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Original article

Computed tomography as a tool to detect potential brain-dead donors☆

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ABSTRACT

Background and objective: To assess the ability of urgent head computed tomography (CT) scan screening to detect patients who can evolve to brain death (BD).
Patients and method: Patients who underwent urgent head CT scan and meet the following criteria: midline shift greater than 5 mm and/or decrease or absence of basal cisterns. A follow-up for 28 days of each patient was made. Epidemiological data (sex, age, cause of brain injury), clinical data (level of consciousness, severity index in the CT) and patient outcomes (death, BD, discharge or transfer) were recorded. This was a prospective observational study.
Results: One hundred and sixty-six patients were selected for study, with mean age 60.08 (SD 21.8) years. A percentage of 49.4 were men and the rest women. In the follow-up, 20.5% (n = 34) had BD. In univariate analysis, intracerebral haemorrhage, Glasgow Coma Scale score less than 8 and alteration of basal cisterns were statistically significant in predicting BD ($P < .05$). Multivariate analysis showed that patients with compression of basal cisterns were 20 (95% confidence interval [95% CI] 2.61–153.78; $P = .004$] times more likely to progress to brain death, while the absence there of 62.6 (95% CI 13.1–738.8; $P < .001$] times more.
Conclusions: Our work shows that data as easy to interpret as compression/absence of basal cisterns can be a powerful tool for screening patients at risk for progression to BD.

Utilidad de la tomografía computarizada como herramienta para detectar potenciales donantes en muerte encefálica

Palabras clave:
Donación
Muerte encefálica
Tomografía computarizada de cráneo

RESUMEN

Fundamento y objetivo: Evaluar la capacidad de cribado de la tomografía computarizada (TC) de cráneo urgente para detectar a los pacientes que pueden evolucionar a muerte encefálica (ME).
Pacientes y método: Se incluyeron los pacientes a los que se realiza TC de cráneo urgente y que cumplían los siguientes criterios: desplazamiento de línea media mayor de 5 mm y/o disminución o ausencia de las cisternas de la base. Estos pacientes fueron sometidos a seguimiento durante 28 días. Se recogieron los datos epidemiológicos (sexo, edad, causa de la lesión encefálica), clínicos (nivel de consciencia, índices de gravedad tomográficos) y la evolución de los pacientes: fallecimiento, ME, alta o traslado.
Resultados: Se seleccionaron para su seguimiento 166 estudios, siendo la media (DE) de edad de 60,08 (21,8) años. El 49,4% fueron varones. Del total de casos estudiados, fallecieron por ME el 20,5% (n = 34). En el análisis univariado, la hemorragia cerebral, la puntuación inferior a 8 de la *Glasgow Coma Scale* y la alteración de las cisternas de la base resultaron ser estadísticamente significativas para predecir ME (p < 0,05). Mediante análisis multivariante observamos que la compresión de cisternas de la base suponía 20 (intervalo de confianza del 95% [IC 95%] 2,61–153,78; p = 0,004) veces más posibilidades de evolucionar a ME, mientras que la ausencia de las mismas, hasta 62,6 (IC 95% 13,1–738,8; p < 0,001) veces más.

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Conclusiones: Nuestro trabajo demuestra que un dato tan sencillo de interpretar como la compresión/ausencia de las cisternas de la base puede ser una potente herramienta para el cribado de pacientes en riesgo de evolucionar a ME.

Introduction

According to World Health Organisation data, Spain is the country with the highest rate of donors per million inhabitants.[1,2] This continues to be the case despite the fact that in the last few decades there has been an obvious drop in the number of optimum donors, mainly due to a decrease in the number of traffic accidents, and also to better care for patients suffering from head injuries.[3] Donation rates have remained stable as a consequence of an increase in suboptimal organs from extended-criteria donors and forms of donation other than brain deaths (BD). This has become a challenging task for professionals who work in donation–transplantation procedure. It is the transplant coordinators in particular who are most affected by this over-exertion since they have to both find new ways to enable compensatory increases in the donor pool, from, for example, asytole donation, whilst also detecting those potential brain-dead donors who may not be recognised in time, due to diverse circumstances.[4]

The existence of organ waiting list death rates[5,6] has motivated us to implement and develop new detection strategies for potential extended-criteria donors, who are often overlooked in clinical practise because they are not the standard young donors with no previous diseases.

Starting from the premise that all patients suffering from acute severe brain injury, with possible evolution to brain death, have been given a brain scan, we focused our study on the screening capacity of this imaging tool for selecting those patients who could evolve to BD. Early identification and follow-up of this type of patient by transplant coordinators would undoubtedly largely reduce the number of losses of potential donors.

The aim of our study was therefore to assess the screening capacity of the emergency brain scan to detect patients who may evolve to brain death.

Patients and method

We carried out a prospective, observational study in the University Hospital Virgen del Rocío in Seville between 1st August 2011 and 31st May 2012. The working protocol was assessed and approved by the ethics Committee of our centre.

During the period of study, all emergency CT brain scans were assessed every 24 h in our hospital. From these scans we recorded the studies of those patients who presented with the following inclusion criteria: (1) acute injuries with criteria of severity, characterised by leading to a midline shift (MLS) greater than 5 mm and/or a decrease or absence of basal cistern (BC) space (Figs. 1 and 2)[7,8] and to be the first study of that patient meeting with the previously exposed severity criteria. Subsequent brain scans of the same patient were excluded from the study although there was a continued presence of severity. Two doctors specialising in the care of neuro-critical patients independently reviewed all imaging, contrasting their observations with reports issued by the radiologist on duty at the time. The kappa index was used for analysis of the interobserver correlation when assessing each CT scan.

Once the patient had been included in the study he or she was digitally monitored for 28 days or until the episode which had led to the CT indication was resolved. Follow-up involved data collection in the digital record of each patient, with no intervention from the doctors in attendance at that time. Basic epidemiological data was collected (gender, age, cause of the head injury), clinical data (level of consciousness using the *Glasgow Coma Scale*[9] [GCS], official classification of the different diseases: *Traumatic Coma Data Bank* [CTDB][10] in the (TBI), and the final evolution of the patients (death, brain death, discharge or transfer to another centre).

The CT scans were performed on the General Electric (General Electric Company, Fairfield, Connecticut, U.S.A.) LightSpeed 16 device, in compliance with our hospital's own protocol for emergency brain tomography: canthomeatal plane with 5 mm slices of the posterior fossa and 10 mm supratentorial slices. Reproduction of the images was made with the 10.2 version Kodak Carestream Pacs software (Carestream Health Incorporated, Rochester, Nueva York, U.S.A.).

Statistical analysis

For Statistical analysis a descriptive analysis was developed using standard means and deviations for numerical variables. For non numerical variables, frequency and percentage numerical tables were calculated. 95% confidence interval estimates were obtained for averages and percentages. The comparison of means between 2 groups (BD and non BD) was established using the *t*-student test for separate samples, meeting requirements for randomisation, normality and equality of variance. If the latter was not met, the t-student test with Welch correction was performed. When the assumption of normality was not met, the non-parametric Mann–Whitney *U* test was used. To relate qualitative type variables the chi-squared test, the chi-squared test with correction for continuity or Fisher's exact test were applied,

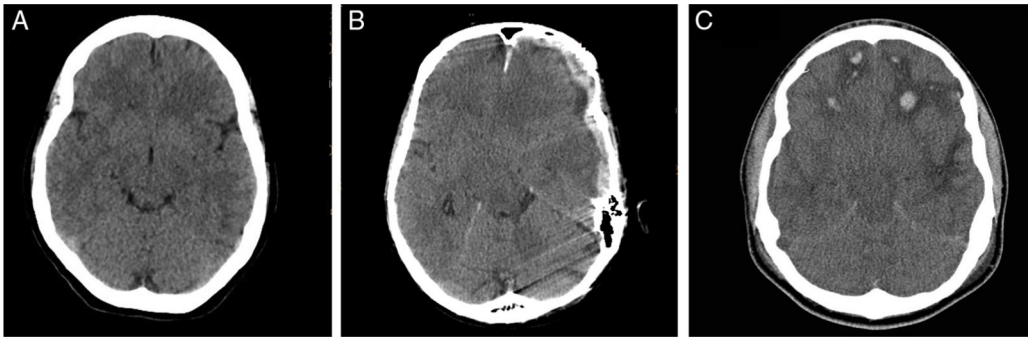

Fig. 1. Computed axial tomography imaging of the brain. (A) Normal. (B) With compromised basal cisterns. (C) With absence of basal cisterns.