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USE OF DECOMPRESSIVE CRANIECTOMY IN THE TREATMENT OF HEMISPHERIC INFARCTION

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Abstract – Decompressive craniectomy (DC) has demonstrated efficacy in reducing mortality in hemispheric infarction of the middle cerebral artery. The aim of our study was to compare the outcome of patients submitted to DC to patients treated in a conservative way. Eighteen patients were submitted to DC and 14 received conservative treatment. Neurological status was assessed by the Glasgow Coma Score and National Institutes of Health Stroke Scale score. Mortality, modified Rankin Scale and Barthel Index scores were assessed at 90 days to evaluate outcome. We did not observe reduction in overall mortality and functional outcome in patients submitted to DC. The differences between our group and previously published series are probably related to the neurological status of the patients at the time of therapeutic decision.

KEY WORDS: craniectomy, decompressive surgery, middle cerebral artery infarction.

Uso da craniectomia descompressiva no tratamento do acidente vascular cerebral isquêmico hemisférico

Resumo – Craniectomia descompressiva (CD) tem demonstrado eficácia em reduzir a mortalidade em pacientes com infarto hemisférico (IH) da artéria cerebral média. Este estudo avaliou o prognóstico dos pacientes submetidos a CD comparando a pacientes com IH tratados de maneira conservadora. Dezoito pacientes foram submetidos a CD e 14 receberam tratamento conservador. Escala de Coma de Glasgow e Escala de AVC do *National Institutes of Health* foram utilizadas para graduar o déficit neurológico. A mortalidade, bem como os escores obtidos na escala modificada de Rankin e índice de Barthel foram avaliados em 90 dias. Não foi observada redução de mortalidade nos pacientes submetidos a CD. Essa diferença entre os nossos resultados e os estudos publicados previamente se deve, provavelmente, à decisão cirúrgica tardia em pacientes com sinais clínicos de herniação cerebral.

PALAVRAS-CHAVE: craniectomia, descompressão cirúrgica, infarto da artéria cerebral média.

Decompressive craniectomy (DC) has been used to treat intracranial hypertension and cerebral edema associated with several causes. In 1905, Cushing was the first to describe this procedure in the treatment of brain tumors[1]. Today, DC is the main treatment option for other diseases, such as brain trauma[2], subdural and epidural hematoma[3], edema due to subarachnoid hemorrhage[4], cerebral venous thrombosis with intractable intracranial hypertension[5], cerebellar infarction[6] and hemispheric infarction of the middle cerebral artery (HI)[7]. HIs occur in strokes with occlusion of the distal internal carotid artery or the proximal middle cerebral artery. They represent 10 to 15% of overall strokes[8]. Clinical worsening related to cerebral edema occurs two or three days after the stroke onset, and is associated with high early mortality[9]. DC increases cerebral perfusion, preventing infarction enlargement, and attenuates the expansive effect of edema that leads to cerebral herniation[10].

Recent international trials showed the importance of DC in reducing mortality and morbidity in HI[11]. Few Brazilian studies have analyzed the efficacy of DC in HIs. Nobre et al. worked on a retrospective study, with 34 patients submitted to DC. The authors concluded that men over 50 years have the worst outcome after DC[12].

The aim of our study was to compare the outcome of HI patients submitted to DC to patients treated in a conservative way.

METHOD

We retrospectively analyzed data of a consecutive series of patients with HI at the Neurological Emergency Department in the Hospital S.Paulo (UNIFESP-EPM) between February 2002 and

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August 2006. HI was an acute ischemic stroke defined by CT as a large parenchymal ischemic lesion that involved at least 50% of the vascular territory of the middle cerebral artery, or the anterior and middle cerebral arteries territories simultaneously, associated with early brain swelling signs, such as midline shift, compression of the lateral ventricles and basal cisterns. Patients with prior poor clinical conditions (mRS ≥02), those with other critical diseases that affect clinical prognosis, and those who died during surgery were excluded.

Epidemiological data were obtained from medical records. We have selected the clinical neurological parameters Glasgow Coma Score (GCS) and National Institute of Health Stroke Scale (NIHSS) scores and outcome measures modified Rankin Scale (mRS) and Barthel Indice (BI) scores that were systematically registered by the neurological and stroke team upon hospital admission, at the time of therapeutic decision and in a follow-up at 90 days.

This study was approved by the Ethics Committee of Hospital S.Paulo (UNIFESP-EPM) and a signed informed consent was obtained from all patients or their legal representatives.

Statistical analysis

Statistical analyses were performed using SPSS software version 10.0 (SPSS Inc). A descriptive analysis, including mean±SD and median, was used to describe patient data. Parametric data was expressed as mean±SD and was analyzed by *t*-test. Nonparametric data was expressed as median and was analyzed by *Kruskal Wallis* test. Dichotomic data was expressed by percentage and analyzed by χ^2 test and *Fisher's exact* test. Statistical significance was assigned to *p* value<*0.05*.

RESULTS

Thirty-two HI patients were analyzed. Eighteen patients were submitted to DC and 14 received conservative treatment (Ct). The therapeutic decision to perform DC was evaluated by the neurosurgeon on call at the neurological emergency department.

Demographic data

The median age of our patients was 59.1±18 years (range 17–93 years). Patients in the operated group were younger (52±15 years) than those with Ct (68±17 years), while patients who received Ct had a higher educational level than those submitted to surgery.

Admission to the hospital

The mean time between the onset of symptoms and admission to the emergency room was 6.3±11.3 hours (range 0.5–50), and did not differ between the two groups. Table 1 summarizes the clinical characteristics of the patients upon admission. The GCS and NIHSS scores did not differ between the two groups. In addition, there was no statistical difference in arterial blood pressure and capillary glucose level, between the two groups at admission. Nearly 15% of all HI patients were submitted to thrombolytic treatment.

Therapeutic decision

The mean time between the onset of symptoms and therapeutic decision among our HI patients was 35.4±27.1 hours and did not differ between the two groups. Fifty percent of our patients submitted to DC were treated in less than 24 hours of symptoms onset. However, at therapeutic decision, patients submitted to DC had lower GCS scores than those with Ct. In addition, NIHSS scores were also worse in those selected to DC. There was a rapid neurological deterioration between admission and therapeutic decision in both groups, marked in those patients selected to DC, as demonstrated in Figures 1 and 2. All patients in the DC group had a decreased level of consciousness and almost half of them showed unilateral fixed and dilated pupil at the time of therapeutic decision (Table 2).

Follow-up at 90 days after therapeutic decision

Mortality, GCS, NIHSS, mRS and BI scores did not differ between the two groups at 90 days (Table 3).

DISCUSSION

Many international studies confirmed that age is the most important predictor affecting outcome in DC[13-15].

Table 1. Clinical and neurological parameters at admission in patients with HI.

Hemispheric infarction	DC N=18	Ct N=14	p
Admission			
Mean (median) of time delay from onset to admission (hrs)	5.4±8.4 (2,0)	7.3±13.7 (2.0)	NS
Mean (median) GCS score	10± 4 (12)	12±2 (12)	NS
Mean (median) NIHSS score	17±7 (15)	14±6 (14)	NS
Mean systolic arterial pressure (mmHg)	145±32	141±39	NS
Mean diastolic arterial pressure (mmHg)	89±20	85±21	NS
Mean arterial pressure (mmHg)	109±22	104±26	NS
Mean capillary glucose (mg⁄dl)	172±68	183±92	NS
Intra-venous thrombolysis	22%	7%	NS

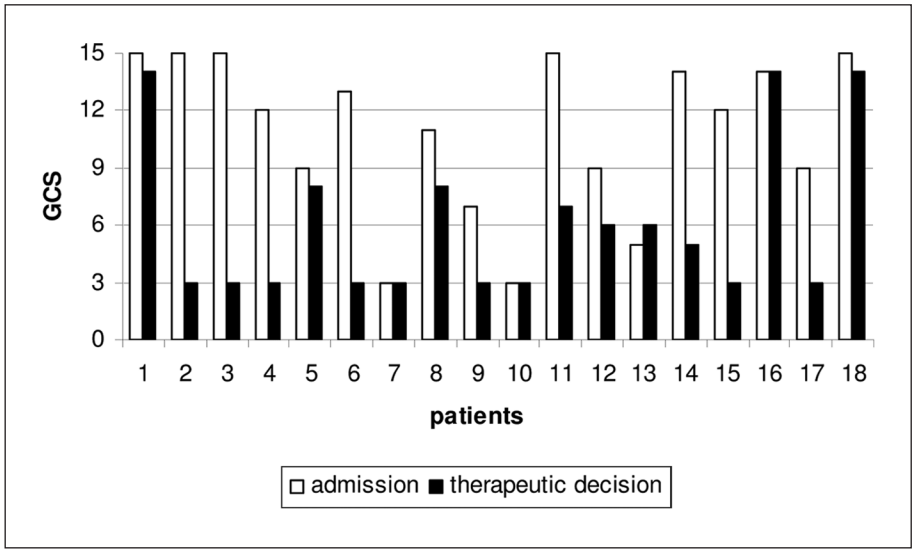

Fig 1. GCS score in DC patients.

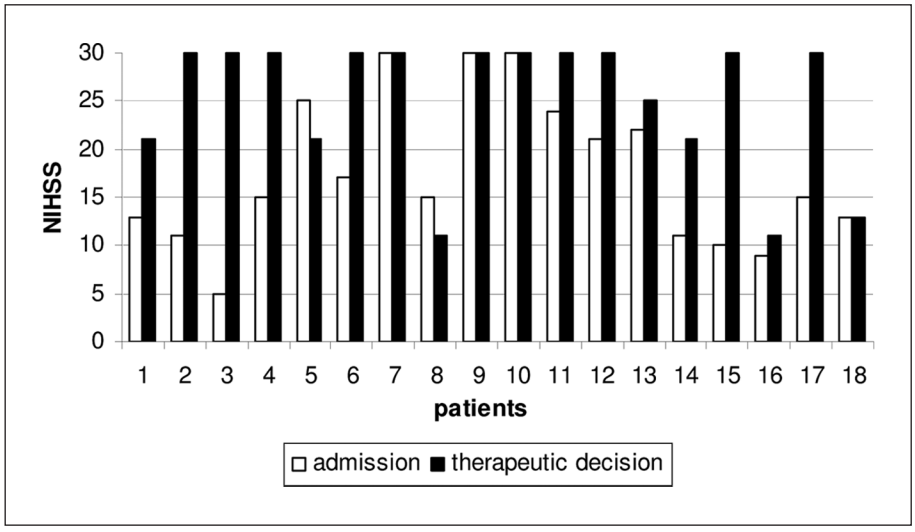

Fig 2. NIHSS score in DC patients.

Table 2. Clinical and neurological parameters at therapeutical decision in patients with HI.

Hemispheric infarction	DC N=18	Ct N=14	P
Therapeutic decision			
Mean (median) time delay from onset (hrs)	33±25 (25)	37±29 (29)	NS
Mean (median) time delay from admission (hrs)	31±20 (30)	34,7±27.8 (27)	NS
Mean (median) GCS score	6±4 (4)	9±3 (10)	**0.016**
Mean (median) NIHSS score	25±7 (30)	19±7 (17)	**0.025**
Decreased level of consciousness	100%	50%	**0.001**
Anisocoria	38%	0	**0.01**
Treatment with manitol	56%	36%	NS

Table 3. Outcome parameters at 90 days in patients with HI.

Hemispheric infarction	DC N=18	Ct N=14	p
Follow-up at 90 days			
Death	55%	57%	NS
Mean (median) GCS score	11±3 (13)	13±2 (13)	NS
Mean (median) NIHSS score	15±8 (13)	10±5 (10)	NS
mRS≤04	50%	50%	NS
BI≥56	12.5%	33.3%	NS

Yu Yao et al. conducted a study comparing the effects of DC in older and younger patients. The mortality was 7.7% in patients with less than 60 years, compared to 33.3% in those ≥60 years[14]. In a systematic review of DC with 138 patients, Grupta et al. also cited the importance of age[15]. Eighty percent of 75 patients over 50 years had poor functional outcome or death when treated with DC, while in younger patients, these endpoints occurred in only 32%. Our DC patients have been selected within the theoretically ideal age group (<60 years) to obtain good results with this procedure.

Patients in both groups arrived early in the Emergency Department. This is probably due to the severity of the neurological deficits that leads the patient and the family to seek out hospital care immediately[16]. Despite early arrival, the decision to perform DC in our patients was delayed. This time frame between hospital arrival and therapeutic decision-making probably played an important role in the neurological deterioration and the outcome in HI patients.

Kilincer et al. showed that a pre-surgery GCS>8 is an important determinant of a favorable outcome[17]. Performing surgery on several patients with clinical signs of brain herniation was probably one of the most important reasons for the lack of clinical benefits from DC in our group.

Most of the studies on DC in HI patients evaluated outcome after 90 days. In a study with 118 patients, 63 submitted to DC, Schwab et al. demonstrated the great benefit on mortality reduction in patients with HI submitted to DC. Results were even better when surgery was performed earlier than 24 hours, causing an extraordinary decrease in deaths and a mild improvement in functional outcome[10].

Besides the timing to perform DC in HI patients, neuroimaging seems to be another important tool to select the ideal patient. Der-Yang Cho et al. used diffusion (DWI) and perfusion (PWI) sequences of magnetic resonance (MRI), and proposed the new concept of ultra-early DC (<6 hours from onset)[18]. The authors obtained excellent results, with mortality lower than 10% and a better functional outcome than prior studies. Thomalla et al. studied the role of early MRI to predict the occurrence of HI. Thirty-seven patients with acute HI were submitted to DWI, PWI, and MR angiography within 6 hours of symptom onset. Predictors of HI were as follows for sensitivity and specificity, respectively: apparent diffusion coefficient (ADC) $_{<80\%}$ >82 ml (87% and 91%), time to peak (TTP) $_{>+4s}$ >162 ml (83% and 75%) and TTP/ADC mismatch ratio <2.4 (80% and 79%) ($p<0.05$)[19]. Although there was a significant difference in the clinical parameters in our patients at the time of therapeutic decision, we could not detect any differences in the outcome at 90 days follow-up visit.

Our initial results were not as encouraging as the previously published ones[10]. We could not observe a significant reduction in overall mortality, when comparing patients treated with DC to Ct. The lack of benefit of DC in our study group is probably a consequence of performing late surgery in patients with rapidly evolving clinical signs of brain herniation and less salvable brain tissue. This fact may suggest that if patients submitted to DC had been operated in equal neurological conditions that those indicated to Ct, they might have had better outcome.

Early DC, performed within 24 hours from stroke onset, is a well established option of treatment in HI, in which thrombolysis was unsuccessful. Hypothermia maybe another possible early synergic therapy in future trials with HI patients. When combined to DC, hypothermia seems to reduce the final brain infarction volume, improving neurological outcome[20]. It is obvious that intensive care conditions play an additional important role in the final results of DC. Control of temperature[21], arterial blood pressure[22], glycemia[23] and intracranial pressure[24] must be rigorous.

Further protocols should improve decision-making for DC to optimize patient selection and minimize treatment delays selecting the patient with acute HI that will mostly benefit from this therapeutic procedure. Based on our data and reviewing the literature, we may suggest the following criteria: age less than 60 years; early decision for surgery within the first 24 hours of stroke onset; patients with rapidly neurological worsening evaluated by

GCS and NIHSS scores without signs of brain herniation; and finally subtle large and early acute ischemic lesions detected by the initial CT or MRI.

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