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**Diagnostic yield of neuroimaging in syncope patients without high-risk symptoms
indicating neurological syncope**

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Running Head: Yield of neuroimaging in syncope

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Introduction:

Syncope is defined as a sudden loss of consciousness with an inability to maintain postural tone, which results in quick and spontaneous recovery. It is considered to be caused by cerebral hypoperfusion (1-3). It is important to differentiate syncope from other causes of loss of consciousness, such as seizures and hypoglycemia (2).

The overall prevalence of syncope in the general population is considerably high. In a study in which 7814 patients were followed-up for 17 years, 10.5% of the patients had at least one episode of syncope (4). In another study, 19% of the patients had at least one episode of syncope (5). Syncope may occur as a result of vasovagal (21%), cardiac (10%), orthostatic (9%), medication-related (7%), neurological (4%) or idiopathic (37%) causes (4).

In some patients, syncope may result in head trauma. Most head traumas caused by syncope are in the form of a mild head trauma, and thus, traumatic brain injury is not expected (3,6). Mild head trauma is defined as a head trauma without serious injury, in which the Glasgow Coma Scale (GCS) score is 14 or 15 (6,7).

Detailed neuroimaging is often performed in patients with syncope, even if the patient has no neurological findings (3). Though not routinely recommended, neuroimaging studies are increasingly being used (1). However, this may lead to negative consequences such as radiation exposure, high costs, and increased length-of-stay in the ED. Therefore, there is a need for clinical trials which investigate the efficacy of diagnostic tests according to risk groups in patients with syncope (3). This study aimed to determine the diagnostic yield of neuroimaging tests in syncope patients without high-risk symptoms indicating neurological syncope.

Materials and Methods:

This retrospective study was conducted in the ED of an urban, tertiary care academic medical center which receives approximately 180,000 visits annually. Ethics committee approval was obtained prior to the study.

The electronic medical record system was accessed to identify patients older than 18 years who presented to the ED with syncope between January 1, 2016, and December 31, 2016. All electronic and paper medical records of the patients were reviewed. Patients who suffered a mild head trauma due to syncope were also included. Mild head trauma was defined as a head trauma with a GCS score of 14 or 15.

Patients with neurological examination findings (confusion, amnesia, focal neurological deficit, severe headache, dizziness, nausea and vomiting), patients on anticoagulant medication, patients with known intracranial malignancies, and patients who were diagnosed with seizure, hypoglycemia, alcohol or substance abuse and pseudosyncope were excluded from the study. In these patients, loss of consciousness was attributed to neurological causes or to reasons other than syncope.

The demographic data, physical examination findings, neuroimaging results and patient outcomes were recorded. A positive neuroimaging result was defined as the presence of one or more of the following: intracranial hemorrhage, mass, ischemia, contusion, edema, hydrocephalus or skull fracture.

Statistical Analysis: All statistical analyses were performed using the IBM[®] SPSS 24.0 statistical software package. Categorical variables were expressed as the number of observations and percentages. Qualitative data were analyzed using the chi-square test. Quantitative data were expressed as median and interquartile range (IQR) values. All

statistical analyses were performed at a 95% confidence interval. A p-value less than 0.05 was considered statistically significant.

Results:

The number of patients who presented to the ED with syncope within the study period was 1193. This constituted 0.7% of all ED visits. A total of 79 patients were excluded from the study. Patients with neurological symptoms (n=27), pseudosyncope (n=20), hypoglycemia (n=6), seizures (n=7), intracranial malignancies (n=2), patients on anticoagulants (n=8), and patients with alcohol or substance abuse (n=9) were excluded.

As a result, 1114 patients who met the inclusion criteria were included in the study. The median age was 48 years (IQR=34-66 years) and 576 (51.7%) of the patients were male. The distribution of patients according to gender and age is presented in Table 1.

Of the patients included, 694 (62.3%) had undergone cranial computerized tomography (CT) and 114 (10.2%) had undergone magnetic resonance imaging (MRI). All patients who had undergone MRI had also been assessed by a CT scan priorly. Syncope-related mild head trauma was observed in 116 (10.4%) patients. All patients with mild head trauma had undergone cranial CT; 16 of these were also evaluated with MRI. None of the neuroimaging studies had revealed any clinically significant findings.

The clinical features of syncope patients with probable neurological syncope are listed in Table 2. Neuroimaging studies were not found to be beneficial in patients without these features ($p<0.001$).

A total of 15 patients (1.3%) were hospitalized due to syncope-related reasons. One patient was admitted to the neurology ward with a presumptive diagnosis of transient ischemic attack. The definitive diagnoses of the remaining patients were cardiac dysrhythmia

(n=4), acute myocardial infarction (n=2), dehydration (n=3), anemia (n=2), pneumonia (n=2) and gastrointestinal bleeding (n=1). The remaining patients were referred to the outpatient clinic for further investigation.

Discussion:

Syncope is an important presenting complaint in the ED, and it accounts for about 0.7-1.4% of ED visits (1,8,9). In our study, syncope accounted for 0.7% of all ED visits. Given the diverse etiological spectrum of syncope, physicians sometimes have difficulty deciding which tests to order for the differential diagnosis. This leads to an unnecessary use of numerous diagnostic tests (3).

In the literature, routine neuroimaging is not recommended for patients who present to the ED with syncope (3). However, there has been an increase in the utilization of neuroimaging studies in the recent years. In a large-scale study, it was found that the neuroimaging rates in patients with syncope increased from 20.9% in 2001 to 44.6% in 2010 (1). This substantial increase may stem from the fear of misdiagnosis as well as medicolegal concerns. Therefore, it is important to identify which syncope patients will not benefit from neuroimaging. In our study, neuroimaging tests were not found to be beneficial for the selected patient group.

In the 2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients with Syncope, it was stated that even though 57% of patients with syncope underwent cranial CT, imaging only 1% had positive findings in their CT scans (3). Likewise, it was reported that 11% of patients with syncope underwent MRI, and that only 0.2% of the MRI scans revealed positive findings (3).

In our study evaluating patients without high-risk symptoms, 62.3% of the patients underwent cranial CT and 10.2% underwent MRI. None of the scans revealed any clinically significant findings, even if the patient had suffered a mild head trauma. Among patients who were hospitalized, only one patient was admitted to the hospital due to a neurological cause, namely transient ischemic attack. This emphasizes the importance of obtaining a detailed history from patients with syncope.

The prevalence of syncope in patients older than 45 years was found to be higher in females compared to males (22% versus 15%) (5). In our study, there was no statistically significant difference between patients with syncope in terms of gender (51.7% male and 48.3% female). However, in the 56-75 years age group, the proportion of males was significantly higher compared to females (69% versus 31%).

Limitations: The main limitations of the study are that it is single-centered and retrospective. The fact that the research was carried out in a comprehensive center and the facilities in obtaining the required data have reduced these limitations.

Conclusion: Neuroimaging should not be a routine procedure in the management of patients with syncope in the ED. In patients whose medical history and physical examination findings do not indicate neurogenic syncope, neuroimaging studies are not beneficial, even if the patient has mild head trauma.

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Tables

Table 1. Distribution of patients with syncope according to gender and age.

Age Group	Male n (%)	Female n (%)	Total n (%)
18-35 years	168 (51.5%)	158 (48.5%)	326 (100.0%)
36-55 years	146 (41.0%)	210 (59.0%)	356 (100.0%)
56-75 years	200 (69.0%)	90 (31.0%)	290 (100.0%)
>75 years	62 (43.7%)	80 (56.3%)	142 (100.0%)
Total	576 (51.7%)	538 (48.3%)	1114 (100.0%)

Table 2. Clinical features of patients with probable neurological syncope.

Confusion	Nausea and vomiting
Amnesia	Signs of serious head injury
Focal neurological deficit	Intracranial malignancies
Dizziness	Use of anticoagulant drugs
Severe headache	