

Diagnostic Accuracy of D-Dimer Levels in Predicting Brain Injuries in Children with Head Trauma in Emergency Department

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ABSTRACT

Background: traumatic brain injury (TBI) is a leading cause of morbidity and mortality in children. The aim of this study was to evaluate the diagnostic accuracy of D-dimer levels for predicting brain injuries.

Method: This prospective clinical observational study was conducted in Imam Hossein hospital in 2011. Head injury in children aged 1 to 18 years were assessed in this study. Demographic and clinical data regarding the type and mechanism of injury, awareness, treatment, and conditions were registered. CT scans were performed to assess brain injury. D-dimer concentrations in blood were measured as well. Data was analyzed by SPSS software, version 20.

Results: A total of 127 patients participated in this study. Mean \pm SD age was 5.7 ± 8.7 years. The cut point for D-dimer was 0.029 mg/ml with 91% sensitivity and 86% specificity, and positive and negative predictive values were 78% and 59%, respectively. Significant correlation was observed between serum levels of D-dimer and CT lesion ($p < 0.5$) in a way that those patients who had traumatic brain injury also they had higher levels of D-dimer.

Conclusion: Negative D-dimer in children with head trauma can indicate the lack of brain damage. But given the serious consequences of brain injury due to lack of sensitivity and negative predictive value obtained in this study, routine measurement of D-dimer can not be a good alternative for emergency CT scan in patients at high risk of brain damage.

Keywords: D-dimer, head trauma, children, Brain Injury, Diagnosis

INTRODUCTION

The traumatic brain injury (TBI) is a leading cause of morbidity and mortality in children. In recent years according to the increasing knowledge about the neurocognitive and neuroeffective effects of traumatic brain injury, researchers were motivated to find new diagnostic methods for brain injury more. Currently, physical examinations, Glasgow coma scale (GCS) and brain computed tomography (CT) are methods for detection of traumatic brain injury of children(1-3).

CT scan led to considerable progress in the ability to recognize and manage pediatric trauma and is a useful diagnostic tool. However, due to the increasing use of CT scans there are increasing concerns about the risks of radiation received by the children. Currently it is estimated that the use of CT is the reason of 20 percent of cancers in the United States. Despite the high number of children who are exposed to CT radiation, it will be increased too. Due to the milder injuries, traumatic brain injuries are already in the field identified (4). Overlap of protocols are causing confusion in diagnosis and different guide lines that define light TBI and its diagnosis from other injuries with similar symbols and indication considerations of CT in Traumatic Brain Injury in children are not so valuable. The existence of one criteria or diagnostic biomarker that states TBI with fewer doubts should be considered and given the wide range of neurological and traumatic brain injury is very high negative predictive value (8-9). several studies indicate that it is essential to normal clotting tests associated with progressive brain injury, including ischemia, hemorrhage or cerebral edema (12). For example, D-dimer, which is the end product of the coagulation pathway and increases during TBI (14). The aim of this study was to evaluate the diagnostic accuracy of D-dimer levels to predict brain injuries.

METHOD

A Prospective observational study in Imam Hossein hospital during the months of January to March 1390 was performed. Children 1 to 18 years old, suffered head trauma and the highest AIS (abbreviated injury score)

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without measuring head trauma was at most 3, and more than 12 hours had passed since the incident involved in this study. Inclusion and exclusion criteria are listed in Table 1.

Table 1 - inclusion and exclusion criteria of the study.

Inclusion criteria

Age less than 18 years
Refer To hospital in less than 12 hours after the accident
AIS less than 3 without Calculation of head trauma

exclusion criteria

Age over 18 years
Coagulopathy

The use of anticoagulant
CT performed before the patient's death.
neurological disease.
Previous brain injuries
Existence of trauma in the chest, abdomen and extremities multi-system

All patients admitted to the emergency trauma center with head trauma were visited by trauma team and evaluated according to the common guidelines. Demographic data, vital signs, mechanism of injury, time from accidents and diseases through standardized questionnaires and interviews with the patient were collected; Patients with clinical suspicion of brain injury that Criteria had the need to do a CT scan, the CT scan was performed. CT scans were interpreted by the emergency physician and the presence of brain injury (subdural hemorrhage, epidural and subarachnoid hemorrhage, contusion and edema) were investigated. All scans by (SIEMENSE SOATOM emotion GERMANY) were performed with 5mm slices. For all patients D-dimer test was performed by ELISA. The data were analyzed using SPSS software 20. Sensitivity, specificity, positive and negative predictive value for D-dimer levels were determined.

RESULTS

A total of 138 subjects participated in the study. 85 patients (61.6%) were boys and 53 (38.4%) were girls. the mean±SD of the age of participants was 8.74 ± 5.74 . mechanism of trauma was as follow: 43 patients (31.2%) due to stumble, 21 patients (15.2%) fall from a height , 36 cases (26.1%) due to direct trauma, and 38 (27.5%) patients due to accident. 110 patients had a lesion on CT scan (79.7%) and in 28 patients the lesions were detected on CT scan (18.8%).Table 2 shows the demographic and clinical information of the patients.

Table 2: Demographic and clinical data

Variable		n(%)
sex	Boys	85(61.6)
	Girls	53(38.4)
age		8.7±5.7
Mechanism of trauma	Stumble	43(31.2)
	Fall	21(15.2)
	Accident	38(26.1)
	direct trauma	36(27.5)
CT loss	linear fracture	14(10.1)
	EDH	4(2.9)
	SDH	2(1.4)
	ICH	2(1.4)
	SAH	5(3.6)
Consciousness	Conscious	113(81.9)
	Confused	20(14.5)
	Coma	3(2.2)
D-dimer level		0.52±0.92
Final condition	Discharged	116(84.1)
	Hospitalized	19(13.8)
	Death	3(2.2)

EDH: epidural hematoma, SDH: subdural hematoma, ICH: intracranial hematoma, SAH: subarachnoid hematoma. Statistical analysis indicated that age and duration of phlebotomy of trauma in D-dimer levels were not effective. In 28 patients, lesions were seen on CT in 22 patients with positive D-dimer level (True positive) and 6 persons had a

D-dimer in the normal level (False negative), respectively. Figure 1 shows the Roc curve of blood levels of D-dimer. In order to accurately assess blood levels of D-dimer in prediction of traumatic brain injury is drawn. The best cutoff point with the highest sensitivity and specificity were calculated 0.029 mg/ml. Sensitivity and specificity were 32% and 91%, respectively. Significant correlation was observed between serum levels of D-dimer and CT lesion ($p < 0.5$).

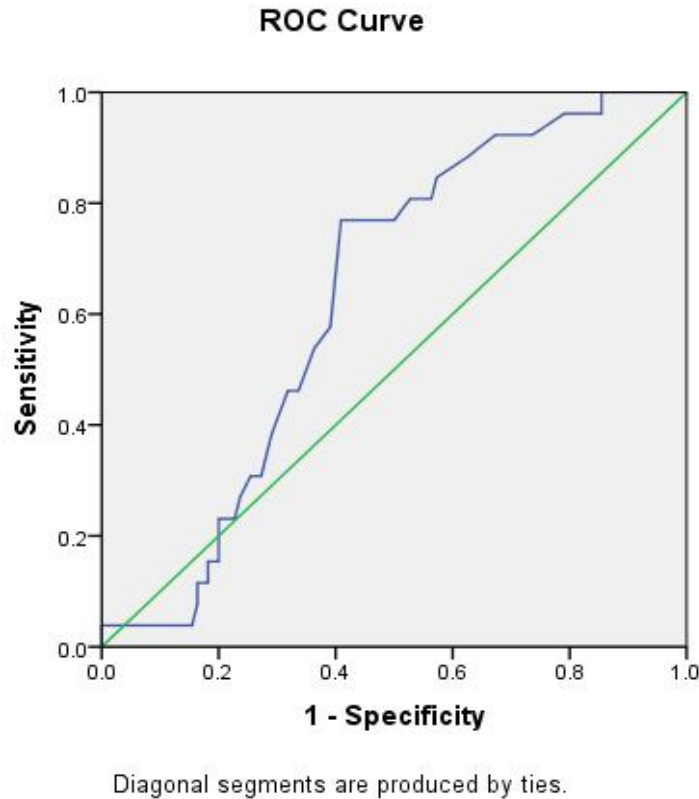


Figure 1 - ROC curve for blood levels of D-dimer to predict brain injury

Six patients had negative D-dimer and abnormal CT, 4 persons from these patients had linear fx. two of them were discharged after neurosurgery visit in emergency department without any problem. The follow up after two months after discharge showed that they did not have any complications. the two other patients with the linear fracture were respectively a three year old boy suffered head trauma and was dropped from a height of 15 meters. Nausea and confusion, and left parietal fracture were seen on a CT scan of his brain. Another 4-year-old girl who was looking down from the second step was to develop isolated trauma and she had nausea and vomiting several times in the emergency department and CT scan of the brain showed a fracture line Temporo-parietal area. These two patients were hospitalized and were monitored in neurosurgery unit. Without the need for special measures and were discharged after a few days with no adverse effects were followed. The third patient had an abnormal D-dimer negative CT: 5-year-old boy who suffered serious head trauma and was looking for a physical confrontation. The patient was referred to a decreased level of consciousness (GCS: 6/15). Brain CT scan revealed he had SDH. The patient was taken to the operating room for craniotomy. D-dimer level (4 h after trauma) was 0.027. The patient was admitted to ICU for a week and after this period has expired. D-dimer was measured again after 12 hours of positive cases was 0.11. The next patient was a 17-year-old girl suffered head trauma and was in a car crash. Admission in nausea, vomiting and loss of consciousness was much confusion. His brain CT scan shows small epidural hematoma in the parietal region.

The patient was admitted to the neurosurgery unit. Her D-dimer was 0.019 (5 hours after trauma). The repeated D-dimer test of this patient was negative again (0.013 mg/ml) and subsequent hematoma rate was not

increased. the patient didn't require to surgical intervention and was discharged after 6 days. At follow-up the patient had no other complaints except for occasional headaches.

DISCUSSION

The study indicated that D-Dimer level can be considered as a helpful factor in consideration of children suffering from head trauma. D-dimer is a degradation product of fibrin which shows the activation of coagulation for producing fibrin and degradation by plasmin which could be due to the activity of brain cells damage and release of traumoblasin or other factors(14,15). D-dimer as a predictive factor for traumatic brain injuries coagulation in children with head trauma injury in the emergency department. Currently it is estimated that the use of CT causes a significant percentage of cancer incidences in the United States and it on growing Due to the increasing use of CT in children in the future and there are a lot of concerns about the risks of radiation received by the children(4-5). Many studies indicate abnormal coagulation in patients with progressive brain damage (12). The specificity of D-dimer for the diagnosis of traumatic brain injury was 59% (CI:95%) and negative predictive value was estimated 91% (CI :%95). Although according to the results of the study there was a high probability of brain injuries in patients with higher amounts D-dimer, so that the sensitivity and specificity of D-dimer test should be closed to 100 percent if it would be used as a safe screening tools in TBI in children and decrease the CT scans.

It is resulted from the finding of this study that the use of this test for routine screening is not recommended in children with head trauma. The main concern is that we do not exclude the CT diagnosis of severe injury and it might lead to life-threatening events. There are 6 patients in our study had abnormal D-dimer negative and CT scan was done for them. 4 patients had a linear fracture in CT findings and there were no complications and no need for surgical intervention. One of the sub-dural hematoma CT scan of the patient was initially admitted with severe loss of consciousness and eventually died. D-dimer of these patients was measured 4 hours after trauma. Another patient had a parietal epidural hematoma, persistent nausea and vomiting in the emergency department with confusion and decreased level of consciousness. The causes of negative D-dimer could be related to Errors in sampling or sample preparation. There is a broader range of normal D-dimer levels in children due to the evolution of the coagulation system although there wasn't significant difference between D-dimer levels and age.

Limitations:

Patients enrolled in our study had isolated head injury and AIS with 3 and head injury patients so that The results of the study may not be generalized to patients with multiple trauma.

Standardization of D-dimer test in different centers is not isn't applicable with a variety of current measurement methods and results of laboratory tests would be have significant differences in sensitivity. In this study the effect of interval time after trauma on D-dimer level and brain injuries wasn't measured.

Conclusion

In children with head trauma and those who need to have a CT scan, but there is a low pre-test probability for brain injury, negative D-dimer could indicate a lack of brain injury and as a result of the CT scan in this particular group is decreased. But given the serious consequences due to lack of serious brain injuries diagnosis because of the low sensitivity of D-dimer test, the routine measurement of D-dimer can not be a good alternative test in Emergency department instead of CT Scans in patients with high probability of brain injuries.

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