Abstract no. 51

Experience with the hinged craniotomy technique in "refractory intracranial hypertension" (case series)

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Background

Decompressive craniectomy (DC) is performed as last-tier treatment for refractory intracranial hypertension in traumatic brain injury (TBI) and other conditions with severe cerebral edema, e.g. in cases of malignant middle cerebral artery (MCA) infarction. The hinged craniotomy (HC) technique has been proposed[1-3] as an alternative procedure to prevent complications related to absence of the bone flap (e.g. hygroma formation, hydrocephalus, and "syndrome of the trephined") and cranioplasty (e.g. infection, hematoma, seizures and death).

Materials and methods

Patients operated with HC at Rigshospitalet was retrospectively identified. HC was performed at the discretion of the treating neurosurgeon. Demographic variables, surgical technique, postoperative course, and outcome after 3 months were reviewed.

Surgical technique

Decompression was achieved by a large frontotemporoparietal craniotomy. The temporal bone was resected to expose the floor of the middle fossa, and a stellate durotomy was performed. After decompression, the bone flap was hinged at its superior edge using either thin titanium plates or a prolene mesh (*Fig. 1 and 2*), and two small plates were placed inferiorly to prevent later inward sinking of the bone flap.

Fig. 1 Extend of the standard frontotemporoparietal craniotomy for cerebral decompression.

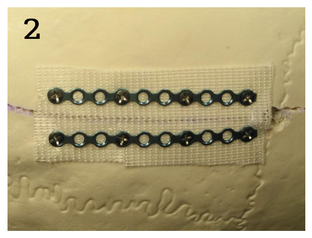

Fig. 2 Hinge at the superior edge of the craniotomy (here: prolene mesh), secured by titanium plates and self-drilling screws.

Results

From 2009 to 2011 we performed HC in 5 patients (*Table 1 and 2*). One patient with TBI was re-operated with removal of the bone flap (DC) due to a postoperative hematoma and one patient with left MCA infarction had treatment consent withdrawn by his relatives due to a poor prognosis. The remaining three patients had sufficient cerebral decompression and no further episodes of refractory intracranial hypertension (*Table 2*). After three months, Case 1 (M40, right epidural/subdural hematoma) showed good neurological recovery with normal motor function and a good cosmetic result. Case 2 (M29, right MCA infarction) showed good neurological recovery with no cognitive defects, but with left hemiparesis. He also had slight sinking of the bone flap at the superior edge and had cranioplasty performed to improve the cosmetic result. Case 3 (F59, right MCA infarction) showed good neurological recovery with a mild left hemiparesis and a good cosmetic result.

Fig. 3 Fixation of the hinge by self-drilling screws.

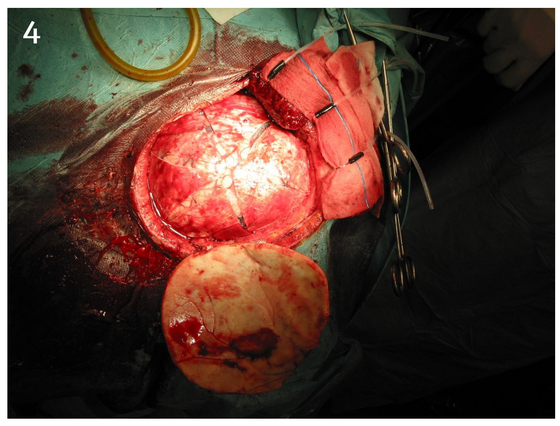

Fig. 4 Hinged craniotomy and stellate durotomy.

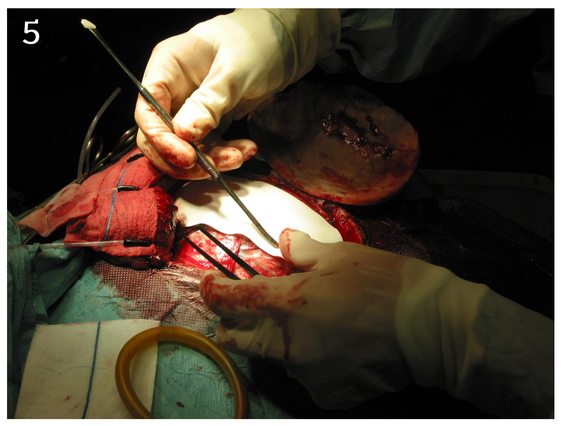

Fig. 5 Placement of dural substitute.

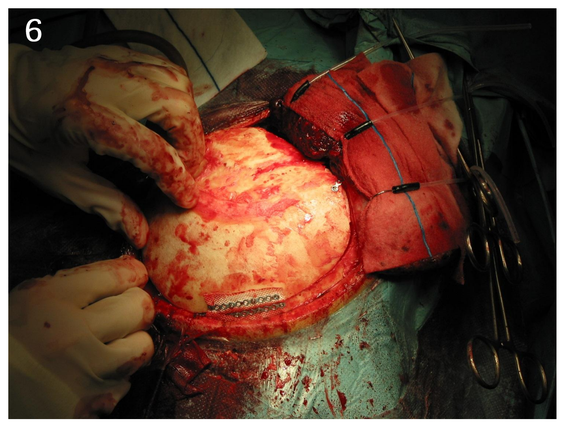

Fig. 6 Approximation of the bone plate before closure.

Case	Age	Gender	Diagnosis	Pre-operative GCS	Anisocoria	Reactive pupils	Timing of HC
1	40	M	Right epidural and subdural hematoma (TBI)	4 (before sedation)	No (miotic pupils)	NA	Primary
2	29	M	Right malignant MCA infarction (M1 occlusion)	8	No	Yes	Secondary (97 hours)
3	59	F	Right MCA infarction (MCA occlusion)	11	Yes (R>L)	Yes	Secondary (70 hours)
4	49	M	Left malignant ACA/MCA infarction (ICA occlusion)	10	Yes (R<L)	Yes	Secondary (24 hours)
5	49	M	Left temporal contusion and epidural/subdural hematoma (TBI)	7 (before sedation)	No	Yes	Secondary (8 days), ICP > 30mmHg

Table 1 Characteristics of the 5 cases. Two patients (1 and 5) had elevated ICP after severe TBI and three cases (2, 3 and 4) needed decompression due to development of malignant cerebral infarction.

Case	Postoperative ICP > 20 mmHg	Outcome at 3 months	Cosmetic result
1	No	GOSE 7. Slightly affected short-term memory. Normal gait function.	Good. Small depression of the bone plate can be palpated.
2	Yes (sedation was increased and ICP normalized)	mRS 3 (moderate disability).	Good. Small depression of the plate corrected with minor surgery.
3	Yes (sedation was increased and ICP normalized)	mRS 4 (moderate severe disability).	Good. No depression of the bone plate.
4	Yes (treatment withdrawn at request from relatives)	-	-
5	Yes (postoperative hematoma, classic DC performed)	GOSE 7. Moderately affected short-term memory. Normal gait function.	- (Cranioplasty after 2½ months)

Table 2 Outcome after hinged craniectomy.

Discussion and future challenges

Morbidity and mortality in relation to DC and cranioplasty is high and warrants investigation of alternative surgical techniques for cerebral decompression. Our limited experience with HC suggests that HC can be performed as alternative to DC to prevent refractory ICP elevation, although it does not lower ICP as effectively. None of the five cases developed hygroma or hydrocephalus, which might indicate less distorted cerebrospinal fluid circulation, than in cases of DC.

The future challenges in development of the HC technique are to:

1. Technically achieve sufficient cerebral decompression (location of the hinge?)
2. Prevent inward sinking of the bone plate (telescopic hinge?)[4]
3. Insure correct patient selection (moderate ICP elevation, contraindications for DC)
4. Provide clinical evidence (prospective trials of effect on ICP and clinical outome)

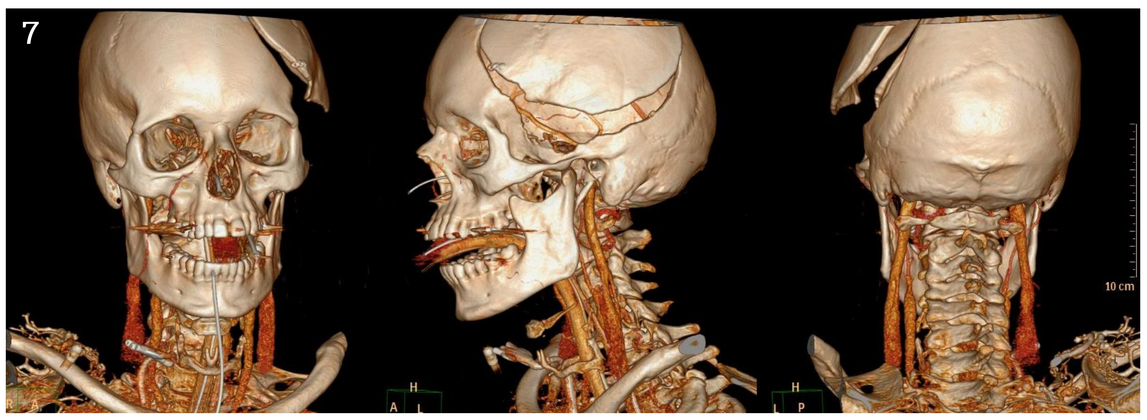

Fig. 7 CT scan (3D reconstruction) performed just post-operatively (case 4).

Conclusion

HC is an appealing technique which could theoretically minimize complications related to emergency cerebral decompression. Laboratory tests are needed to develop the optimal hinge mechanism for maximal intracranial volume increase and minimal later inward sinking (depression) of the bone plate. Clinical studies are needed to document sufficient decompression and to identify the subgroup of patients fit for this treatment.

References

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