

Brain computed tomography in patients with syncope

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ABSTRACT

الأهداف: تحديد فعالية استعمال التصوير الطبقي المحوري للدماغ كأداة تشخيص فعالة في حالات المرضى الذين يعانون من الإصابة بالإغماء.

الطريقة: خلال الفترة من مارس 2006 حتى أبريل 2008م بلغ عدد المرضى المصابون بحالة الإغماء والذين راجعوا قسم الطوارئ 292 مريض - مركز الملك حسين الطبي - عمان - الأردن. تم فحص جميع المرضى من قبل أطباء الأعصاب وإجراء التصوير الطبقي المحوري. و صنف المرضى إلى 4 مجموعات وفقاً لنتائج التصوير الطبقي المحوري والفحص السريري للأعصاب.

النتائج: أجرى التصوير الطبقي للدماغ 254 (86.9%) مريض من أصل 292، كما تم استبعاد 38 مريض (13%). اشتملت المجموعة الأولى على 203 مريض (79.9%) الذين كانت لديهم نتيجة تصوير الدماغ طبيعية و نتائج الفحوصات طبيعية. اشتملت المجموعة الثانية على 10 مريض (3.9%) كانت لديهم صورة الدماغ غير طبيعية، مع وجود نتائج ذات صلة بحالة الإغماء ولديهم أيضاً الفحص العصبي غير طبيعي. اشتملت المجموعة الثالثة على 39 مريض (15.3%) كان لديهم صورة الدماغ غير طبيعية مع نتائج ليس لها علاقة بحالة الإغماء أو الفحص العصبي الطبيعي أو غير الطبيعي الذي ليس له علاقة، بنتائج تصوير الدماغ غير طبيعية، و نوبات الإغماء، و اشتملت المجموعة الأخيرة على 2 مريض (0.7%) لديهم صورة الدماغ غير طبيعية و نتائج الفحص السريري للأعصاب طبيعية.

خاتمة: إن استعمال التصوير الطبقي المحوري للدماغ كأداة تشخيص روتيني على المرضى الذين يعانون من حالات الإغماء هو غير موضوعي و مجرد إلا في حالة أن هؤلاء المرضى لديهم مؤشرات لتاريخ مرضي أو الاختبارات العصبية لديهم غير طبيعية.

Objective: To determine the use of brain CT as a routine diagnostic tool in patients presenting with syncope.

Methods: From March 2006 to April 2008, 292 patients presented with a history of transient loss of consciousness to the emergency department at the King Hussein Medical Center, Amman, Jordan. A neurologist examined all investigated patients and brain scans were obtained. Patients

were classified into 4 groups according to brain scan findings and their neurological examination.

Results: Out of the 292 patients, 254 (86.9%) patients underwent brain scan, 38 (13%) patients were excluded. The first group included 203 (79.9%) patients, who had normal brain scan, and normal neurological examination. The second group included 10 (3.9%) patients all of which had abnormal brain CT scan findings related to their syncope, and also had abnormal neurological examination. The abnormal neurological findings can be attributed to their syncopal episode and abnormal brain CT findings. Classified into 3 groups based on their brain CT findings and their neurological examination on presentation. The third group included 39 (15.3%) patients who had abnormal brain scan with findings not related to their syncope and either normal or abnormal neurological examination not related and cannot be attributed to the abnormal head CT findings and their syncopal episode. The last group had 2 patients (0.7%) with abnormal scan and normal neurological examination.

Conclusion: The use of brain scan as a routine diagnostic tool in patients with syncope is unjustifiable, unless there is an indication in the history or physical examination.

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In the evaluation of patients with syncope, a multidisciplinary approach in the emergency department (ED) is not only helpful but it is very important for diagnosis and management, as evident by the numerous causes of syncope that require the attention of ED physicians.¹ It is important to identify patients with true syncope and exclude patients with other conditions that can reduce the level of consciousness for many reasons (acute mental status changes in intoxicated

patients) as these are not true syncope. Several studies have classified causes of syncope into 3 categories; cardiac, non-cardiac (including neurological causes), and unknown causes.² In cases where the cause of syncope is not clear even after a complete clinical examination, laboratory testing, and neurological imaging are often performed.³ In the United States, syncope is one of the most common causes of presentation to the ED.⁴ It accounts for up to 3% of ED visits and between 1-6% of all hospital admissions.⁵ It is also an indicator of reduced survival rate among older adults.⁶ In Jordan, we do not have statistics on what percentage syncope accounts for ED visits. Syncope may be defined as sudden loss of consciousness, associated with a decrease in cerebral blood flow from which the patient fully recovers without the need for resuscitation or medical treatment.⁷ Causes of syncope are multiple, and patients are often subjected to many diagnostic tests and hospitalizations.⁸ Detailed clinical examination is an essential part of the work-up of patients with syncope to establish the diagnosis, cause of syncope, or guide the physicians to a specific strategy in the evaluation and management of these patients.⁹ In our hospital we noticed that ED physicians frequently performed CT scan for patients with syncope regardless of their neurological examination (normal or abnormal). However, current guidelines do not recommend obtaining a brain CT for patients presenting with syncope, unless there is a justifying indication in the history and physical examination.¹⁰ The aim of our study was to evaluate the value of using brain CT as a routine diagnostic tool in the evaluation of patients presenting with true syncope to the emergency department, regardless of their neurological examination.

Methods. This prospective study was carried out between March 2006 and April 2008 at the King Hussein Medical Center (KHMC), Amman, Jordan. The hospital's ethical committee approved the study, and all patients gave their consent for inclusion in the study. Our study includes patients that presented to the ED with syncope with selection criteria based on presence of true syncope in the attending patients. True syncope was identified by the ED physicians from other conditions that can, for many reasons, cause a reduced level of consciousness. Patients with history of trauma, known to have brain tumor, epilepsy, psychiatric illnesses, seizures, acute mental status changes due to intoxication, and patients with metabolic causes of syncope (hypoglycemia, hyperventilation, psychiatric causes) were excluded. Pediatric patients were not enrolled in this study, as all pediatric patients were evaluated at the children's emergency clinic. For all patients, the following information was obtained and analyzed: age and gender, history of diabetes, or

hypertension, cardiac, neurological, psychiatric, and pulmonary diseases. Detailed physical examination was carried out. All patients underwent various investigations, including: baseline laboratory tests (complete blood cell count, electrolytes, serum urea nitrogen, creatinine, and glucose blood level), chest radiography, 12-lead electrocardiogram, electroencephalography, and carotid Doppler ultrasonography, with or without intravenous injection of contrast media (non ionic contrast) according to the CT scan features (if clinically indicated, such as in patients with known carotid atherosclerotic disease). A brain CT scan was performed using the adult protocol of 5 mm slice thickness by GE Light Speed Plus machine (GE Healthcare, CT, USA), with or without intravenous injection of contrast media (non-ionic contrast), according to the CT scan features.

All CT scans were reviewed by a radiology specialist (shortage of staff) and all patients examined by a neurologist. Results of the CT scans were recorded and analyzed. The patients were categorized into 4 groups according to head CT scan findings and their neurological examination. The CT scan findings were classified into normal brain scan and abnormal CT scan. The CT scan was considered normal if there was no focal brain lesion, no shift of midline structures, no intra- or extra-axial brain hemorrhage, and normal gray white matter differentiation. The CT was considered abnormal, if there was any intracranial hemorrhage (epidural, subdural, subarachnoid, or intraparenchymal), intracranial space-occupying lesion with mass effect (brain abscess, tumor, granulomas) and ischemic changes. The analysis of brain CT scan findings was based on the assessment of the ability of these radiological findings to explain patients' abnormal neurological examination or identify the cause of their syncope. The patients were classified into 2 groups: patients with normal and abnormal neurological examination. Patients were classified according to CT scan findings, and these findings were correlated with their neurological examination. The first group included patients with a normal neurological examination and normal head CT scan. The second group included patients with abnormal neurological examination, and abnormal head CT scan, where the neurological findings could be attributed to the abnormal head CT findings and syncopal presentation. The third group included patients with abnormal head CT and either normal neurological examination or abnormal neurological examination, which is not related, and could not be attributed to the abnormal head CT findings and syncopal episode. The last group had an abnormal scan and normal neurological examination. The neurological examination was considered normal if there were no focal neurological deficit recorded on the admission

physical examination, and neurological examination or any signs suggestive of true syncope (neurological assessment included evaluation of cranial nerves, gait, mental state, muscle tone, postural reactions, sensory perceptivity, spinal and visceral function, while the neurological deficit indicated defect or absence of a peripheral nerve or system).

The patients were also categorized into 3 groups according to the cause of syncope. The first group included patients with cardiac causes, the second group included patients with non-cardiac identified causes (including neurological causes), and the third group included patients with no identifiable cause for syncope. The approach to the patient with syncope begins with a meticulous medical history. In most patients, the cause of syncope can be determined from the history and the physician's examination alone. Measuring blood pressure and pulse rate in the upper and lower extremities in the supine and upright positions can identify orthostatic hypotension and autonomic dysfunction. A 12-lead ECG and lab tests for a basic metabolic panel and complete blood count should be performed in all patients with syncope. Patients with abnormal neurological examination and normal CT scan patients were referred to the neurology clinic for further investigations.

Results. Two hundred and ninety-two patients with syncope presented to the ED at KHMC, with a history of a brief episode of loss of consciousness. The diagnosis of true syncope was identified in 254 (86.9%) patients and these patients were enrolled in the study. Patients included 134 (52.7%) males and 120 (47.2%) females with a mean age of 62 ± 27 years (range: 32-73 years). Patients were examined for the cause of syncope as summarized in Figure 1. Non-cardiac causes of syncope included vasovagal in 68 patients, neurological in 49 patients, and metabolic causes in 30 patients, 20 of which presented due to hypoglycemia and the rest (10 patients) presented due to hyperventilation. Patients that presented to the ED with syncopal episodes underwent many diagnostic tests, and the diagnostic protocol was performed to classify the patients according to the cause of their syncope. These investigations are summarized in Table 1. We noticed that routine chest x-ray was frequently performed for patients with syncope and showed no abnormal findings in 246 (96.9%) patients, and was positive in 47 patients (19.1%). Twenty patients out of 67 patients who had cardiac causes had normal ECG. Two hundred patients out of 254 had 2 or more previous episodes of syncope, and 54 patients experienced the syncopal episode for the first time. One hundred and four patients had a medical history of hypertension and cardiac problems, 120 patients

Table 1 - Investigations requested for patients presenting with syncope at the emergency department.

Type of investigation	n	(%)
Chest x-ray	246	(96.9)
Electrocardiography	239	(94.1)
Brain computed tomography scan	221	(87.0)
Basic blood analysis	239	(94.1)
Carotid Doppler ultrasound	76	(29.9)
Electroencephalography	33	(13.0)
Total patients	254	(100)

had a history of diabetes mellitus, and 30 patients had miscellaneous diseases.

For all investigated patients, 254 (87%) underwent head CT scan, and 38 patients were excluded as they did not have a true syncopal episode according to our diagnostic criteria. The results of the head CT are summarized in Figure 2. Two hundred and three patients had normal CT with normal neurological exam. Ten patients had abnormal head CT scan with CT findings related to the syncope episode, and abnormal neurological examination; 2 patients had brain tumor, 3 patients had intra-parenchymal hemorrhage, one patient had subarachnoid hemorrhage, and 4 patients had cerebral ischemia. The third group of patients included 39 patients who had abnormal head CT scan findings, which were not related to their syncopal episode, and had either normal or abnormal neurological examination. The last group included 2 patients with abnormal CT

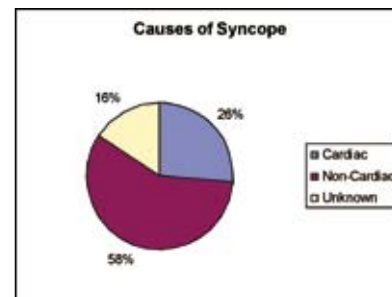


Figure 1 - Causes of syncope.

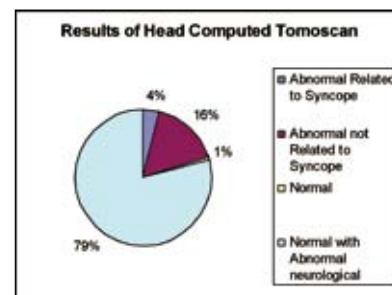


Figure 2 - Results of head CT scan.

scan and normal neurological examination. These CT scan abnormalities included: peri-ventricular white matter changes due to small vessel ischemia in 14 patients, 12 patients had cerebral atrophy, 5 patients had chronic left middle cerebral artery infarction, pineal gland cyst was found in 2 patients, and small temporal arachnoid cyst in one patient. Seven patients presented with chronic lacunar infarct, 2 patients were found with normal neurological examination and abnormal CT scan examination.

Discussion. Emergency physicians frequently admit syncope patients to the hospital after a non-diagnostic ED evaluation because they believe that further investigation may elucidate a cause for the syncope.¹¹ Syncope is a common problem in the general population.¹² There are many possible causes, and a variety of conditions that can cause a reduced level of consciousness resembling true syncope. These conditions included patients who had stroke, brain tumors, subarachnoid hemorrhage, history of trauma, seizures, hypoglycemia, hyperventilation (due to metabolic causes of syncope.) The ED physicians should be able to differentiate these conditions from true syncope.

Reviewing the literature we found that there are 4 criteria that should be met in order for an event to be considered true syncope, these criteria include: short period, self-limited spontaneous and full recovery, and early and rapid onset. Our results show that a normal brain CT scan is not a reliable diagnostic tool in patients presenting with syncope, even in patients who have abnormal neurological examination. Chest radiography is also a poor diagnostic indicator for these patients. Only 2 patients out of 254 in the last group had an abnormal CT scan and normal neurological examination. Investigations are often obtained to determine the etiology of syncope when the clinical examination does not provide an underlying cause. The attending physicians should always strive to achieve a certain or highly suggestive diagnosis, and determine the cause of syncope, so patients can be treated properly and accordingly. However, patients with undetermined causes of syncope need further work-up aimed at the suspected cause.¹³

Our study was designed to optimize the work-up of syncope, minimize the use of unnecessary head CT examinations in patients with syncope who had normal neurological examination, avoiding excessive testing that can cause over-utilization of medical resources. Unfortunately, brain CT scan is one of the most frequent investigations requested, and the most overused in our ED department for evaluation of patients with syncope. Similar studies in the literature confirmed that the use of abundant additional testing

should be avoided in most patients with syncope, and good clinical evaluation is of paramount importance for optimal in-emergency management, diagnostic choices, and therapeutic decisions.¹⁴ On literature review, 13 articles published on this subject classified diagnostic modalities used in syncope patients into 3 groups: helpful, not helpful, or of unclear value.¹⁵ Brain CT scan was classified to be not helpful, unless the cause was neurological seizures.¹⁶ The American College of Emergency Physicians issued guidelines for treatment of syncope and determined what diagnostic testing data should be performed for patients with syncope, one of these recommendations was: echocardiography, cranial CT scanning, and other laboratory testing and advanced investigative testing should not be performed routinely in the absence of specific findings in the history or physical examination.¹⁷

The results of our study also confirmed that brain imaging is unlikely to be abnormal in patients who had no neurological deficit or any evidence of certain or suspected neurological disease. Only 10% of the patients who underwent head CT examination were found to have abnormal head CT scan findings, which were related or can be attributed to their abnormal neurological examination findings and syncopal episode. Physicians should consider that only absence or presence of neurological symptoms can be a justifiable indication to perform brain CT scan or not, to rule out stroke, acute hydrocephalus, and structural causes that might be the cause for seizures and syncope (like tumors), so there is no need for patients presenting with syncope to undergo brain CT scan routinely, unless indicated.

Limitations of our study include the follow up of patients presenting to the ED, especially attending patients with cardiac problems, who need head up tilt table testing and prolonged ECG monitoring (including Holter monitoring, trans-telephonic monitoring, and implantable loop recording) in the cardiac center. We could not also report the prevalence of syncopal episode in the pediatric age group, as they are evaluated in the children's clinic.

In conclusion, the evaluation of patients presenting to the emergency department with syncope is often a challenging task. Physicians must determine the possible etiology and most probable causes of syncope, and determine which patients are eligible for brain CT scan and other diagnostic tests to avoid unnecessary investigations that can increase overall healthcare cost. Further studies are required on a larger population in order to better understand the differences between true syncope and other conditions causing decreased levels of consciousness, and to describe a uniform strategy for evaluation of syncope in every day practice.

References

- Blanc JJ, L'her C, Gosselin G, Cornily JC, Fatemi M. Prospective evaluation of an educational programme for physicians involved in the management of syncope. *Eurpace* 2005; 7: 400-406.
- Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ, et al. Incidence and prognosis of syncope. *N Engl J Med* 2002; 347: 878-885.
- Giglio P, Bednarczyk EM, Weiss K, Bakshi R. Syncope and head CT scans in the emergency department. *Emerg Radiol* 2005; 12: 44-46.
- Shen WK, Decker WW, Smars PA, Goyal DG, Walker AE, Hodge DO, et al. Syncope Evaluation in the Emergency Department Study (SEEDS): a multidisciplinary approach to syncope management. *Circulation* 2004; 110: 3636-3645.
- Elesber AA, Decker WW, Smars PA, Hodge DO, Shen WK; American College of Emergency Physicians. Impact of the application of the American College of Emergency Physicians recommendations for the admission of patients with syncope on a retrospectively studied population presenting to the emergency department. *Am Heart J* 2005; 149: 826-831.
- Costantino G, Perego F, Dipaola F, Borella M, Galli A, Cantoni G. Short- and long-term prognosis of syncope, risk factors, and role of hospital admission: results from the STePS (Short-Term Prognosis of Syncope) study. *J Am Coll Cardiol* 2008; 51: 276-283.
- Crane SD. Risk stratification of patients with syncope in an accident and emergency department. *Emerg Med J* 2002; 19: 23-27.
- Oh JH, Hanusa BH, Kapoor WN. Do symptoms predict cardiac arrhythmias and mortality in patients with syncope? *Arch Intern Med* 1999; 159: 375-380.
- Goyal N, Donnino MW, Vachhani R, Bajwa R, Ahmad T, Otero R. The utility of head computed tomography in the emergency department evaluation of syncope. *Intern Emerg Med* 2006; 1: 148-150.
- Alboni P, Brignole M, Menozzi C, Raviele A, Del Rosso A, Dinelli M. Diagnostic value of history in patients with syncope with or without heart disease. *Am Coll Cardiol* 2001; 37: 1921-1928.
- Morag RM, Murdock LF, Khan ZA, Heller MJ, Brenner BE. Do patients with negative emergency department evaluation require hospital admission? *J Emerg Med* 2004; 27: 339-343.
- Brignole M, Ungar A, Bartoletti A, Ponassi I, Lagi A, Mussi C, et al. Standardized-care pathway vs. usual management of syncope patients presenting as emergencies at general hospitals. *Eurpace* 2006; 8: 644-650.
- van Dijk N, Boer KR, Colman N, Bakker A, Stam J, van Grieken JJ, et al. High diagnostic yield and accuracy of history, physical examination, and ECG in patients with transient loss of consciousness in FAST: the Fainting Assessment study. *J Cardiovasc Electrophysiol* 2008; 19: 48-55.
- Lamarre-Cliche M. Syncope in Older Adults. *Geriatrics and Ageing* 2007; 10: 236-240.
- Jhanjee R, van Dijk JG, Sakaguchi S, Benditt DG. Syncope in adults: terminology, classification, and diagnostic strategy. *Pacing Clin Electrophysiol* 2006; 29: 1160-1169.
- Reed MJ, Gray A. Collapse query cause: the management of adult syncope in the emergency department. *Emerg Med J* 2006; 23: 589-594.
- Huff JS, Decker WW, Quinn JV, Perron AD, Napoli AM, Peeters S, et al. Clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with syncope. *Ann Emerg Med* 2007; 49: 431-444.

ETHICAL CONSENT

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed. Research papers not involving human or animal studies should also include a statement that approval/no objection for the study protocol was obtained from the institutional review board, or research ethics committee.