, Eric Vicaut, Bernard George, Ale Algra, G Johan Amelink, Peter Schmiedeck, Stefan Schwab, Peter M Rothwell, Marie-Germaine Bousser, H Bart van der Worp, Werner Hacke, for the DECIMAL, DESTINY, and HAMLET investigators

Summary

Background Malignant infarction of the middle cerebral artery (MCA) is associated with an 80% mortality rate. Non-randomised studies have suggested that decompressive surgery reduces this mortality without increasing the number of severely disabled survivors. To obtain sufficient data as soon as possible to reliably estimate the effects of decompressive surgery, results from three European randomised controlled trials (DECIMAL, DESTINY, HAMLET) were pooled. The trials were ongoing when the pooled analysis was planned.

Methods Individual data for patients aged between 18 years and 60 years, with space-occupying MCA infarction, included in one of the three trials, and treated within 48 h after stroke onset were pooled for analysis. The protocol was designed prospectively when the trials were still recruiting patients and outcomes were defined without knowledge of the results of the individual trials. The primary outcome measure was the score on the modified Rankin scale (mRS) at 1 year dichotomised between favourable (0–4) and unfavourable (5 and death) outcome. Secondary outcome measures included case fatality rate at 1 year and a dichotomisation of the mRS between 0–3 and 4 to death. Data analysis was done by an independent data monitoring committee.



Hemicraniectomy:

- **absolute risk reduction in death: 49%**
- **absolute increase in mRS 2, 3, 4: 12%, 10%, 29%**

For every 10 hemicraniectomies for MCA stroke:

- **5 will escape death, of which, at one year, 1 will have mild disability, 1 will have mod disability, and 3 will have mod-severe disability (can't walk independently)**

UK Physician Survey of DHC

National Survey of Neurosurgeons and Stroke Physicians on Decompressive Hemicraniectomy for Malignant Middle Cerebral Artery Infarction

Pallavi Basu, Harri Jenkins, Kevin Tsang, Vejay N. Vakharia

World Neurosurg. 2017 Feb 21.

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Survey Results

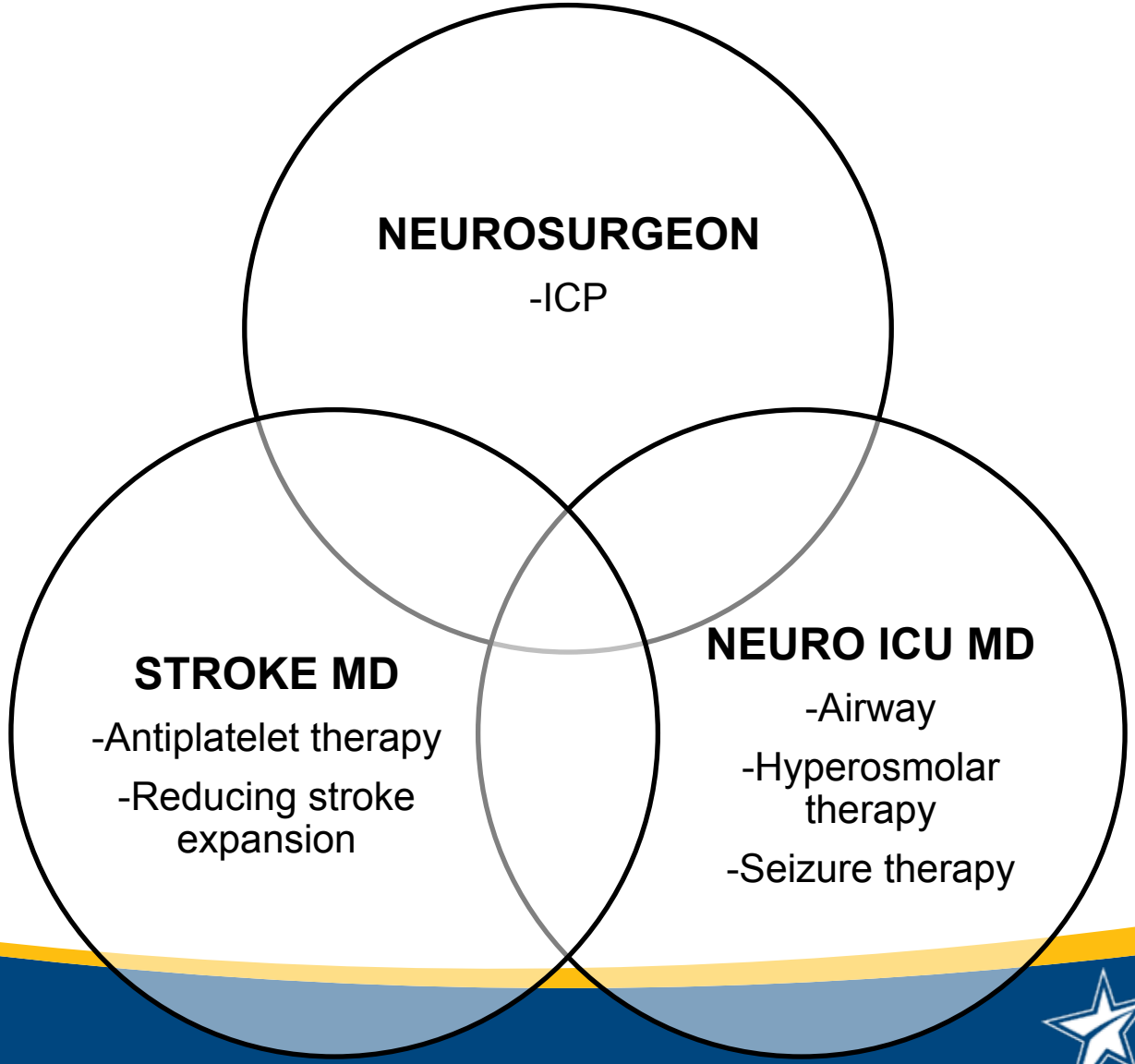
- 78 responses (51 neurosurgeons, 27 stroke physicians)
- 54% (60-70 years) 24% (70-80 years)
- 60% (48-72hrs) 27% (>72hrs)
- 36% (GCS 15)

Survey Results

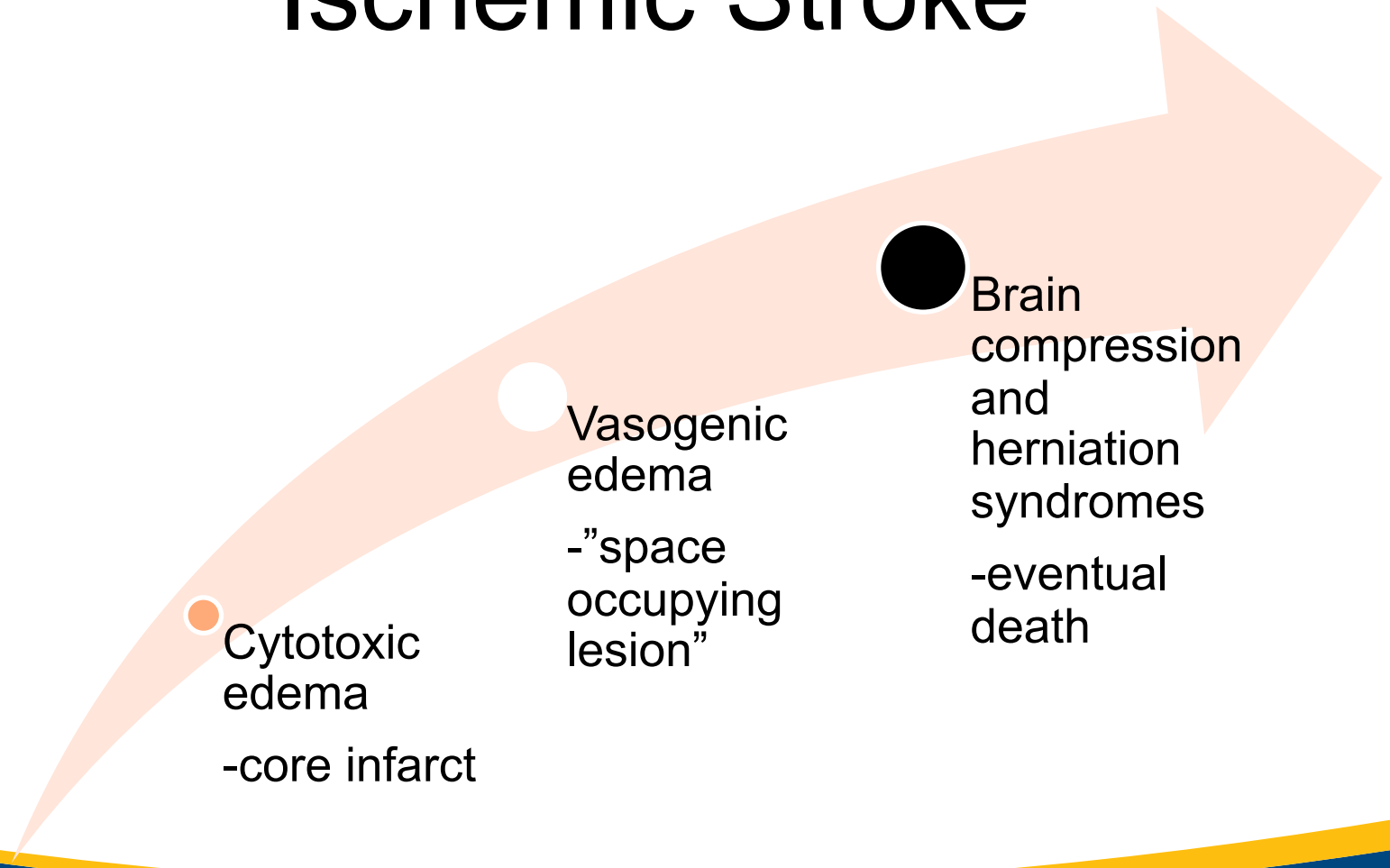
- Stroke physicians statistically more likely to recommend DHC >60 years ($p = 0.032$), multi-territorial infarcts ($p = 0.042$) and accept higher postop mRS ($p = 0.034$) compared to neurosurgeons

- >1/2 neurosurgeons/stroke physicians recommend DHC >60 years and 48-72 hours

MMI Management



Pathogenesis of Malignant Ischemic Stroke



Edema

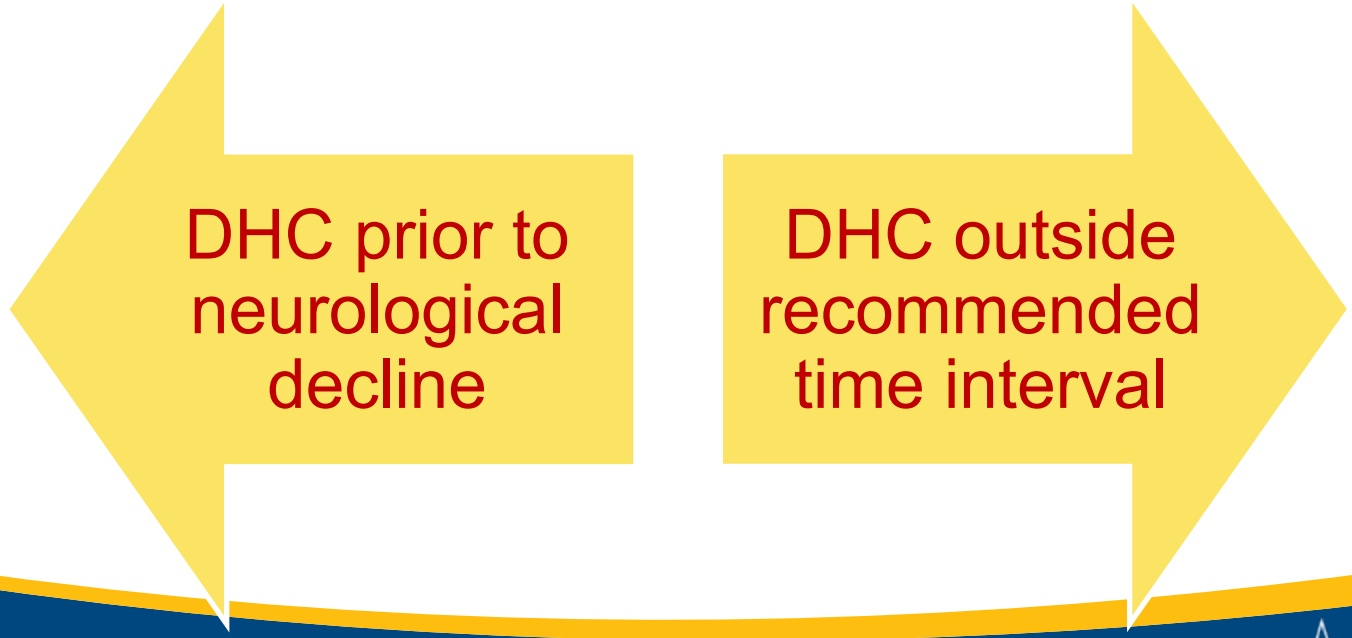
- Cytotoxic edema
  - Intracellular water accumulation due to Na/K pump collapse
  - BBB intact
  - Due to ischemia
  - Edema seen in cortex and white matter

Edema

- Vasogenic edema
  - Increased permeability of capillary endothelial cells (tight junctions)
  - White matter primarily affected
  - Proteins migrate from IV space to EC space

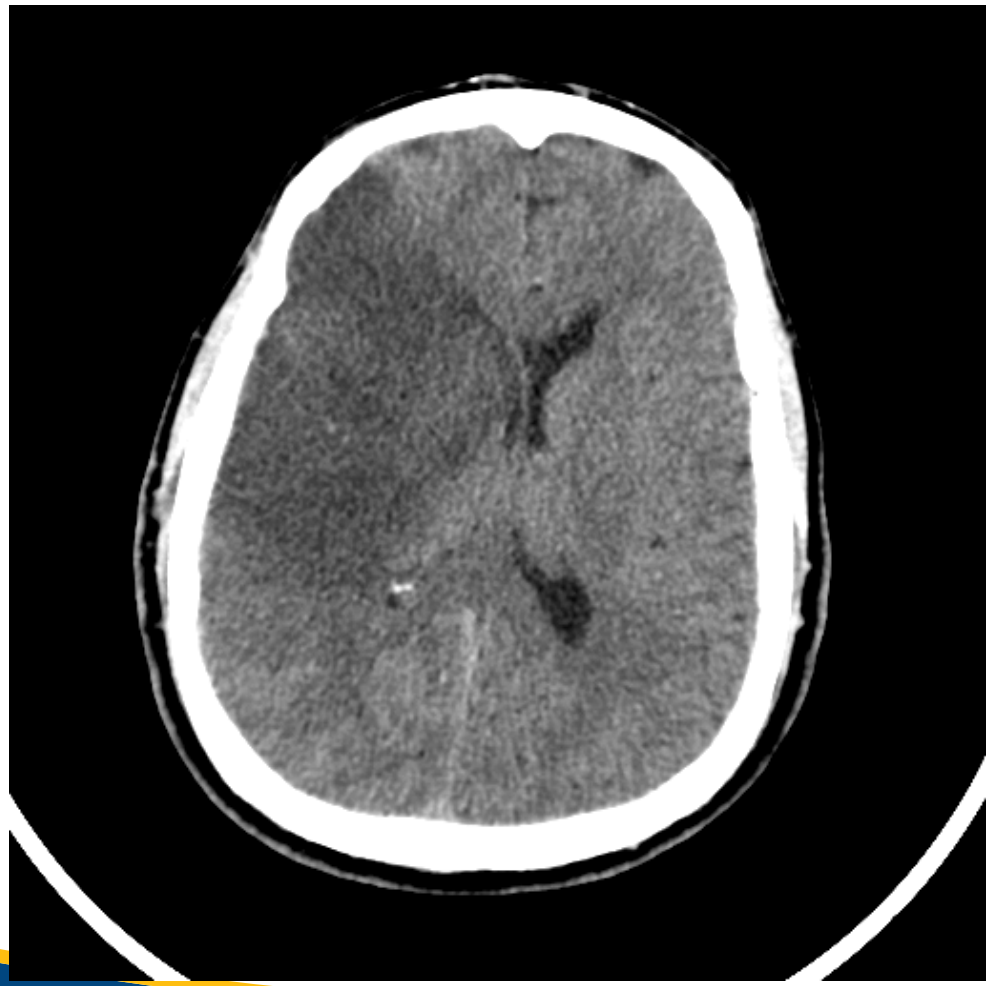
Edema

- Progression of cerebral edema 2-5 days
- 2/3 deteriorate within 48 hours
- *1/3 deteriorate after 48 hours*



58 yo man NIHSS 17 chronic right ICA occlusion

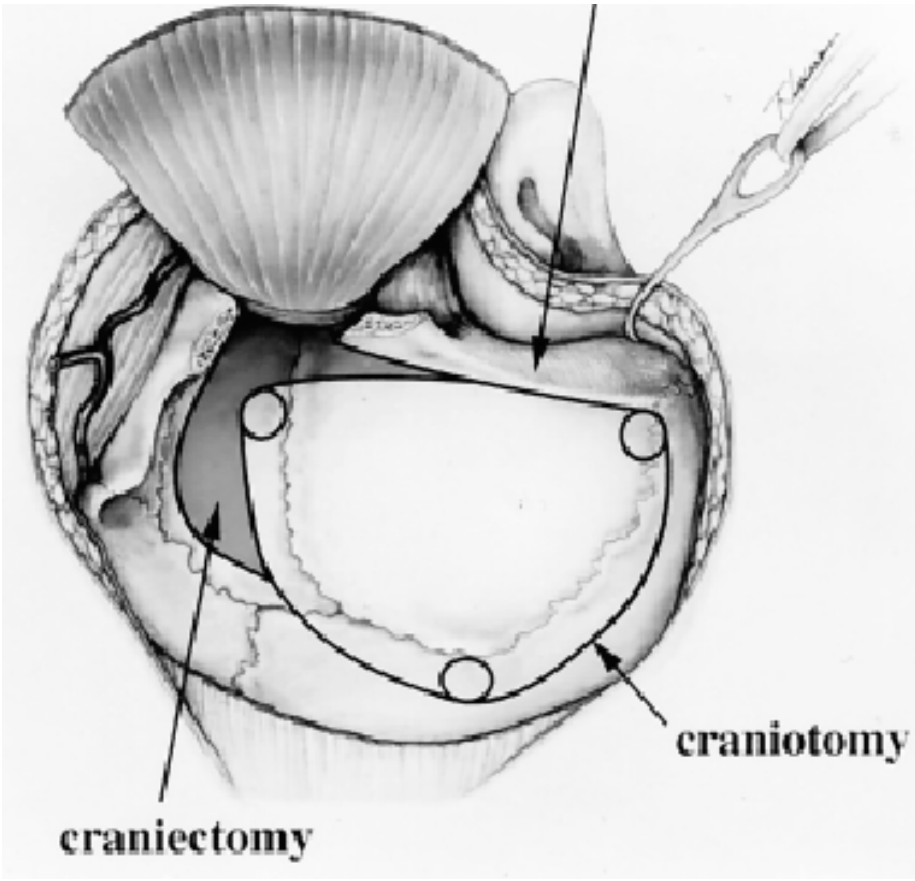
48 hour CT scan 6 mm shift

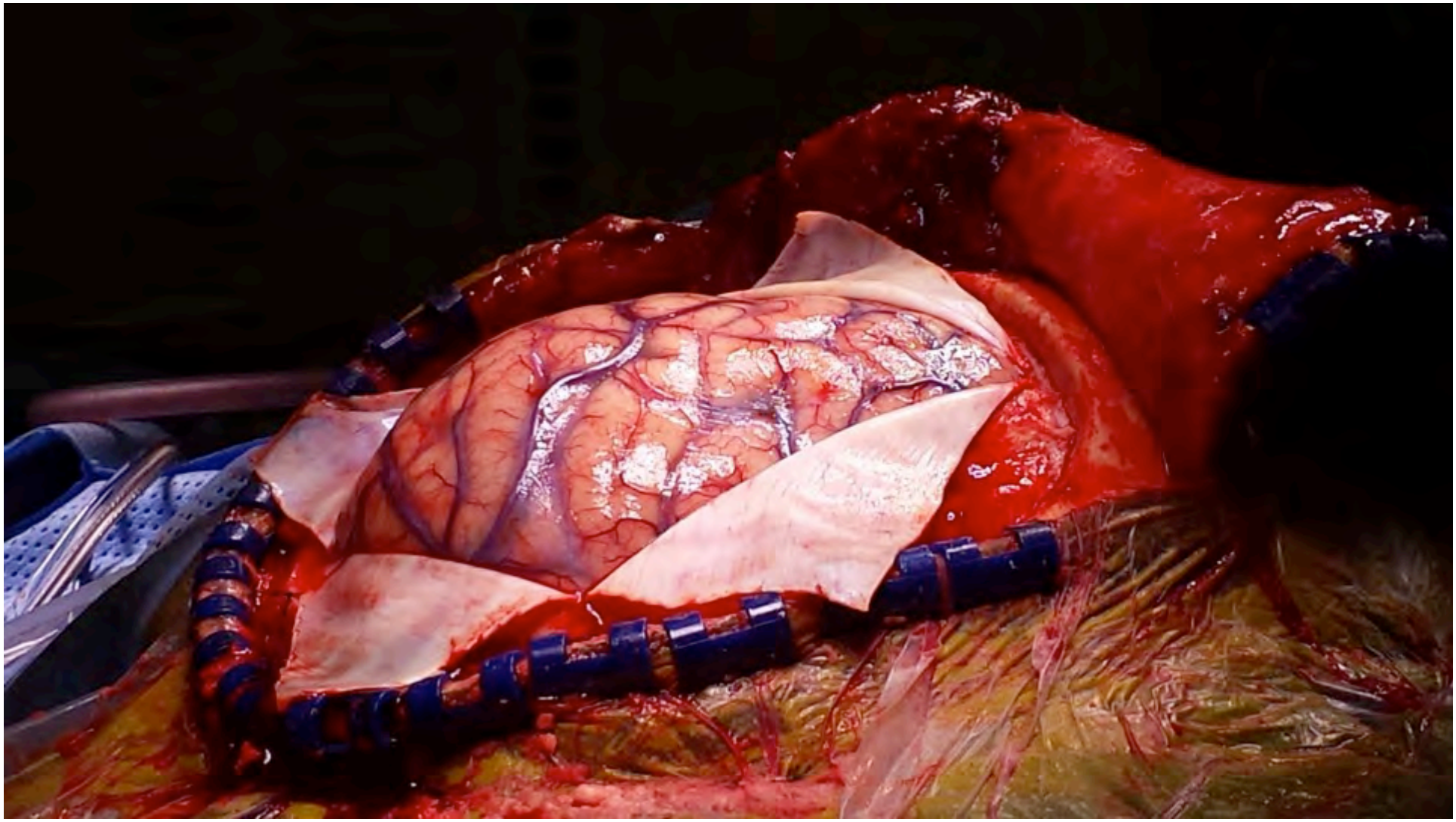


Pupillometer
Hypertonic saline
HOB up
Q1 hour neuro checks
Lengthy conversation with patient/family

96 hour CT scan 14mm shift
Increased lethargy

DHC





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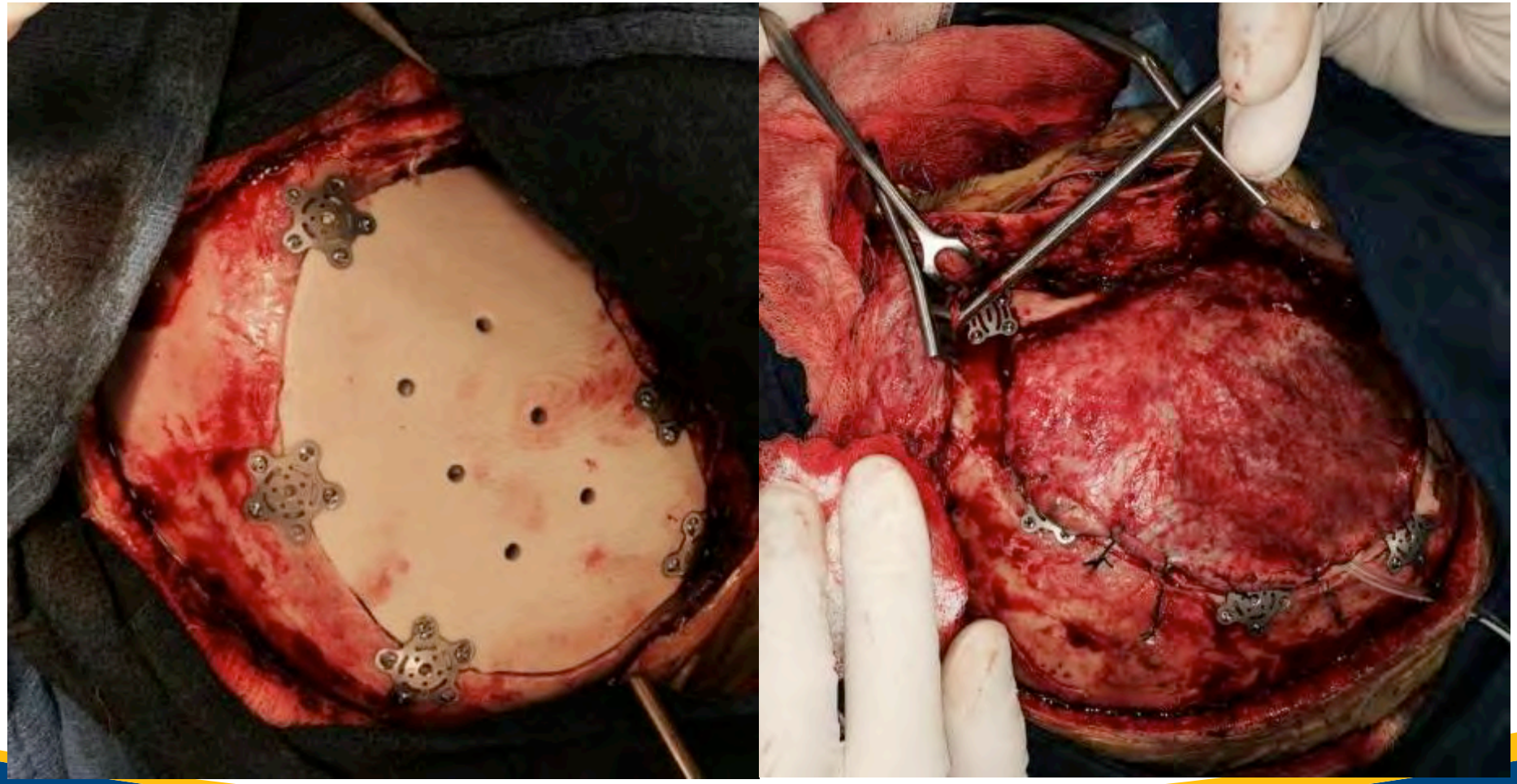
POD 1 CT scan
30 day mRS 4
Discharge to inpatient rehab

Cranioplasty



Predictors of MMI

- High NIHSS
- Large MRI DWI positive infarct territory
- ASPECTS <4
- Hyperdense MCA sign
- Carotid T occlusion

Predictors of MMI

The DASH score: A simple score to assess risk for development of malignant middle cerebral artery infarction

Takashi Shimoyama *, Kazumi Kimura, Junichi Uemura, Shinji Yamashita, Naoki Saji, Kensaku Shibazaki, Yasuyuki Iguchi

Journal of the Neurological Sciences
Volume 338, Issues 1–2, 15 March 2014, Pages 102–106

- 119 patients, 57 developed MMI
- Multivariate regression analysis identified 4 independent factors associated with MMI

DASH Score (each 1 point)

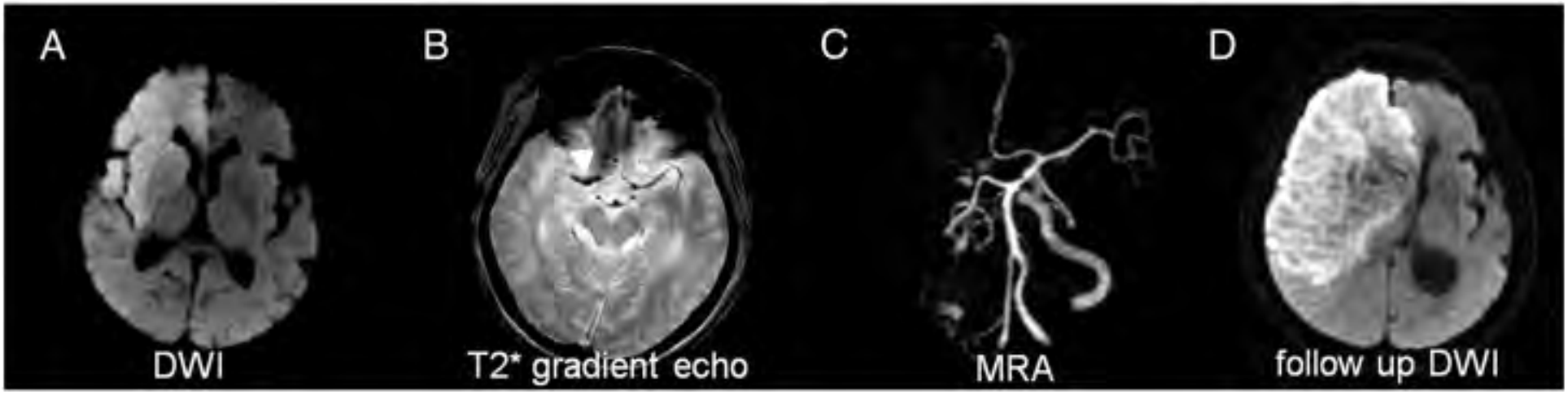
- D……DWI (ASPECTS <4) OR, 4.16
- A……ACA territory involvement,
  OR 6.9
- S……Susceptibility M1 sign T2* GE,
  OR 4.55
- H……Hyperglycemia (>145), OR 5.31

DASH

- 0 (9.1% likelihood of developing MMI)
- 1 (20.5%)
- 2 (63.0%)
- 3 (94.7%)
- 4 (100%)

70 yo NIHSS 17, glucose 158, MRI 3.3 h, DWI ASPECT 3, including ACA territory, M1 SVS on T2* ge, ICA occlusion

36 hour MRI demonstrating space-occupying cerebral edema and brain compression



Timing of Decompressive Hemicraniectomy for Stroke

A Nationwide Inpatient Sample Analysis

Hormuzdiyar H. Dasenbrock, MD, MPH*; Faith C. Robertson, BS*; Henrikas Vaitkevicius, MD; M. Ali Aziz-Sultan, MD; Donovan Guttieres, BS; Ian F. Dunn, MD; Rose Du, MD, PhD; William B. Gormley, MD, MPH, MBA

Background and Purpose—Previous clinical trials were not designed to discern the optimal timing of decompressive craniectomy for stroke, and the ideal surgical timing in patients with space-occupying infarction who do not exhibit deterioration within 48 hours is debated.

Methods—Patients undergoing decompressive craniectomy for stroke were extracted from the Nationwide Inpatient Sample (2002–2011). Multivariable logistic regression evaluated the association of surgical timing with mortality, discharge to institutional care, and poor outcome (a composite end point including death, tracheostomy and gastrostomy, or discharge to institutional care). Covariates included patient demographics, comorbidities, year of admission, and hospital characteristics. However, standard stroke severity scales and infarct volume were not available.

Results—Among 1301 admissions, 55.8% (n=726) underwent surgery within 48 hours. Teaching hospital admission was associated with earlier surgery (P=0.02). The timing of intervention was not associated with in-hospital mortality. However, when evaluated continuously, later surgery was associated with increased odds of discharge to institutional care (odds ratio, 1.17; 95% confidence interval, 1.05–1.31, P=0.005) and of a poor outcome (odds ratio, 1.12; 95% confidence interval, 1.02–1.23; P=0.02). When evaluated dichotomously, the odds of discharge to institutional care and of a poor outcome did not differ at 48 hours after hospital admission, but increased when surgery was pursued after 72 hours. Subgroup analyses found no association of surgical timing with outcomes among patients who had not sustained herniation.

Conclusions—In this nationwide analysis, early decompressive craniectomy was associated with superior outcomes. However, performing decompression before herniation may be the most important temporal consideration.

(*Stroke*. 2017;48:704-711. DOI: 10.1161/STROKEAHA.116.014727.)

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Poor outcome ~ mRS ≥ 4

Retrospective
No stroke volumes
No NIHSS
Only inpatient data

Results

- 1301 patients
- 24/48/72 hours evaluated continuously, dichotomously
- 55.8% (726) surgery <48 hours
- Timing of surgery not associated with in-hospital mortality
- Evaluated continuously later surgery increased OR discharge to institutional care and poor outcome
- Evaluated dichotomously no difference in poor outcome <48 hours, increased >72 hours
- ***Subgroup analysis no association of timing with outcomes as long as no herniation sustained***

Conclusion

- Establish predictors for MMI at your institution (clinical and radiographic)
- Establish concensus for how to monitor large MCA stroke patients after 48 hours

Thank you!