

Retrospective investigation of cases diagnosed with brain death

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ABSTRACT

Aims: Early and rapid detection of brain death in intensive care units is important for organ transplantation. This study aimed to evaluate cases diagnosed with brain death.

Methods: The retrospective study was conducted by examining the patients diagnosed with brain death in intensive care units of the city hospital between 06.10.2023 and 01.09.2024. Demographic characteristics of the cases, hospitalization diagnoses, clinics where they received treatment, the time from admission to intensive care and the beginning of clinical suspicion of brain death until the report was prepared, additional tests applied, family organ donation rate, donor rate, and the time from the diagnosis of brain death to cardiac arrest in non-donor cases were recorded.

Results: 33 patients were diagnosed with brain death. The mean age of the cases was 52.1, and 51.6% of them were male (n=17). 57.6% of the cases had no known comorbid diseases (n=19). The intensive care units where the cases were hospitalized were 36.4% anesthesia (n=12) and 36.4% neurosurgery (n=12). The hospitalization diagnosis of the cases was intracranial hemorrhage in 30.4% (n=10) and cerebral infarction in 30.4% (n=10). Digital subtraction angiography was used in 70% (n=23) for additional supporting tests. Organ donation was made by the family in 12.1% of the cases (n=4), and organs were transplanted in 9% of these cases (n=3). The average time from admission to diagnosis of brain death was 6.66 days. The average time from follow-up of patients thought to have brain death to diagnosis of brain death was 2.03 days. The average time from diagnosis of brain death to cardiac arrest was 31.85 hours.

Conclusion: It is very important to diagnose brain death in order to increase the number of organ transplants from cadavers. In patients who may be potential donors, brain death should be determined quickly, and rapid action should be taken after diagnosis, and unnecessary loss of time should be avoided.

Keywords: Brain death, intensive care unit, transplantation

INTRODUCTION

Brain death is the persistent and irreversible loss of all activities of the brain, brain stem, and cerebellum, which are the parts of the central nervous system that remain within the skull. There are three main findings in the clinical diagnosis of brain death: deep coma, brainstem areflexia, and a positive apnea test.¹ The definition of brain death was first made by Mollaret and Goulon² in 1959, and many studies and criteria have been developed since then. The Harvard criteria, published in 1968, expanded the medical definition of brain death and formed the basis of today's definitions.³

In our country, since 02.01.2014, the diagnosis of brain death is decided unanimously by two physicians, one of whom is a

neurologist or neurosurgeon and the other is an anesthesiology and reanimation specialist or intensive care specialist.⁴

The number of patients who develop organ failure and need transplantation is increasing. Developments in transplantation and the increasing number of patients waiting for transplantation make cadaver organ transplantation, and therefore brain death and donor care, very important.⁵

The correct and prompt diagnosis of brain death, monitoring of potential donors, obtaining family consent, quality of donor care, and careful management of organ harvesting are essential for an efficient transplantation. Intensive care units play a very important role at this stage. In this study, the characteristics

of brain death cases that occurred in the last 11 months in the city hospital, the supporting tests used in the diagnosis of brain death, and the organ donation acceptance rates of families were examined.

METHODS

The study was conducted with the permission of the Scientific Researches Evaluation and Ethics Committee of Gaziantep City Hospital (Date: 16.10.2024, Decision No: 62/2024), a retrospective study was conducted by examining the archive records of adult and pediatric patients diagnosed with brain death in intensive care units of the city hospital between 06.10.2023 and 01.09.2024. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Patients who were diagnosed with brain death at the end of the follow-up period were included in the study. Patients whose diagnosis process could not be completed or who exited before the necessary procedures were excluded from the study.

Demographic characteristics of the cases, such as age, gender, blood type, comorbid diseases, hospitalization diagnoses, clinics where they received treatment, the time from admission to intensive care and the beginning of clinical suspicion of brain death until the report was prepared, additional tests applied, family organ donation rate, donor rate, and the time from the diagnosis of brain death to cardiac arrest in non-donor cases, were recorded. The data were accessed by examining archive files and computer records. All brain death cases between the dates specified above were included in the study, and cases outside this date range were excluded from the study.

Statistical Analysis

Statistical analyses of the obtained data were performed using SPSS 20.0 (Chicago IL, USA). The Kolmogorov-Smirnov test was used for homogenization of the obtained data. Statistical analysis of homogeneous randomized independent groups would be performed using the Chi-Square Test. Descriptive statistics of the study data were expressed as mean±standard deviation for quantitative data and frequency and percentage values for qualitative data. In the results obtained from the applied statistical tests, p-value below 0.05 and CI 95% were considered statistically significant.

RESULTS

Between 06.10.2023 and 01.09.2024, the total number of adult/pediatric intensive care patients was 1393, the total number of patients followed up with suspicion of brain death was 225, and the number of patients followed up with suspicion of brain death but not diagnosed with brain death was 193. Between 06.10.2023 and 01.09.2024, 33 patients diagnosed with brain death in our hospital were examined. Demographic and clinical data of the patients are shown in [Table 1](#). The mean age of the cases was 52.1, and 51.6% of them were male (n=17). While 57.6% of the cases had no known comorbid diseases (n=19), 24.4% had hypertension (n=8), 9% had coronary artery disease (n=3), 6% had diabetes mellitus (n=2), and 3% had other diseases (n=1). When the blood types of the cases were examined, the majority were group A (36.4%), and 87.8% were Rh positive according to the Rh groups. The intensive care units where the cases were hospitalized were 36.4% anesthesia (n=12), 36.4% neurosurgery (n=12), 9%

Table 1. Demographic data and characteristics of patients

	n (33)	%
Age(years)	52.1±13.3	
Gender (%)		
Male	17	51.6%
Female	16	48.4%
Comorbidity (%)		
None	19	57.6%
Hypertension	8	24.4%
Diabetes mellitus	2	6%
Coronary artery disease	3	9%
Other	1	3%
Blood group (%)		
A	12	36.4%
B	7	21.2%
AB	3	9%
O	11	33.4%
Rh		
Positive	29	87.8%
Negative	4	12.2%
Intensive care unit (%)		
Anesthesia and reanimation	12	36.4%
Neurosurgery	12	36.4%
Neurology	3	9%
Surgical	2	6%
Internal medicine	2	6%
Cardiovascular surgery	2	6%
Admission diagnoses (%)		
Cerebral infarction	10	30.4%
Intracranial hemorrhage	10	30.4%
Traumatic brain injury	6	18.1%
Brain tumor	4	12.1%
Other diseases	3	9%
Nationality (%)		
Turkish	28	84.8%
Other	5	15.2%
Transplantation (%)		
Donation	4	12.1%
Transplant	3	9%
Auxiliary tests used in diagnosis (%)		
None	1	3%
CT angiography	9	27%
DSA	23	70%

CT angiography: Computed tomography angiography, DSA: Digital subtraction angiography

neurology (n=3), 6% surgery (n=2), 6% internal medicine (n=2), and 6% cardiovascular surgery intensive care (n=2). The hospitalization diagnosis of the cases was intracranial hemorrhage in 30.4% (n=10), cerebral infarction in 30.4% (n=10), traumatic brain injury in 18.1% (n=6), brain tumor in 12.1% (n=4), and other diseases in 9% (n=3). While 84.8% of the cases were Turkish (n=28), 15.2% were not citizens of the Republic of Turkey (n=5). Due to apnea test conditions failing to meet in 5 cases (15.15%), brain death was diagnosed with supportive additional testing. While no additional supporting tests were used in 3% of the cases for the diagnosis of brain death (n=1), digital subtraction angiography was used in 70% (n=23), and computerized tomography angiography was used in 27% (n=9). Organ donation was made by the family in 12.1% of the cases (n=4), and organs were transplanted in 9% of these cases (n=3).

The average time from admission to diagnosis of brain death was 6.66 days. The average time from follow-up of patients

thought to have brain death to diagnosis of brain death was 2.03 days. The average time from diagnosis of brain death to cardiac arrest was 31.85 hours (Table 2).

The organs of one case could not be used for medical reasons. In the other three cases, the liver and the right and left kidneys were used for transplantation.

Age, hypertension, Rh-negative blood group, and intracranial hemorrhage diagnosis are statistically associated with the time from admission to the diagnosis of brain death. The time from follow-up to diagnosis of brain death was statistically significantly shorter in cases diagnosed in the anesthesia intensive care unit ($p<0.05$). The time from diagnosis of brain death to cardiac arrest was statistically significantly shorter in patients with coronary artery disease ($p<0.02$) and those diagnosed in the cardiovascular surgery intensive care unit ($p<0.04$). Male gender, absence of comorbid disease, and diagnosis in the anesthesia intensive care unit were statistically significantly associated with donation (Table 3).

DISCUSSION

Similar to the rest of the world, the number of patients waiting for organ transplantation in our country is increasing day by day. For this reason, organ transplantation from a cadaver is of great importance. For organ transplantation from a cadaver, it is important to closely monitor potential donor candidates and diagnose brain death.

In our study, cases diagnosed with brain death between 06.10.2023 and 01.09.2024 were examined. The total number of brain deaths was 33, and the number of organ donations was 4.

In two studies conducted in our country, 70.7% and 61.3% of patients diagnosed with brain death were male, and their mean age was 46.7.^{6,7} In a cohort study conducted on 69,735 cases in the USA, 56.47% of the cases were male, and the average age was 48 years.⁸ The cases in our study were similar to these studies in terms of age and gender.

Table 2. Follow-up processes of cases

	Mean	Median	SD	%95 CI
Time admission-BD (day)*	6.66	5 (1-26)	5.90	2.09
Time follow up-BD (day)**	2.03	2 (0-6)	1.48	0.52
Time BD-cardiac arrest (hour)***	32.67	28 (0-90)	24.25	6.86

*Time from admission to diagnosis of brain death, **Time from start of follow-up to diagnosis of brain death, ***Time from diagnosis of brain death to cardiac arrest, SD: Standard deviation

Table 3. Statistical relationship between demographic data and follow-up processes

	Time admission-BD*	Time follow up-BD**	Time BD-cardiac arrest***	Donation
Age	<0.05			
Gender				
Male				<0.03
Female				
Comorbidity				
None				<0.05
Hypertension	<0.01			
Diabetes mellitus				
Coronary artery disease			<0.02	
Other				
Blood group				
A				
B				
AB				
O				
Rh				
Positive				
Negative	<0.05 (no comorbid)			
Intensive care unit				
Anesthesia		<0.05		<0.05
Neurosurgery				
Neurology				
Surgical				
Internal medicine				
Cardiovascular surgery			<0.04	
Admission diagnoses				
Traumatic brain injury				
Intracranial hemorrhage	<0.05			
Cerebral infarction				
Brain tumor				
Other diseases				
Nationality				
Turkish				
Other				
Transplantation				
Donation				
Transplant				

*Time from admission to diagnosis of brain death, **Time from start of follow-up to diagnosis of brain death, ***Time from diagnosis of brain death to cardiac arrest

In Palabıyık's⁶ study, while there was no comorbid disease in 48.7% of the cases, hypertension (34.1%) was the most common comorbid disease. Similar to Palabıyık's⁶ study, in our study, there was no comorbid disease in 57.6% of the cases, while the most common comorbid disease was hypertension (24.4%). The most common blood group was ARh+ in the study of Eira et al.⁹ ORh+ (41.9%) in the study of Kuşcu et al.⁷ while in our study it was determined as 36.4% A and 87.8% Rh+.

The most common cause of brain death in the cases included in our study was intracranial hemorrhage and cerebral infarction at equal rates. In the studies of Escudero et al.¹¹, Kuşcu et al.⁷, and Karasu et al.¹⁰, the most common cause of brain death was intracranial hemorrhage, while in the study of Karan et al.¹², cerebrovascular events were reported as the most common cause of brain death, and in the study of Akbaş et al.¹³, ischemic stroke was reported as the most common cause of brain death.

In Uzuntarlan's¹⁴ study, it was seen that the cases diagnosed with brain death were mostly hospitalized in the anesthesia and reanimation intensive care unit while in the study of Avcı et al.¹⁵ it was seen that the cases were hospitalized in the brain and neurosurgery intensive care unit. In our study, it was observed that the cases diagnosed with brain death were mostly hospitalized in the anesthesia and reanimation intensive care unit and the neurosurgery intensive care unit in equal numbers. It is thought that the number of brain death detections may vary from service to service, depending on the internal functioning of the hospital and the sensitivity of the healthcare personnel on the issue.

The use of auxiliary tests, or which auxiliary test to use, varies depending on the laws of the country and the facilities of the hospitals.¹⁶ While the use of supportive tests in Spain is around 95%¹¹, the use of supportive tests in two studies conducted in our country was 58.1% and 62%.^{7,17} In our study, the use of supportive tests was 97%, which is higher than other studies conducted in our country. In the study by Sipahioğlu et al.¹⁸ in 1998 examining brain death cases, the most commonly used supportive test was computed tomography angiography with a rate of 30.2%. In our study, digital subtraction angiography was used most frequently as a supporting test, with 70%. We think that the choice of supporting test may be related to hospital conditions and access opportunities.

While organ donation in brain death cases was 70% in a study conducted in Spain, organ donation rates in studies conducted in our country were reported between 19% and 69%.^{7,11,19} In our study, the organ donation rate in brain death cases was 12.1%, which was lower than similar studies in the country. We think that the reasons for this may be that 5 of the cases were not citizens of the Republic of Turkey and were excluded from evaluation for donation and that the organ donation rate may vary by region.

In studies conducted in our country, the mean time from admission to intensive care until the diagnosis of brain death was found to be 2.5-6 days.^{17,18} In our study, similar to the literature, the mean time from admission to intensive care until the diagnosis of brain death was found to be 6.6 days. The mean time from suspicion of brain death to diagnosis of brain death was found to be 1 day in the study conducted by Akbaş et al.¹³ and 3 days in the study conducted by Karasu et al.¹⁰ In our study, this period was also found to be 2 days. In our study, the

mean time from diagnosis of brain death to cardiac arrest in non-donor cases (n=30) was 32.67±24.25 hours, and this time was similar to the study by Karasu et al.¹⁰ and Kuşcu et al.⁷

In our study, we found that age, hypertension, Rh-negative blood group, and the time from hospitalization to brain death diagnosis with intracranial hemorrhage diagnosis were statistically related. We think that this may be due to the fact that the majority of cases were patients with intracranial hemorrhage, hypertension being a major factor in the etiology of patients with spontaneous intracranial hemorrhage, and the poor prognosis of this disease in neurological terms.

In our study, we found that the time from follow-up to diagnosis of brain death was statistically significantly shorter in cases diagnosed in the anesthesia intensive care unit. We think that the time from suspicion of brain death to diagnosis is shorter in anesthesia intensive care units because the brain death detection team in our country includes an anesthesia specialist or intensive care specialist, and they have the competence of brain death detection and care as their specialty.

We found that the time between the diagnosis of brain death and cardiac arrest was statistically significantly shorter in patients with coronary artery disease and in patients diagnosed in the cardiovascular surgery intensive care unit. In their study evaluating the frequency of mortality and risk factors in the intensive care unit, Çakır et al.²⁰ found the highest mortality rate (47.8%) in patients hospitalized due to cardiovascular disease. For this reason, we think that the time from diagnosis to cardiac arrest is shorter in patients with cardiovascular disease.

Limitations

The limitations of the study can be stated as being the study was conducted in a single center with a small number of cases and the retrospective acquisition of the data.

CONCLUSION

It is very important to diagnose brain death in order to increase the number of organ transplants from cadavers. It should be kept in mind that brain death may occur in patients with poor neurological prognosis who are hospitalized with diagnoses such as intracranial hemorrhage and cerebral infarction. In patients who may be potential donors, brain death should be determined quickly, rapid action should be taken after diagnosis, and unnecessary loss of time should be avoided.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Scientific Researches Evaluation and Ethics Committee of Gaziantep City Hospital (Date: 16.10.2024, Decision No: 62/2024).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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