



# Does Traumatic Brain Injury by Firearm Injury Accelerates the Brain Death Cascade? Preliminary Results

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## ABSTRACT

Brain death (BD) triggers a series of pathophysiological events similar to multiple-organ dysfunction. Traumatic brain injury (TBI) due to firearm injury (FAI) causes lesions that could lead to BD. Patients admitted to the ICU due to severe TBI that evolved to BD were studied, including those caused by FAI; the 2 groups were compared with the objective of demonstrating that the support of the deceased donor by TBI due to FAI is more unstable and of shorter duration than the one related to TBI by another cause. Preliminary results demonstrated that the individuals with TBI by FAI died in BD in a higher percentage than the individuals with TBI caused by accidents (83% vs 41%). The donor treatment period was lower in individuals who presented TBI by FAI. These individuals needed higher doses of noradrenaline as vasopressor support for their treatment, without showing a statistically significant difference ( $P = .15$ ), compared with individuals whose BD cause was TBI caused by accident.

**B**RAIN death (BD), the final result of the “brain interlock” as a result of a severe traumatic brain injury (TBI), triggers a series of events of inflammatory nature, very similar to the multiple-organ dysfunction (MOD) model associated with sepsis. These manifestations of the pathophysiological processes must be faced by the transplant coordinator during the donor treatment. TBI caused by a firearm injury (FAI) is usually devastating; it causes lesions, most of the time irreversible, which can lead to BD.

Our objectives were to demonstrate that BD by TBI due to FAI has particular characteristics that determine a great instability during the donor treatment and that the duration of the donor treatment is shorter when BD is caused by TBI due to FAI compared with TBI from other cause.

## METHODS

We studied 194 patients between December 2007 and February 2017 admitted to different public and private intensive care units (ICUs) with a diagnosis of severe brain injury. In all cases, the circulatory cerebral flow velocities were studied through transcranial Doppler (TCD) with SONARA/tek equipment (Viasys Healthcare, Inc. Madison, Wisc, USA). We analyzed a group of patients admitted to the ICU of different centers for severe brain injury due to TBI by FAI that evolved to BD, and we compared these subjects to a group of patients admitted by TBI from other origin, which also evolved to BD. To avoid the possibility of a bias, the compared groups had the same demographic characteristics.

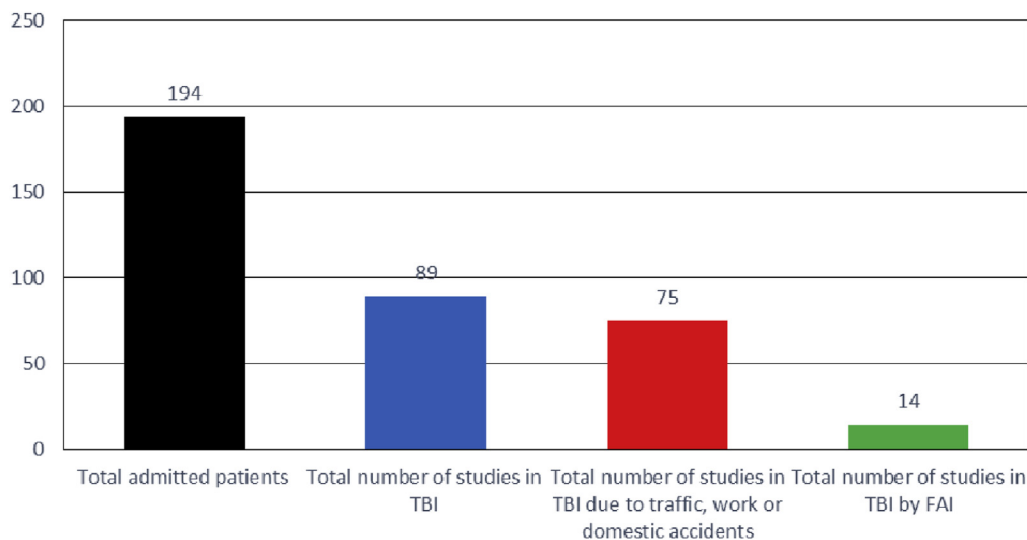
A retrospective study was performed, using descriptive statistical tests. Each group included 8 patients, with distribution analyzed by sex and age range; if they were donors or not, and, if not, the causes of discarding; and whether the donation was mono- or multiorgan. The time of the donor treatment prior to the ablation, transplanted organs, and reason for requesting TCD, with its most frequent patterns of cerebral circulatory arrest (CCA), were also analyzed; donor factors studied included prothrombin ratio, platelet count, and requirement of vasoactive drugs.

## RESULTS

During the study period, 194 patients were registered, and a total of 271 TCDs were performed in their follow-up. Of the total number of studies, 89 (33%) were performed in patients who were admitted for severe TBI, as follows: 75 were (28%) due to traffic, work, or domestic accident (this group included 3 patients to whom decompressive craniectomy was performed), and 14 studies (5%) were performed in individuals who suffered TBI by FAI (Fig 1).

The number of patients admitted for severe TBI of other causes was 67 (35%) of the total admittance. Of 33 (49%) cases that evolved to BD, the mean age was 38 years, with

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**Fig 1.** Distribution of studies in relation to the pathology of admission. Abbreviations: FAI, firearm injury; TBI, traumatic brain injury.

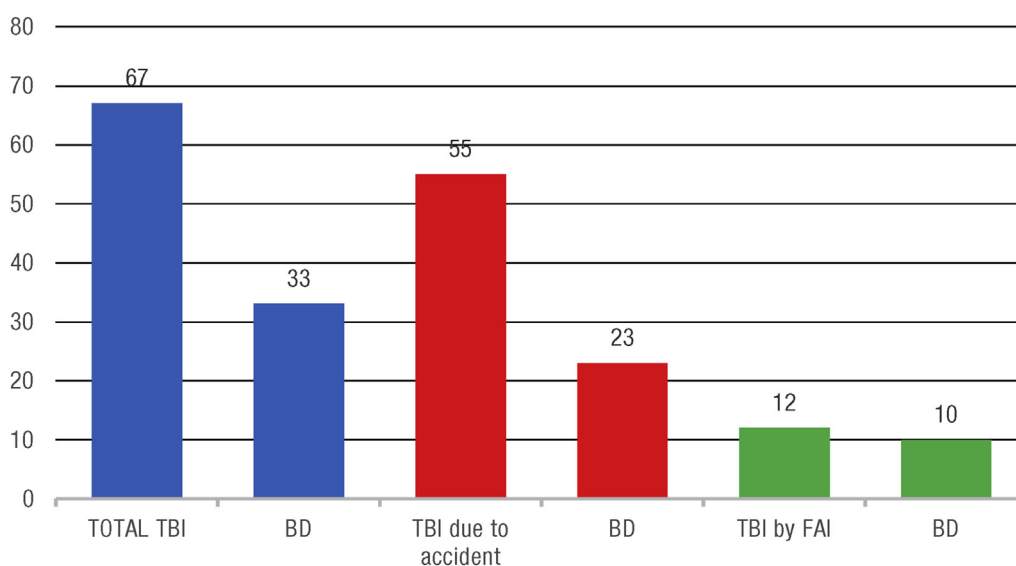
standard deviation of 25.5; there were 26 or 33 men (79%) and 7 women (21%). TBI due to accident (traffic, work, or domestic) accounted for 23 of 33 (70%) cases, and TBI by FAI, 10 of 33 (30%). Mortality in TBI by accident was 23 of 55 (42%), and in TBI by FAI, 10 of 12 (83%) (Fig 2). The total TCD was 89, which indicates that some patients required more than one study to diagnose CCA (15 in total).

We compared the 2 groups and analyzed their characteristics, integrating them in the following way. Group 1 consisted of patients admitted to ICU for TBI due to FAI, and included 8 members in total, as follows (Table 1): 7 men (87.5%), 1 woman (12.5%); mean age: 24 years, with a standard deviation of 7.21 and median of 23 years, ranging

from 15 to 39 years. Group 2 consisted of patients admitted to ICU for TBI due to accident (traffic, work, or domestic) and included 8 members in total, as follows: 6 men (75%), 2 women (25%); mean age: 27 years, with standard deviation of 7.42 and median of 25 years, ranging from 18 to 38 years.

Analysis showed that the demographic characteristics of each group (considering sex and age) were comparable, emphasizing the *t* test for equality of means, related to age, with a *P* = .389, indicating that there was no significant difference between the groups (Table 2).

Of the patients included in group 1, 6 (75%) were organ donors, 4 (50%) donating multiple organics and 2 (25%) donating a single. In the cases in which it was not possible to



**Fig 2.** Distribution of frequencies between pathologies and brain deaths. Abbreviations: BD, brain death; FAI, firearm injury; TBI, traumatic brain injury.

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