Decompressive craniectomy for acute stroke

Michal Bar MD.Ph.D

Faculty Hospital Ostrava

Pathophysiology of intracranial hypertension

- The syndrome of intracranial hypertension appears when the intracranial pressure (ICP) arises up to more than 20-25mmHg.
- Sustained ICP values of greater than 40-45 mm Hg indicate severe life-threatening state

Pathophysiology of intracranial hypertension

- The high ICP reduces the cerebral blood perfusion and space occupying lesion causes mass effect which then leads to brain tissue displacements and herniation.
- There are four most common types of herniations; the subfalcial , temporal lobe tentorial (uncal herniation) , cerebellar – foramen magnum and cerebellar – tentorial herniation .(transcranial)

Types of herniation

The causes of increased intracranial pressure (ICP)

- mass effect such as malignant ischemic stroke with edema, contusions, subdural or epidural hematoma, brain tumor etc.
- generalized brain swelling without mass effect can occur in ischemic-anoxia states, traumatic brain edema , acute liver or renal failure ,hypertensive encephalopathy, status epilepticus etc.
- increasing venous pressure can be due to venous sinus thrombosis or heart failure
- obstruction of cerebrospinal fluid flow or malfunction of its absorption can occur in hydrocephalus in meningeal disease (e.g., infecious, carcinomatous or subarachnoidal hemorrhage)
- idiopathic or unknown cause (idiopathic intracranial hypertension , pseudotumor cerebri)

Conservative treatment of intracranial hypertension

- Several types of the conservative treatment for reducing intracranial hypertension of various causes to prevent midline shift or herniation have been proposed in the past decades such as management of the airway, breathing and circulation (ABCs) , osmotherapy , sedation , steroids , hyperventilation , and induced therapeutic hypothermia .

Conservative treatment of intracranial hypertension

- None of the randomized trials in patients with ischemic stroke which would prove efficacy on their favourable outcome has been carried out. So far none of these terapeutic conservative strategies are recommended on level A or B for the treatment of ICH in space occupying ischemic stroke.
- Mannitol is typically used at 0.25 to 0.5 g/kg IV administered over 20 minutes, lowers intracranial pressure, and can be given every 6 hours.

Decompressive Craniectomy for supratentorial malignant ischemic infarction

- Since the conservative medical treatment of intracranial hypertension is ineffective in many patients , the idea of decompressive surgery of temporary release of swollen brain outside the cranium has been developed.
- Decompressive surgery was first reported as a potential treatment for large hemispheric infarction in case reports as early as 1956. (Scarcella ,1956)

Rationale and randomized trials

- There have been many studies published up until the year 2004 giving evidence of the benefit of decompressive hemicraniectomy in the reduction in mortality.
- Gupta et al analysed 15 studies with the total number of 129 patients who fulfilled the criteria for entering the analysis. In his analysis he proved the reduction in mortality of 25-30% in operated patients

Rationale and randomized trials

- Craniectomy reduced mortality in patients with malignant MCA stroke , but it was not still clear which patients may avoid severe disability after the procedure.
- Studies carried out up to 2004 were not randomized and with retrospective design in most of them and therefore
- Cochrane´s review from 2002 concluded there was no evidence to recommend DC to treat intracranial hypertension following ischemic stroke.

Rationale and randomized trials

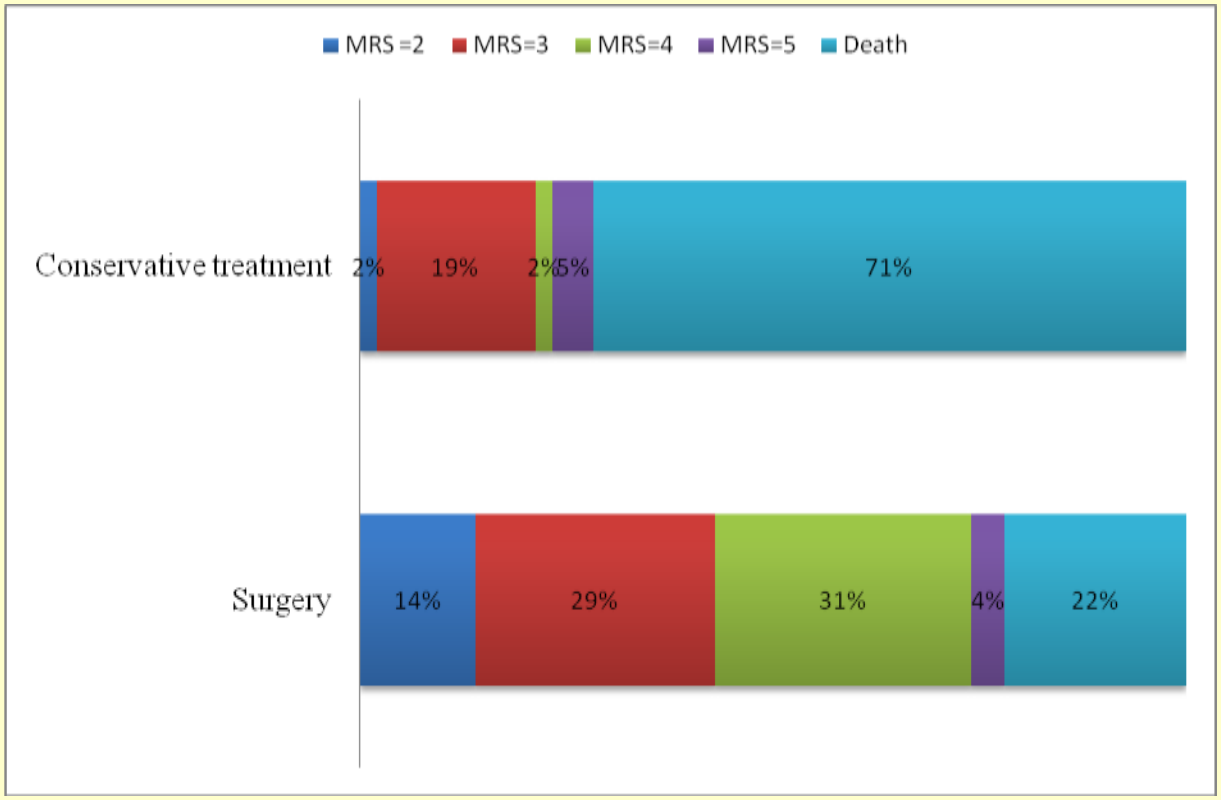
In past decade the clinical effect of decompressive surgery on functional outcome has been studied in three randomized European studies:

- DECIMAL trial (Decompressive Craniectomy in Malignant Middle Cerebral Artery Infarcts) ,
- DESTINY trial (Decompressive Surgery for the Treatment of Malignant Infarction of the Middle Cerebral Artery)
- HAMLET (Hemicranietomy after Middle Cerebral Infarction with Life-threatening Edema Trial).

Rationale and randomized trials

- In 2007 the results from the three European randomized controlled trials (DECIMAL, DESTINY, HAMLET) were pooled to obtain sufficient data to reliably estimate the effects of decompressive surgery not only on the reduction in mortality but also in order to increase the number of patients with a favourable outcome.

Pooled analysis of DECIMAL, DESTINY, HAMLET



Patient selection

Inclusion criteria

- age range 18-60 years
- ischemic infarction in the territory of the MCA with a score on the National Institutes of Health stroke scale (NIHSS) >15
- less than 45 hours from the symptoms onset to surgery
- decrease in the level of consciousness to a score 1 or greater on item 1a of the NIHSS
- CT evidence of at least 50% infraction in the MCA territory, or infarct (volume > 145 cm3 on diffusion-weighed MRI)

Patient selection

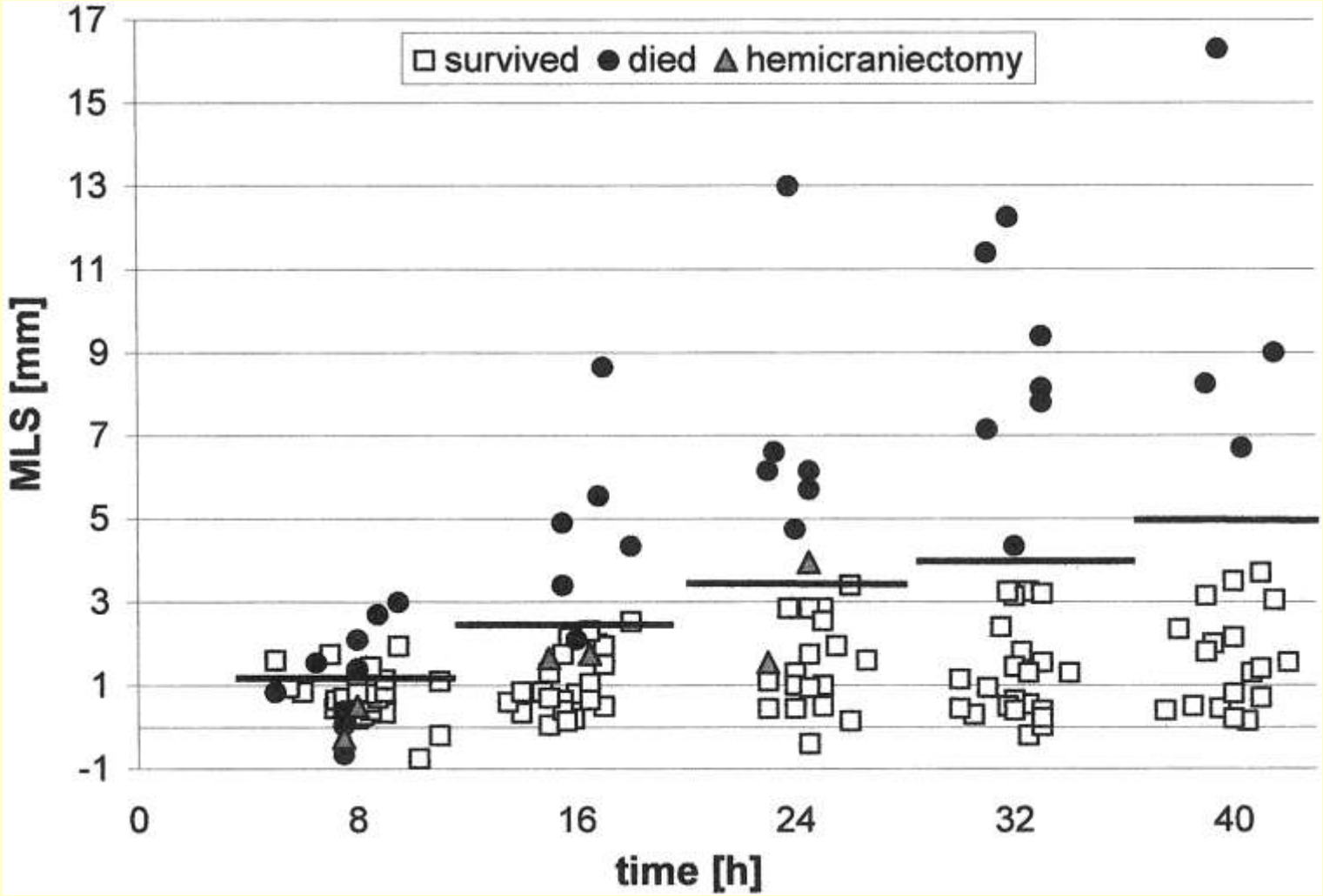
Main Exclusion criteria

- prestroke score on the MRS > =2
- coma with two dilated pupils
- other serious illness
- contralateral ischemia or other brain lession

Timing of procedures

- Hamlet demonstrates no benefit of late surgery between 48-96 hours from the stroke onset between groups of patients who were operated on and those who were not operated on
- In the pooled analysis (DECIMAL , DESTINY HAMLET) no difference was found between patients treated on the first and the second day
- In my opinion early DC should be carried out up to 24 hours in patients with MLS more than 4mm

Cut-off value of midline shift



Gerriets T et al. Stroke 2001;32:442-447

Utilization of procedure

- In spite of the clear guidelines from 2008, the utilization of decompressive surgery for stroke patients with malignant ischemia did not increase essentially . In the Czech republic the number of procedures increased from 39 in 2006 to 56 in 2009.
- We estimate that only about 10% of the patients who met the criteria underwent the surgery

DC for space occupying cerebellar ischemic infarction

- In spite of the lack of evidence based medicine this procedure is accepted more than craniectomy in malignant supratentorial infarction
- The presence of the brainstem infarction has been associated with a poor outcome and it has been analysed as the only independent predictive factor which has been associated with the poor clinical outcome.

DC for space occupying cerebellar ischemic infarction

- Currently we found no level A or B of evidence to support of surgical treatment of space occupying cerebellar infarction . Therefore there is no optimal surgery strategy which would help choose patients with the highest benefit of the operation

DC for subarachnoid hemorrhage (SAH)

- Decompressive Craniectomy for SAH with elevated ICP remains controversial.
- The intracranial pressure could escalate in patients with intracerebral haematoma with the mass effect.
- In patients with only subarachnoid hemorrhage where intracranial hypertension develops on the basis of the generalised brain swelling.
- In case of the delayed ischemic deficit, intracranial hypertension can occur between 5th and 15th day from the SAH onset.

DC for subarachnoid hemorrhage (SAH)

- There are no data nowadays for any kind of guidelines for performing DC in this indication.
- In our opinion DC for SAH with or without intracerebral hematoma should be considered only as an option of the treatment of the elevated intracranial pressure in a patient after SAH with or without intracerebral hematoma.

DC for spontaneus intracerebral hemorhage (ICH)

- According to the only one randomized large study of the surgical treatment of ICH only in patients with lobar hemorrhage within 1 cm of the surface standard craniotomy may be considered(Class IIb).
- Decompressive craniectomy together with the ICH evacuation is supposed to be a life- saving procedure due to the decreasing ICP level.

Conclusion

- The intracranial hypertension means a very serious complication of various diseases of the central nervous system.
- The conservative treatment of ICP such as the management of the airway, breathing and circulation (ABCs) ,osmotherapy , sedation , steroids , hyperventilation , and induced therapeutic hypothermia very often fails and mortality in conservatively treated patients reaches 80%.
- Decompressive craniectomy is a surgical therapeutic option for the treatment of a massive middle cerebral artery infarction , space occupying cerebellar infarction, lobar intracerebral hemorrhage , severe aneurysmal subarachnoid hemorrhage

Conclusion

- The strongest evidence of the effectiveness of the DC is nowadays available in patients with a malignant suratentorial infarction.
- Decompressive craniectory should be performed within 48 hours from the ischemic stroke occurance in every patient younger than 60 with a severe deficit (NIHSS scale more than 15 points) and at least a minor consciousness deterioration (Class I,level A, ESO 2008).

Conclusion

- Decompressive craniectomy in other types of a stroke is still a controversial issue.
- It is the most accepted by doctors in cases of space-occupying cerebellar stroke where the guidelines for executing the performance of type Class IIa, level C are valid. (AHA 2007)
- In case of subarachnoid and intracerebral haemorrhages there are no particular guidelines and doctors approach this treatment based on their individual experience and decisions.

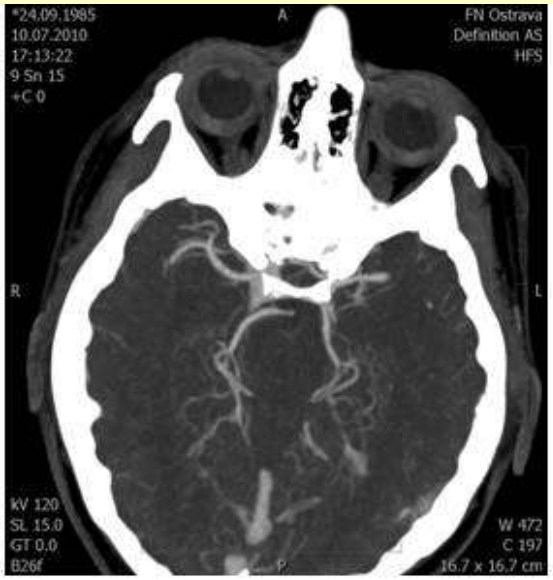


Fig.1

Fig.2

Fig3

Fig.4

Fig.5

Fig.6

Case report. Supratentorial malignant ischemic stroke

Female, 25 years old, was admitted to hospital for severe right side hemiparesis, gaze palsy and aphasia.

CT angiography proved ACM M1 segment artery occlusion. (fig 1) Mechanical recanalization (Wingspan stent) was done within 5th hours from the stroke onset with only partial recanalization. (Digital subtraction angiography - fig2) The CT scan 24 hours after the stroke onset shows massive ischemia in MCA territory on the left side (fig 3).

The CT scan just before surgery showed space occupying lession, midline shift and tentorial herniation (fig4,5). The patient was operated on in 48 hours after the stroke onset CT af Decompressive craniectomy (fig.6). She final outcome in 12-months time after the stroke is mRankin 3, but cortical blindness is present.

In my opinion, the patient was indicated to surgery too late after tentorial herniation.

Fig.1

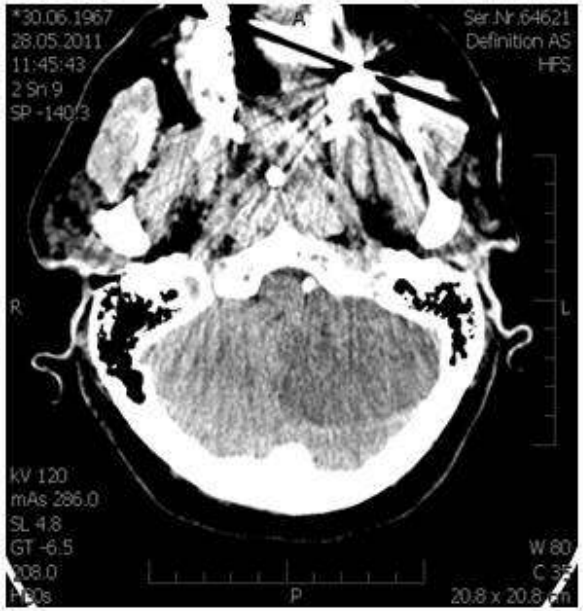


Fig.2

Fig.3

Case report : Space occupying cerebellar infarction
Male , 45 years old, was admitted to hospital for vertigo and desorientation. CT Angiography confirms occlusion of V4 segment of the right vertebral artery and the stenosis V4 segement of the left vertebral artery . (Fig 1,) Mechanical recanalisation of the left vertebral artery was done within 5th hour, unfortunately iatrogenic occlusion of the left posteriro inferior cerebellar artery (PICA) happened within the procedure (DSA, fig 2). This occlusion was followed by ischemia in PICA territory with the beginning expansion of the left cerebellar hemisphere and partial displacement of the 4th ventriculi. (fig. 3) Suboccipital decompressive craniectomy with resection of necrotic tissue and duroplasty was done 72 hours after the stroke onset. (fig 4,5) The outcome in the modified Rankin score is 4 in three months after the stroke.