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The role of ultrasound in the visualization of the ingested medications in acute poisoning – a literature review

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Abstract. – In the patients with medication poisoning, diagnosis and treatment may be complicated due to the decreased level of consciousness or lack of the patient cooperation. In this review, we tried to assess the role of ultrasonography in detection of the ingested medication in the stomach of the patients with suspected medication poisoning. Of the studies performed in this regard, only one managed to determine the extended phenytoin capsules in the stomach of a poisoned patient. In actual acute poisoning – even in the hands of an experienced ultrasonographer – detection of the medications in the patients' stomach seems to be difficult due to the presence of the food or lack of the water in their stomach. Also, after dissolution of the tablets or capsules or their passage from the pylorus, they can not further been visualized by ultrasound. We, therefore, conclude that ultrasonography is not an appropriate tool for diagnosis of the medication ingestion in acute poisoning.

Key Words:
Poisoning, Overdose, Pills, Capsules, Visualization, Ultrasonography.

Introduction

In cases of medication poisoning, the patients may be in comatose status or may not be cooperative (e.g. children) and, therefore, diagnosis and treatment may be complicated. Since the most common form of medication overdose involves ingested medications, visualization of the tablets or capsules in the stomach may be helpful in the diagnosis of the overdose with medications. Nowadays, bedside portable ultrasonography is usually available in every Emergency Medicine Department and has many applications such as detection of the gall bladder diseases, trauma evaluation, pregnancy, etc[1]. The results of ultrasonography can be immediately interpreted enhancing rapid response, which is critical in a patient in an unstable condition such as after a suspected acute poisoning. Whether or not this technique can be used as a diagnostic tool in the cases with suspected poisoning is an issue that has not previously been fully studied. In this review, we, therefore, tried to evaluate the role of ultrasonography in detection of the ingested medications in the stomach of the patients with suspected medication overdose.

Search Strategy and Selection Criteria

This search strategy aimed at recovering documents describing visualization or detection of the ingested medications in acute poisoning by ultrasonography. Articles were identified by searching through PubMed, ISI Web of Knowledge, Google scholar, EMBASE, and Scopus using various combinations of terms including "ultrasound", "bedside ultrasonography", "visualization", "detection", "ingested", "tablets", "drug", "pill", "capsule", "medications", "poisoning", "toxicity", "overdose", "gastrointestinal tract", "stomach", "abdominal", and "gastric". Research papers and case reports were retrieved. Additional articles were obtained by citation tracking of the articles. Data extraction was conducted independently by at least two investigators.

Review of the Published Studies

After exclusion of articles with the subject of "using the ultrasonography in the detection of

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drug packets in the body packing", database searches retrieved 4 unique records[2-5]. For the first time in 1988, Maublant et al[2] described visualization of theophylline tablets in the stomach by ultrasound. These tablets contained dicalcium phosphate which increased its echogenicity. Theophylline tablet was administered to four consecutive fasted volunteers and was detected in their stomach until 90 minutes post-ingestion.

After this study, in 1991, Anderson et al[3] conducted an in-vitro study in order to determine if ultrasound could be used for the evaluation of toxic ingestions. They placed various solid medications in opaque balloons filled by water and air and asked an ultrasonographer to describe the number of the pills he could observe. They had used different pills including diphenhydramine, theophylline, propoxyphene, phenobarbital, ferrous sulfate, enteric-coated aspirin, and chloral hydrate. Since the ultrasonographer could determine the exact number of the pills in this artificial medium with no false positive or false negative results, the Authors suggested that ultrasonography might be useful in determining the success of attempts for gastric decontamination of certain substances, assessing the number of the tablets ingested, and determining toxic ingestion in situations where radiography might be contraindicated (e.g., pregnant women). However, as mentioned, these suggestions were not based on the studies performed on individuals and under *in vivo* circumstances.

The third study in this regard was performed by Amitai et al[4]. They studied 30 commonly ingested pills in-vitro by ultrasound and showed that all were clearly detected with better imaging compared with plain radiography. The Authors also chose four pills with slow disintegration time (sustained release or enteric coated) and two with fast integration (immediate release) and gave each pill to a human volunteer with 250 cc of water and studied them by ultrasound within 15 minutes of its ingestion. They found that all four pills with slow disintegration time were clearly detected in the stomach by ultrasound, while one of the immediate-released pills (ibuprofen 400 mg) was detected 3 minutes after its ingestion and the other pill (pseudoephedrine 25 mg) was not ever detected. In another stage of their study, they tried to detect the pills in four patients who had intentionally ingested multiple immediate released pills and had referred to the Emergency Department within 1 to 6 hours post-ingestion. They could just detect the extended phenytoin capsules in one of them 3 hours after ingestion. They concluded that while the size of the pills did not seem to be a limitation, optimal detection by ultrasonography required the integrity of the pills. This fact may restrict the use of ultrasonography to the detection of only sustained release or enteric coated preparations.

In the last study performed in 2011 by Nordt et al[5], the Authors performed a case-control study on 15 healthy volunteers who were fasting for 12 hours. They were assigned into two groups of cases (9 volunteers who ingested a total of 10 tablets with 500 cc of water) and controls (6 volunteers who only ingested 500 cc of water). All patients underwent ultrasonography by two independent blinded ultrasonographers within 30 minutes after ingestion. A total of 6 false positives and 4 false negatives were recorded by the sonographers. The Authors concluded that application of ultrasonography was not warranted in determination of the presence and absence of the tablets in an individual's stomach after an acute poisoning.

Conclusions

The studies on visualization of the ingested medications by ultrasound are too limited. On the other hand, in the few studies performed on this topic, only one could determine the extended phenytoin capsules in the stomach of a patient in actual acute poisoning[4] while the others have just assessed the pills in an artificial medium such as opaque balloons[3] or in an optimal condition, i.e. fasting volunteers[4,5]. It seems that in the setting of the actual acute poisoning- even if the ultrasonographers' experience is not considered[5] – detection of the medications in the patients' stomach is difficult due to the presence of the food or lack of the water in their stomach as an acoustic medium necessary for the visualization of the medications. Also, after dissolution of the tablets or capsules or their passage from the pylorus, they can not further been visualized. Increasing the time elapsed between the ingestion and hospital presentation may be another limitation for the use of ultrasonography in the diagnosis of acute poisonings since the longest time within which the capsules can be detected post-ingestion has been reported to be three hours in the previous studies[4].

Therefore, ultrasonography is not an appropriate tool for diagnosis of medication ingestion in acute poisoning based on the published studies. In addition, it has been stated that ultrasound may be used to confirm or refute suspected ingestions and may help determine the need for or success of gastrointestinal decontamination[3,6]. These statements are not according to the results of the research studies and there is no support for them.

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