

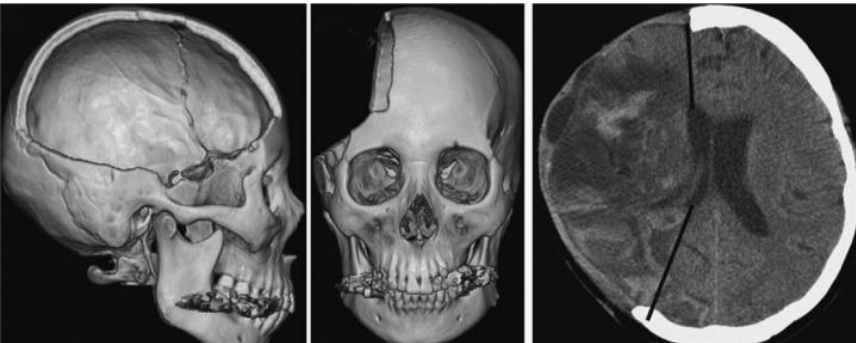


Azienda Ospedaliera Nazionale  
SS. Antonio e Biagio e Cesare Arrigo  
Alessandria



# DECOMPRESSIVE CRANIECTOMY AND STROKECTOMY

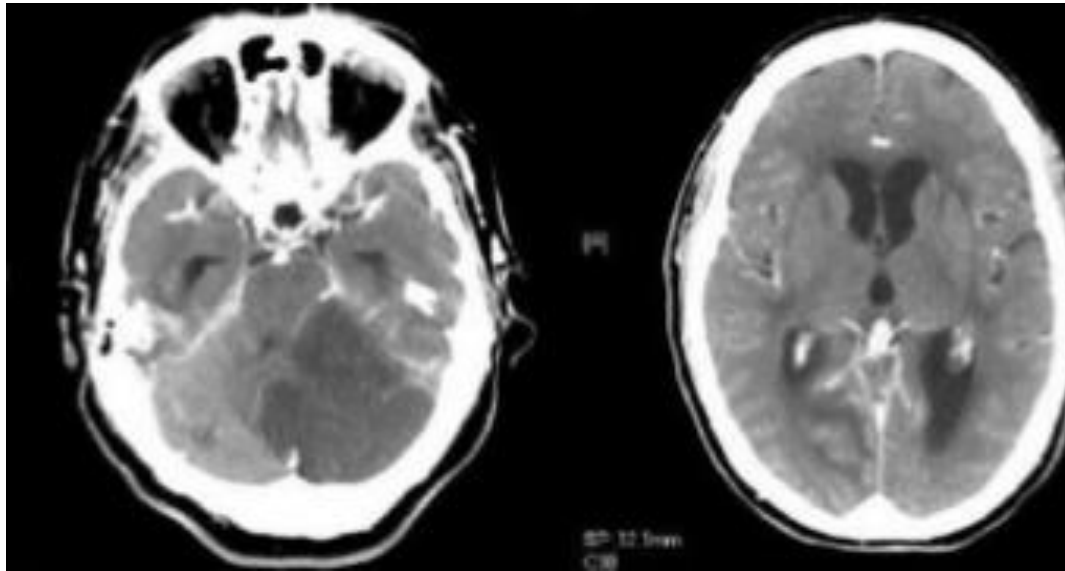
Alessandro Bertuccio, Andrea Barbanera



CALL THE NEUROSURGEON.....



# CEREBELLAR INFARCT OEDEMA AND HYDROCEPHALUS



## AHA/ASA Scientific Statement

### Recommendations for the Management of Cerebral and Cerebellar Infarction With Swelling A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

*The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.  
Endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons  
Endorsed by the Neurocritical Care Society*

### Long-Term Outcome After Suboccipital Decompressive Craniectomy for Malignant Cerebellar Infarction

Thomas Pfefferkorn, MD; Ursula Eppinger; Jennifer Linn, MD; Tobias Birnbaum, MD; Jürgen Herzog, MD; Andreas Straube, MD; Martin Dichgans, MD; Stefan Grau, MD

Suboccipital craniectomy with dural expansion should be performed in patients with cerebellar infarctions who deteriorate neurologically despite maximal medical therapy (Class I; Level of Evidence B).

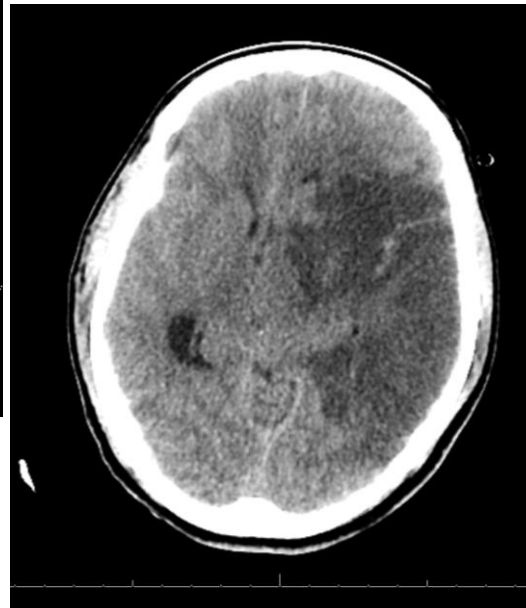
In a large series of 84 patients with *massive cerebellar infarction*, 40% required surgical craniotomies, and 17% were managed with ventricular drainage. In this series, 74% of patients had very good outcomes.(R)

# 'Malignant' Middle Cerebral Artery Territory Infarction

*Clinical Course and Prognostic Signs*

(Arch Neurol. 1996;53:309-315)

Werner Hacke, MD; Stefan Schwab, MD; Marcus Horn, MD; Matthias Spranger, MD;  
Michael De Georgia, MD; Rüdiger von Kummer, MD



**STANDARD  
CONSERVATIVE  
CARE WITH A  
FATALITY RATE OF  
UP TO 80%**



# CONSERVATIVE TREATMENT

## ICP Management: Recommendations

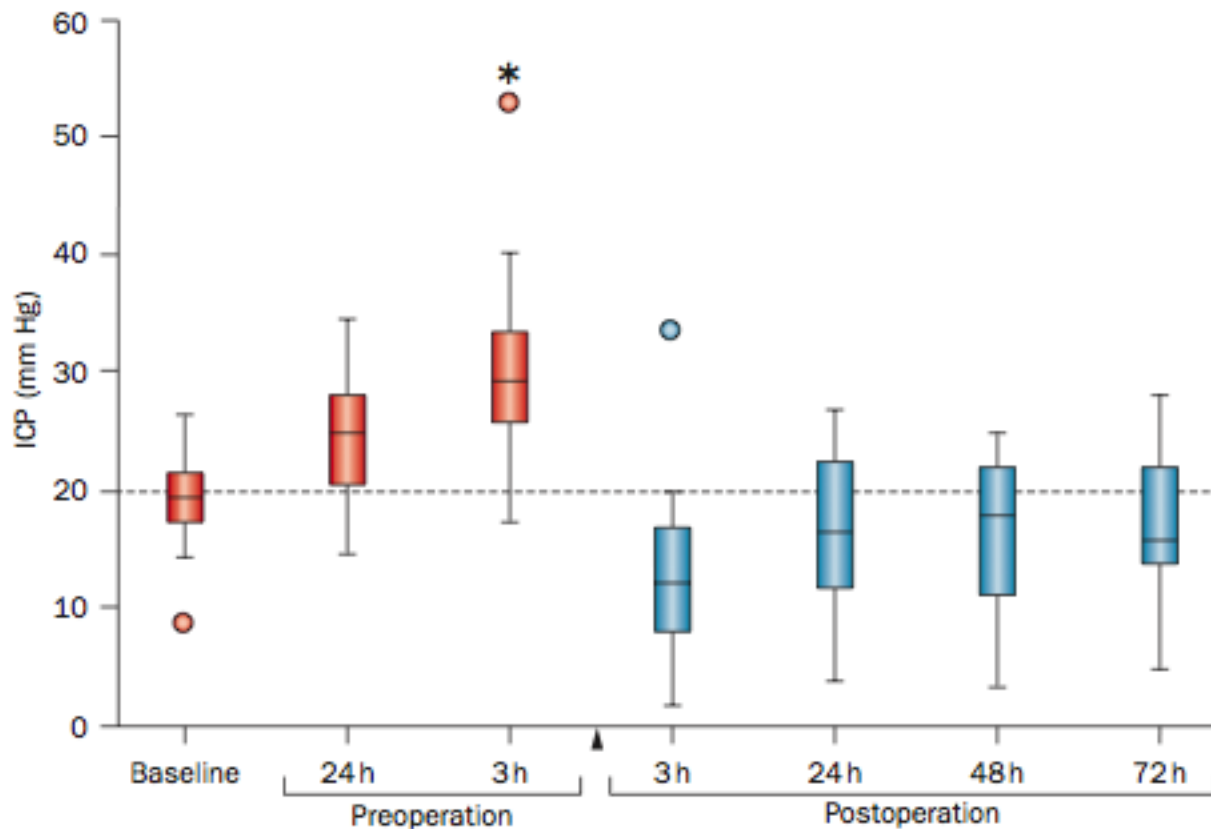
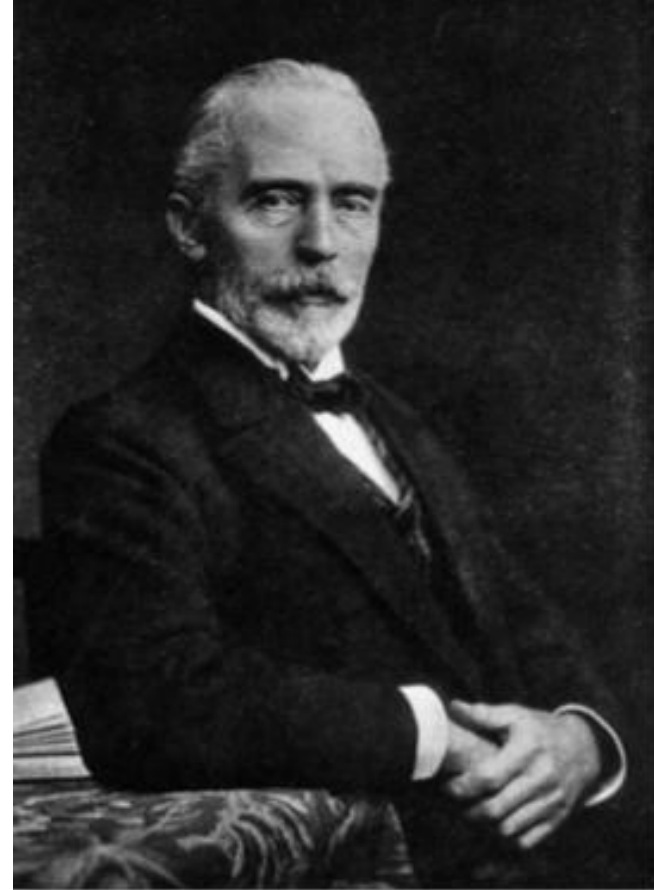
- **1. Routine ICP monitoring is not indicated in hemispheric ischemic stroke (Class III; Level of Evidence C).**
- **2. Ventriculostomy is recommended in obstructive hydrocephalus after a cerebellar infarct but should be followed or accompanied by decompressive craniectomy (Class I; Level of Evidence C).**
- *Clinical deterioration is more often the result of displacement of midline structures such as the thalamus and the brainstem than of a mechanism of globally increased ICP.*
- *There does not appear to be any value of ICP monitoring or placement of a ventriculostomy in a patient presenting early with a large supratentorial swollen hemispheric stroke.(R)*
- *Even in patients with deterioration from cerebral edema, ICP values may remain <20 mm Hg.(R)*

# CONSERVATIVE TREATMENT

## Medical Options: Recommendations

- **1. Osmotic therapy for patients with clinical deterioration from cerebral swelling associated with cerebral infarction is reasonable (*Class IIa; Level of Evidence C*).**
- **2. There are insufficient data on the effect of hypothermia, barbiturates, and corticosteroids in the setting of ischemic cerebral or cerebellar swelling, and they are not recommended (*Class III; Level of Evidence C*).**
- *Mannitol has been used both as a single dose and in recurrent bolus form such as mannitol 15 g once; 0.5 to 1 g/kg; every 4 to 6 hours.*
- *Hypertonic saline has been used at a variety of doses and concentrations(3%, 7.5%, 23%).{Effects of hypertonic saline hydroxyethyl starch solution and mannitol in patients with increased intracranial pressure after stroke. Stroke. 1998;29:1550–1555}*
- *tromethamine buffer at 3 mmol/h.*
- *“Hyper HES,” or hypertonic saline and hydroxyethyl starch,.*

**'If there's no CSF pressure, but brain pressure exists, then pressure relief must be achieved by opening the skull'      *Kocher, 1901***



# MODIFIED RANKIN SCORE (mRS)

Score	Description
0	No symptoms at all
1	No significant disability despite having 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 without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead



## Sequential-Design, Multicenter, Randomized, Controlled Trial of Early Decompressive Craniectomy in Malignant Middle Cerebral Artery Infarction (DECIMAL Trial)

Katayoun Vahedi, MD; Eric Vicaut, MD, PhD; Joaquim Mateo, MD; Annie Kurtz, MS; Mikael Orabi, MD; Jean-Pierre Guichard, MD; Carole Boutron, BS; Gregory Couvreur, MD; François Rouanet, MD; Emmanuel Touzé, MD; Benoît Guillon, MD; Alexandre Carpentier, MD; Alain Yelnik, MD; Bernard George, MD; Didier Payen, MD, PhD; Marie-Germaine Bousser, MD; on behalf of the DECIMAL Investigators

Outcomes	DECIMAL		
	Surgery	Medical Care	Statistical significance
'Favourable' functional outcome (mRS ≤3, 6 months)	25%	6%	None
mRS ≤4 (6 months)	65%	23%	$p = 0.01$
mRS 4 (6 months)	40%	17%	
Survival at 30 days			
Survival at 6 months	75%	22%	$p < 0.0001$

TIME FROM ONSET OF SYMPTOMS: < 24HRS

## Decompressive Surgery for the Treatment of Malignant Infarction of the Middle Cerebral Artery (DESTINY)

A Randomized, Controlled Trial

Eric Jüttler, MD; Stefan Schwab, MD, PhD; Peter Schmiedek, MD, PhD; Andreas Unterberg, MD, PhD; Michael Hennerici, MD, PhD; Johannes Weitzik, MD; Steffen Wite, PhD; Ekkehart Jenetzky, MD; Werner Hacke, MD, PhD; for the DESTINY Study Group\*

Outcomes	DESTINY		
	Surgery	Medical Care	Statistical significance
'Favourable' functional outcome (mRS ≤3, 6 months)	47%	27%	None
mRS ≤4 (6 months)	78%	34%	
mRS 4 (6 months)	29%	7%	$p = 0.01$
Survival at 30 days	88%	47%	$p = 0.02$
Survival at 6 months	82%	47%	$p = 0.03$

TIME FROM ONSET OF SYMPTOMS: < 48HRS

## Surgical decompression for space-occupying cerebral infarction (the Hemicraniectomy After Middle Cerebral Artery infarction with Life-threatening Edema Trial [HAMLET]): a multicentre, open, randomised trial

Jeannette Hofmeijer, L Jaap Kappelle, Ale Algra, G Johan Amelink, Jan van Gijn, H Bart van der Worp, for the HAMLET investigators\*

TIME FROM ONSET OF SYMPTOMS: < 96 HRS

Outcomes at 1 year	Surgery	Medical care	Statistical significance
Good functional outcome (mRS ≤3)	25%	25%	None
Poor functional outcome (mRS ≥4)	75%	75%	None
Mortality	22%	59%	$p < 0.002$

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



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.

*Lancet Neurol* 2007; 6: 215–22

Published Online

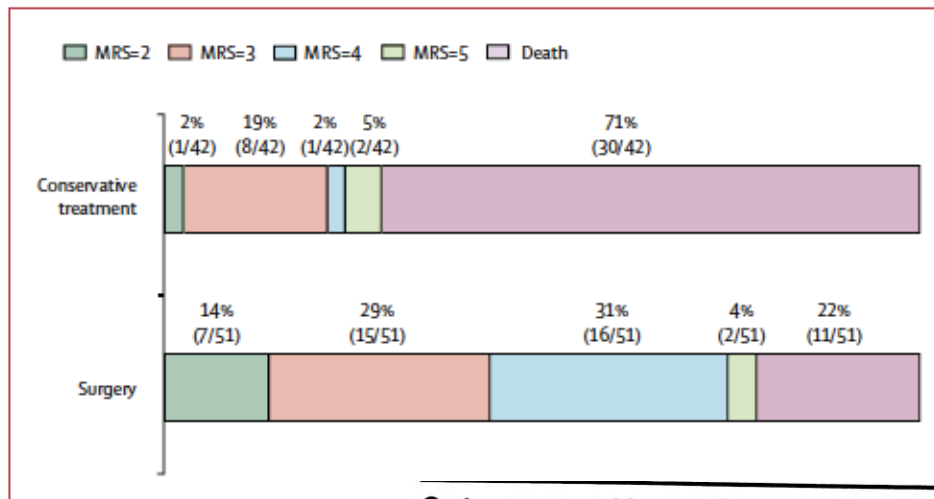
February 9, 2007

DOI:10.1016/S1474-

4422(07)70036-4

See Reflection and Reaction

---



Outcomes at 12 months	Surgery	Medical care	Statistical significance
Mortality	22%	71%	$p < 0.0001$
mRS 4	31%	2%	$p < 0.0001$
mRS <4	74%	23%	$p < 0.0001$



### Hemicraniectomy

#### A Second Chance on Life for Patients With Space-Occupying MCA Infarction

Stephan A. Mayer, MD, FCCM

Stroke. 2007; 38, 2410-2412

- **NON-BLINDING TREATMENT ARMS** (in particular in DECIMAL all surgical group received mechanical ventilation, only 2/3 in medical group)
- **TIMING < 48 HRS** (ultra-early <24 hrs no additional benefit)
- **VOLUME >145 mL** in DWI sequences
- **DOMINANT- NON DOMINANT** (APHASIA/NEGLECT)
- **AGE (< 60 HRS)**

# The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812

MARCH 20, 2014

VOL. 370 NO. 12

## Hemicraniectomy in Older Patients with Extensive Middle-Cerebral-Artery Stroke

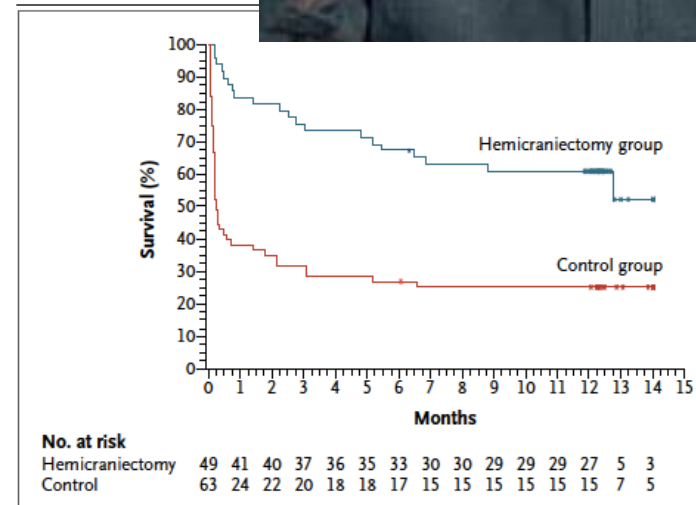
Eric Jüttler, M.D., Ph.D., Andreas Unterberg, M.D., Ph.D., Johannes Woitzik, M.D., Ph.D., Julian Bösel, I Hemasse Amiri, M.D., Oliver W. Sakowitz, M.D., Ph.D., Matthias Gondan, Ph.D., Petra Schiller, Ph.D. Ronald Limprecht, Steffen Luntz, M.D., Hauke Schneider, M.D., Ph.D., Thomas Pinzer, M.D., Ph.D. Carsten Hobohm, M.D., Jürgen Meixensberger, M.D., Ph.D., and Werner Hacke, M.D., Ph.D.,  
for the DESTINY II Investigators\*



Surgery reduced 1-year **mortality by 33%**, as **compared with a 50%** reduction in a prior trial involving younger patients,

and

The rate of survival with a **score of 5 on the modified Rankin scale at 1 year was 19%**, as **compared with 4%** among younger patients





# Decompressive hemicraniectomy

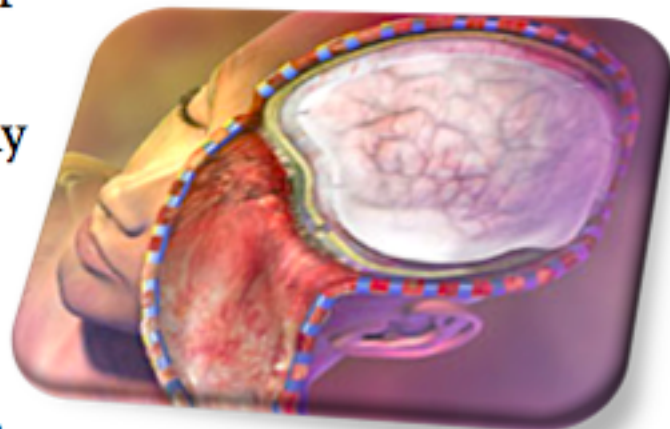
The craniectomy should be at least 12 cm to avoid venous congestion and hemorrhage at the sites of the craniectomy margin

Doubling the diameter of a craniectomy from 6cm to 12cm increases the decompressed brain volume from 9ml to 86ml

Dura can be opened in several manners but typically is done in a stellate fashion

Dura closure is not mandatory and can either be left open, with mild approximation of dural leaflets or replaced with dural substitute

A duraplasty further reduces the intracranial pressure by an additional 55% (Schmidek 2006)



A

A.O. ALESSANDRIA  
TC CRANIO  
Series 2  
10/07/2014 22:31:58  
0002454159  
---  
LOC: 15,75  
THK: 5  
HFS



Z: 1  
C: 35  
W: 115  
DFOV: 23x23cm

P

o

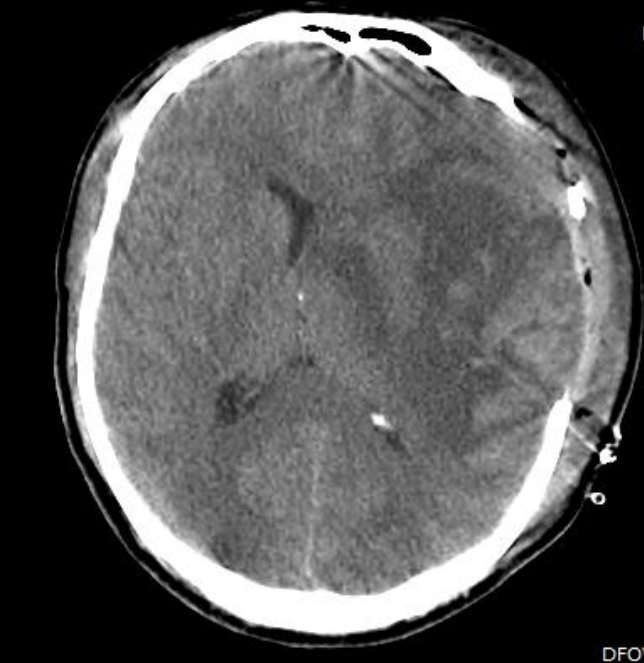
A

A.O. ALESSANDRIA  
TC CRANIO  
x urgenze  
12/07/2014 20:07:48  
0002454667  
---  
LOC: 74,75  
THK: 5  
HFS



Z: 1

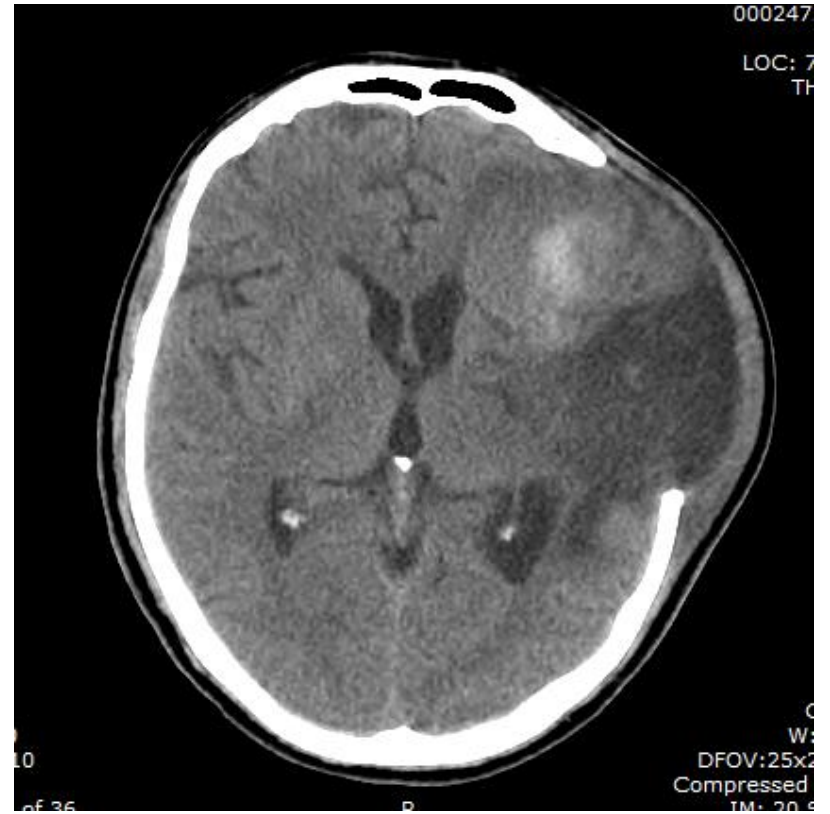
LOC



DFOV: 23



DFOV: 23



# STROKECTOMY

## Decompressive Hemicraniectomy, Strokectomy, or Both in the Treatment of Malignant Middle Cerebral Artery Syndrome


Dean B. Kostov, Richard H. Singleton, David Panczykowski, Hilal A. Kanaan, Michael B. Horowitz, Tudor Jovin, Brian T. Jankowitz

### Key words

- Decompressive hemicraniectomy
- Malignant MCA syndrome
- Stroke
- Strokectomy

### Abbreviations and Acronyms

- CS: Craniotomy for strokectomy
- DHC: Decompressive hemicraniectomy
- DHC+S: Decompressive hemicraniectomy with a strokectomy
- ICP: Intracranial pressure
- MCA: Middle cerebral artery
- mRS: Modified Rankin Scale
- PCA: Posterior cerebral artery

 Department of Neurological Surgery, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

To whom correspondence should be addressed:  
Brian Jankowitz, M.D. (E-mail: [bjankowit@upmc.edu](mailto:bjankowit@upmc.edu))

Citation: *World Neurosurg.* (2012) 78, 5:490-496.

DOI: 10.1016/j.wneu.2011.12.080

Journal homepage: [www.WORLDNEUROSURGERY.org](http://www.WORLDNEUROSURGERY.org)

Available online: [www.sciencedirect.com](http://www.sciencedirect.com)

1878-9752/\$ - see front matter © 2012 Elsevier Inc.

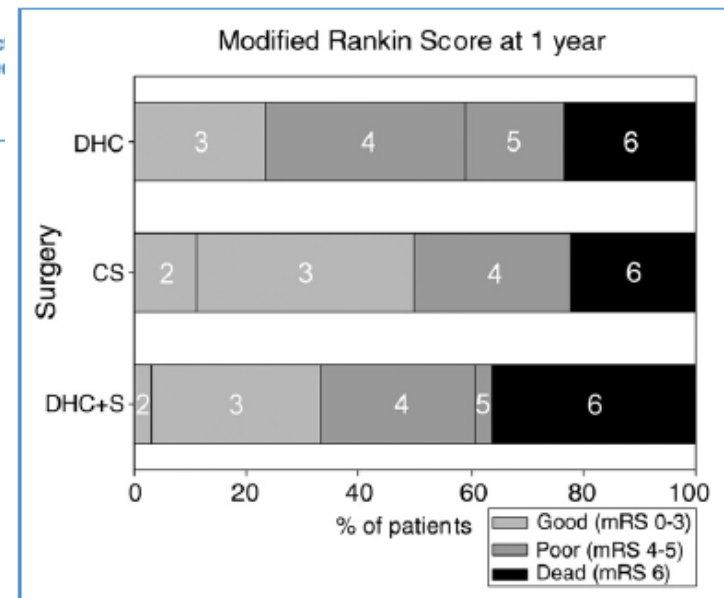
All rights reserved.

■ **OBJECTIVE:** We sought to evaluate the impact of a craniotomy for strokectomy (CS) with bone replacement, decompressive hemicraniectomy (DHC), or DHC with a strokectomy (DHC+S) on outcome after malignant supratentorial infarction.

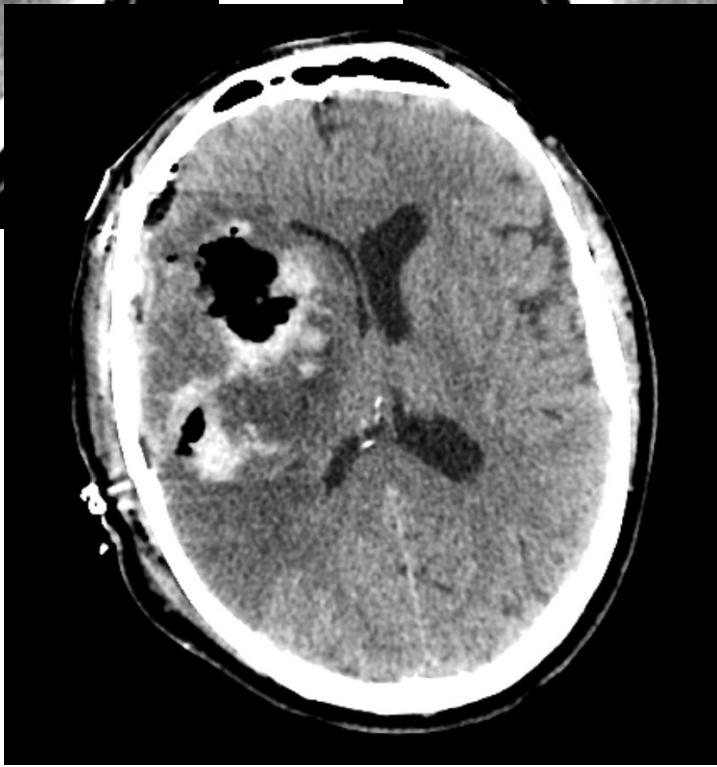
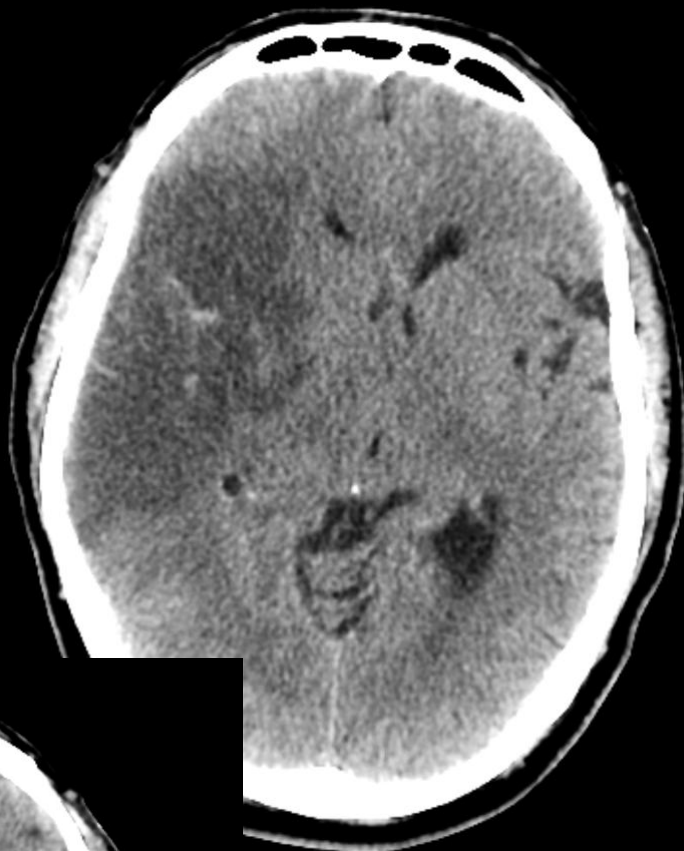
■ **METHODS:** We conducted a retrospective cohort study of cases of malignant supratentorial infarction treated by CS ( $n = 18$ ), DHC ( $n = 17$ ), or DHC+S ( $n = 33$ ) at our institution from 2002 to 2008. End points included functional outcome measured by the modified Rankin Scale and incidence of mortality at 1 year.

■ **RESULTS:** Mean age, gender, side, vessel, and time from ictus to surgery were not statistically different between treatment groups. Stroke volume was significantly higher in the CS group. Operative time and blood loss were significantly higher in the DHC+S group. At 1 year, the median modified Rankin Scale score was 4 and overall survival was 71%. Functional outcomes and mortality for both the CS and DHC+S groups were not significantly different from the DHC group ( $P = 0.24$ ). After adjusting for patient age, stroke volume, and time to surgery, there was no significant difference in outcome.

■ **CONCLUSION:** In patients with malignant supratentorial infarction, strokectomy alone may be equivalent to a decompressive hemicraniectomy without brain resection.



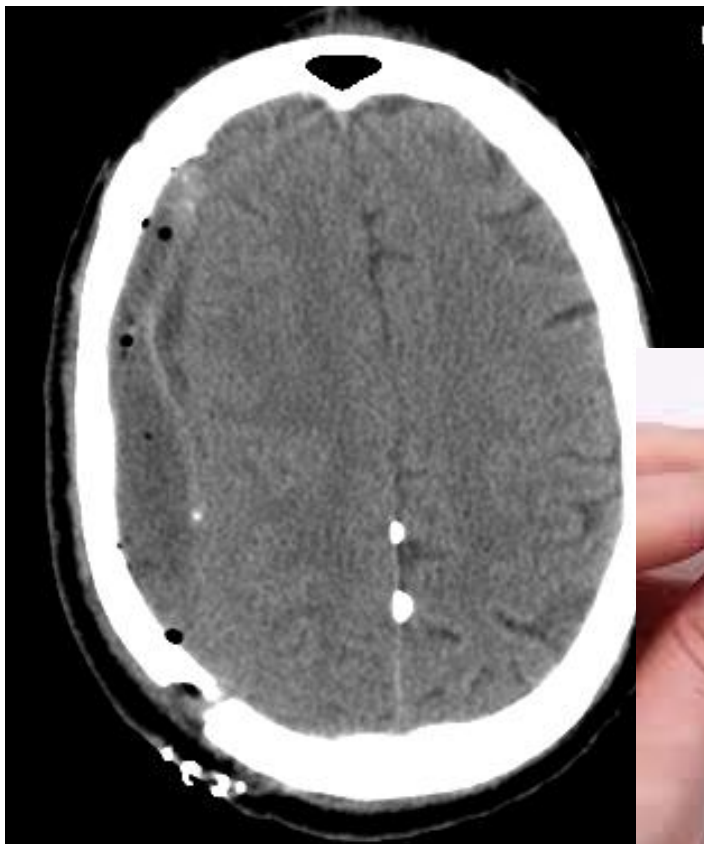




# FORMA NON PERFETTA?



# ALTA PERCENTUALE DI COMPLICANZE



## Cranial repair: how complicated is filling a "hole"?

De Bonis P, Frassanito P, Mangiola A, Nucci CG, Anile C, Pompucci A.

Institute of Neurosurgery, Catholic University School of Medicine, Rome, Italy.

### 218 cranioplasty

The overall complication rate was 19.7%.

infection (8.7%)      cranioplasty dislocation (5.9%)

wound dehiscence (2.3%)      epidural hemorrhage (2.8%)

Three different reconstructive techniques were used:  
repositioning of the autologous bone flap, shaping of hand-  
made polymethyl methacrylate (PMMA) implants  
or positioning of a custom-made prosthesis. PMMA

polyether ether ketone-PEEK  
porous hydroxyapatite



# CRANIOPLASTY

Neuropsychiatric Disease and Treatment

Open Access Full Text Article

## Comprehensive cognitive and cerebral hemodynamic evaluation after cranioplasty

Fernanda Coelho<sup>1</sup>  
Arthur Maynart Oliveira<sup>2</sup>  
Wellingson Silva Paiva<sup>2</sup>

**Abstract:** Decompressive craniectomy is an established procedure to lower intracranial pressure and can save patients' lives. However, this procedure is associated with delayed cognitive decline and cerebral hemodynamics complications. Studies show the benefits of cranioplasty beyond

Dovepress  
open access to scientific and medical research

CASE REPORT



Clinical Neurology and Neurosurgery 108 (2006) 583–585

Clinical Neurology  
and Neurosurgery

www.elsevier.com/locate/clineneuro

Case report

## CT perfusion imaging in the syndrome of the sinking skin flap before and after cranioplasty

Shigeyuki Sakamoto\*, Kuniki Eguchi, Yoshihiro Kiura, Kazunori Arita, Kaoru Kurisu

Department of Neurosurgery, Hiroshima University Graduate School of Biomedical Sciences, 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8551, Japan

Kemmling et al. *BMC Neurology* 2010, **10**:80  
<http://www.biomedcentral.com/1471-2377/10/80>

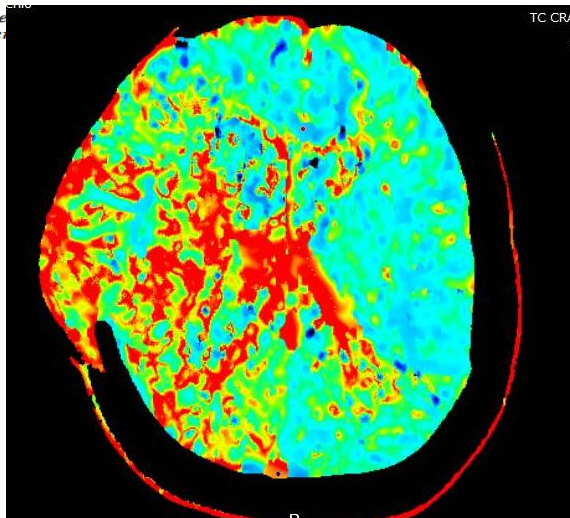
Neurosurg Focus 8 (1):Article 9, 2000



## The influence of cranioplasty on postural blood flow regulation, cerebrovascular reserve capacity, and cerebral glucose metabolism

PETER A. WINKLER, M.D., WALTER STUMMER, M.D., RAINER LINKE, M.D.,  
KARTIK G. KRISHNAN, M.D., AND KLAUS TATSCH, M.D., PH.D.

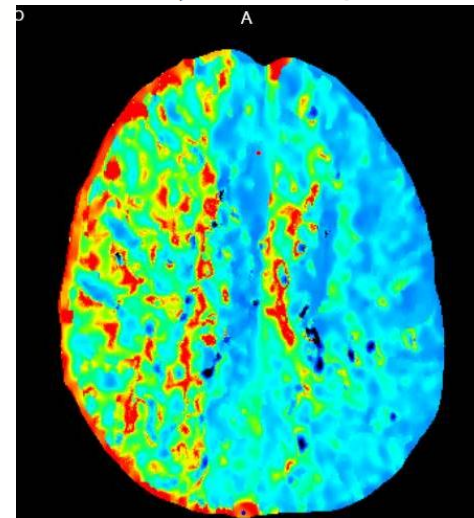
Departments of Neurosurgery  
Ludwig Maximilians Univer



### CASE REPORT

Open Access

## Case report of MR perfusion imaging in Sinking Skin Flap Syndrome: growing evidence for hemodynamic impairment



Niederstadt<sup>1</sup>, Jens Minnerup<sup>2</sup>, Heike Wersching<sup>2</sup>,

## Decompressive hemicraniectomy for malignant middle cerebral artery territory infarction: is life worth living?

### Clinical article

RALPH RAHME, M.D.,<sup>1</sup> MARIO ZUCCARELLO, M.D.,<sup>1</sup> DAWN KLEINDORFER, M.D.,<sup>2</sup>  
OPEOLU M. ADEOYE, M.D.,<sup>1</sup> AND ANDREW J. RINGER, M.D.<sup>1</sup>

*Departments of <sup>1</sup>Neurosurgery and <sup>2</sup>Neurology, University of Cincinnati and Mayfield Clinic, Cincinnati, Ohio*



Despite a substantial proportion of patients with stroke having survived DC with moderately severe (46.8%) or severe (10.8%) disability and a high rate of depression (56.1%) **about three-quarters of the patients and/or caregivers were satisfied with life and did not regret having undergone DC.**

## ...(while Maintaining Quality of Life)....

- Subjective quality of life is acceptable after decompressive hemicraniectomy. When questioned 1-4 years later, most patients:
  - were satisfied with their decision and quality of life [Weil et al. Can J Neurol Sci 2011]
  - and would consent to decompression again [Benejam et al. Journal of Neurology 2009].
- However, the relatives of patients with mRS 5 would not consent again [Kiphuth et al. Neurocrit Care 2010].

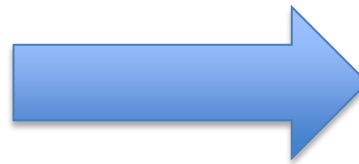
## Recommendations:

- Patients < 60 yrs with good baseline health and large MCA infarcts should receive decompression within 48 hours of symptom onset independent of hemisphere involved.
- Older patients should be offered decompression after careful consideration of their wishes, baseline level of health, and family support.
- Decompression later than 48 hours may be beneficial in select cases with delayed edema, although studies to support this are missing. Surgery should be considered with the earliest (clinical) sign of dangerous mass effect, ideally before uncal herniation.



# CONCLUSIONS

- **MULTIDISCIPLINARY APPROACH BECAUSE IS A COMPLEX DILEMMA FOR ALL PHYSICIANS**
- **CASE BY CASE DISCUSSION**
- **DISCUSSION WITH FAMILY AND PATIENT**
- **CALL THE NEUROSURGEON FROM THE BEGINNING**





***Thank you***



***for attention***