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Ultrasound in Emergency Medicine

USE OF OCULAR ULTRASOUND FOR THE EVALUATION OF RETINAL DETACHMENT

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□ **Abstract—Background: Retinal detachment is an ocular emergency posing diagnostic difficulty for the emergency practitioner. Direct fundoscopy and visual field testing are difficult to perform and do not completely rule out retinal detachment. Ophthalmologists use ocular ultrasound to enhance their clinical acumen in detecting retinal detachments (RD), and bedside ultrasound capability is readily available to many emergency practitioners (EP). Study Objective: Our study sought to assess whether ocular ultrasound would be a helpful adjunct for the diagnosis of RD for the practicing EP. Methods: This was a prospective observational study with a convenience sample of patients. As part of a general course on emergency ultrasonography, practitioners received a 30-min training session on ocular ultrasound before beginning the study. Trained practitioners submitted ultrasound scans with interpretation on patients with signs and symptoms consistent with retinal detachment. Results: Thirty-one of the 72 practitioners trained submitted ocular ultrasound reports on patients presenting to the Emergency Department with concerns for retinal detachments. EPs achieved a 97% sensitivity (95% confidence interval [CI] 82–100%) and 92% specificity (95% CI 82–97%) on 92 examinations (29 retinal detachments). Disc edema and vitreous hemorrhage accounted for false positives, and a subacute retinal detachment accounted for the only false negative. Conclusion: These data show that trained emergency practitioners can use ocular ultrasound as an adjunct to their clinical assessment for retinal detachment.** © 2011 Elsevier Inc.

□ **Keywords—ocular; ultrasound; evaluation; retinal; detachment**

INTRODUCTION

The use of ultrasonography by emergency physicians has greatly expanded over the last 10 years, and one of its potential applications in the emergency department (ED) is in the diagnosis of intraocular disease. Evaluation for retinal detachment, vitreous hemorrhage, and vitreous detachment are all possible using a standard 10-MHz linear probe. Other less common diseases also seen with ocular ultrasound include ocular tumors, intraocular foreign bodies, globe rupture, and retrobulbar hemorrhage. Recently, there has been some literature to suggest that intracranial pressure can also be evaluated by measuring the diameter of the optic nerve sheath (1).

Although many of these intraocular diseases are emergent conditions, most of them have significant physical findings that can be diagnostic without the need for ocular ultrasound. Retinal detachment (RD), on the other hand, has less obvious physical findings, yet if missed, often results in devastating sequelae. The most emergent RD is when the retina is detached, but the macula is not. These "mac-on" RDs have more subtle physical findings than "mac-off" RDs, because the visual center is still functional. Both the risk of a missed diagnosis and the benefit of emergent intervention are significant.

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Current practice using direct fundoscopic examination and visual field testing, if used solely, allows for only a limited view of the retina and would miss a large number of retinal detachments (2). A method to more accurately evaluate for retinal detachment would significantly impact emergency practice by making an earlier diagnosis, leading to a more rapid Ophthalmology consult, and definitive care for the patient.

Because ophthalmologists have been using ultrasound for over four decades to assess a number of different disease processes including retinal detachment, it is reasonable that emergency physicians could be taught to do this in the ED (3). Ophthalmologic literature documents that retinal detachments can be accurately characterized using ultrasonography, and one study found that ultrasound correctly identified the size of the detachment within a small sector of the eye (3 clock hours) in 33 of 35 (94.2%) patients (4,5).

Blaivas et al. published a study assessing the accuracy of ocular ultrasonography in the ED. This study showed that 60 of 61 intraocular diseases were accurately detected by emergency sonographers trained in ocular ultrasound. Nine retinal detachments were diagnosed in that study (6).

Our study sought to evaluate whether emergency practitioners minimally trained in the use of intraocular ultrasound could accurately evaluate retinal detachments during their normal daily practice.

MATERIALS AND METHODS

This was a prospective observational study performed on a convenience sample of patients in a large urban teaching hospital ED with over 136,000 ED visits per year. This study was approved by the institutional review board at our hospital.

Seventy-two practitioners (8 attending physicians, 54 resident physicians, 10 physician assistants) from the ED received a 30-min lecture on ocular ultrasound. All study practitioners had begun their ultrasound education and practice within the last year and were required to attend the ocular lecture in order to participate. The ocular portion included the method of examination, contraindications to examination, and potential diseases encountered during assessment. The lecture emphasized the different findings of the three intraocular diseases: retinal detachment (RD), vitreous hemorrhage (VH), and vitreous detachment. A retinal detachment appears as a taut linear opacity within the vitreous chamber that moves in conjunction with eye movements (Figure 1A). A vitreous hemorrhage consists of wavy linear or curved strands connecting with the retina that sway as the eye moves from side to side (Figure 1B). Severe vitreous hemorrhage results in complete opacification of the vitreous chamber. A vitreous detachment occurs when the vitreous humor detaches from the posterior retina (Figure 1C). This results in a mobile "swaying seaweed" appearance on ultrasound, where the vitreous appears separated from the retina. During the lecture, the practitioners were

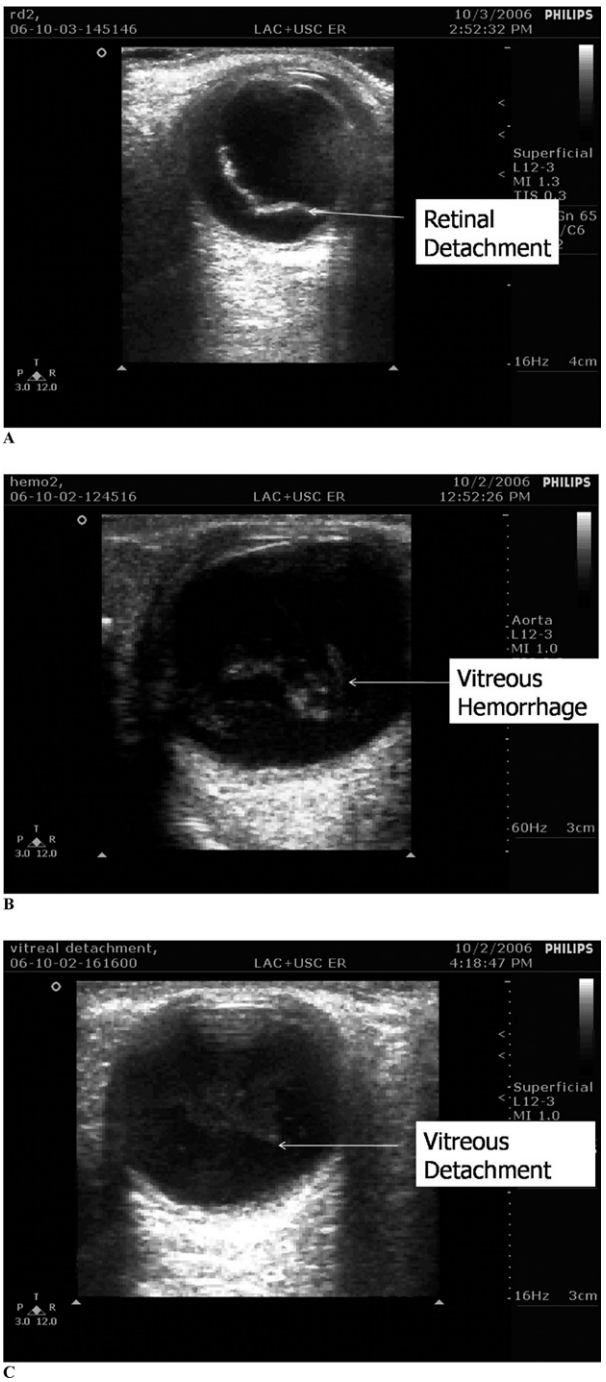

Figure 1. (A) Ocular ultrasound of a retinal detachment. (B) Ocular ultrasound of a large vitreous hemorrhage with no retinal detachment. (C) Ocular ultrasound of a vitreous detachment with no retinal detachment.

Table 1. Demographic and Clinical Characteristics of the Study Population

Characteristic	Finding
Age	
n	90
Mean ± SD	45.5 ± 26.1
Minimum	18
Maximum	80
Gender	
n	90
% (#) Male	71% (64)
% (#) Female	29% (26)
Race	
n with data	89
% (#) Hispanic	81% (72)
% (#) White	10% (9)
% (#) African-American	4% (4)
% (#) Asian	4% (4)
Comorbidity	
n with data	85
% (#) no comorbidity	52% (44)
% (#) diabetes mellitus (DM) only	28% (24)
% (#) hypertension (HTN) only	8% (7)
% (#) high cholesterol (CHOL) only	0% (0)
% (#) HTN + DM	8% (7)
% (#) HTN + CHOL	1% (1)
% (#) HTN + DM + CHOL	2% (2)

also instructed that the signs/symptoms of retinal detachment included sudden loss of vision, visual field defects, or flashing/flickering lights in vision.

Entry criteria included patients with complaints concerning to the practitioner for retinal detachment. Each practitioner was instructed to submit a data collection sheet that included their printed ultrasound scans along with their ultrasonographic assessment for retinal detachment. Only patients who received ophthalmology follow-up were included in the study.

Ocular examinations were performed using an Aloka SSD-1400 (Aloka America, Wallingford, CT) 10-MHz linear probe and a closed eyelid technique. Assessment of retinal detachment included a three-step approach. First, the emergency physician (EP) placed the linear 10-MHz probe on the closed eyelid of the eye of concern. Second, the EP adjusted the contrast and brightness such that small irregularities within the vitreous were visible, creating an optimal image for assessment. Third, the EP asked the patient to look left and right while the physician watched the ultrasound screen for movement patterns consistent with different intraocular diseases.

We used the ophthalmologists' evaluations as the gold standard and compared our assessment with theirs. Their evaluation was not blinded to our interpretations. Their evaluation included indirect fundoscopic examination with dilatated pupils and intermittent use of ultrasound as an adjunct. We estimated the sensitivity and specificity using 95% exact confidence intervals (CI).

RESULTS

Ocular ultrasounds were obtained on 101 patients over 1 year. Of these patients, follow-up records were attained for 90 patients. The patients were 81% Hispanic, 71% male, 39% diabetic, and 20% hypertensive. Their average age was 45.5 years (range 18–80 years, SD 26.1) (Table 1). Thirty-one practitioners contributed cases (n = 101) to the study, of which 36 (36%) were done by first-year Emergency Medicine (EM) residents, 55 (54%) by second-year EM residents, and 6 (6%) by third-year EM residents. One attending and three physician assistants also submitted one case each.

Two patients had examinations of both eyes secondary to bilateral vision loss. Both patients had correct interpretations with ocular ultrasound. Results were reported per eye; demographic data were reported per patient. Of the 92 eye examinations, 29 (32%) were diagnosed with retinal detachments by Ophthalmology. Of these, we correctly identified 28 by ocular ultrasound (sensitivity 97%; 95% CI 82–100%). Of the 63 examinations Ophthalmology stated did not have retinal detachment, we correctly identified 58 examinations (specificity 92%; 95% CI 82–97%) (Table 2). The positive predictive value was 85% (95% CI 68–95%) and the negative predictive value was 98% (95% CI 91–100%). Of the six incorrect diagnoses, two were scanned by first-year EM residents, three by second-year EM residents, and one by an attending.

DISCUSSION

Our results suggest that emergency practitioners with minimal ultrasound training can use ocular ultrasound to detect retinal detachments. Given the high sensitivity (97%) and negative predictive value (98%) found in this

Table 2. Comparison between ED Ultrasound and Ophthalmology Findings

	Ophthalmology Findings		
	RD+	RD−	Total
ED ultrasound			
RD+	28	5	33
RD−	1	58	59
Total	29	63	92
Sensitivity	97% (28/29); 95% CI 82%, 100%		
Specificity	92% (58/63); 95% CI 82%, 97%		
Positive predictive value	85% (28/33); 95% CI 68%, 95%		
Negative predictive value	98% (58/59); 95% CI 91%, 100%		
Accuracy	93% (86/92); 95% CI 86%, 98%		

ED = emergency department; RD = retinal detachment; CI = confidence interval.

study, ocular ultrasound can potentially be used as an adjunct in the clinical assessment of retinal detachment. Comparing the results of our study to the current ED practice of direct fundoscopy alone, there is an advantage to using ocular ultrasound. Siegel et al. found a 38% miss rate of retinal diseases that required intervention when non-dilatated direct fundoscopy was used alone (2). Given our results, ocular ultrasound could potentially improve this number significantly.

Analysis of the false positives and false negatives of our study has lead to some interesting conclusions. The one patient where an emergency practitioner misidentified a true retinal detachment (false negative) involved a patient with diabetes mellitus. This patient presented to the ED with decreased vision over 2 months in her left eye, which was previously treated seven times with laser for VH and RD. The EP diagnosed no pathology and sent the patient to the Ophthalmology clinic urgently. The ophthalmologist diagnosed a pre-retinal hemorrhage with a small mac-on retinal detachment. The patient, given her extensive previous treatments and subacute course, was not given laser treatments but was referred to retina clinic for follow-up the next month.

Concerning the false positives, two involved subhyaloid heme. Subhyaloid heme is hyperechoic, occurs between the retina and the vitreous, and can mimic retinal detachment because the border between the hemorrhage and the vitreous humor may be mistaken for the retina. Usually, the dense hyperechoic retina with hypoechoic fluid between the retina and choroid is distinctive enough to differentiate retinal detachment from subhyaloid heme. Two other false positives had disc edema. Although the images submitted do not show evidence of retinal detachment, one can postulate that significant disc edema could mimic a retinal detachment by increasing the apparent retinal thickness.

An additional point of emphasis is that retinal tears, which are difficult to diagnose with ocular ultrasound, can develop retinal detachment in a delayed fashion. There was one case in our study in which a patient was seen emergently by an EP and an ophthalmologist for a traumatic eye injury. Both the EP's ultrasound and initial ophthalmologist's assessment showed no RD. In outpatient ophthalmology follow-up 2 days later, the patient had developed an RD as fluid had accumulated behind the retinal tear. Consequently, patients with symptoms such as flashes and floaters who do not have an RD on initial ED examination, do require timely outpatient ophthalmology follow-up for further evaluation.

Our practitioners included emergency medicine residents, physician assistants, and an attending physician who were working under normal shift conditions at a large busy academic setting. At our institution, a bedside ultrasound is readily available, and scans generally take < 2 min to perform. Under these conditions, the results of our study show that ocular ultrasound is a useful skill for emergency practitioners to learn.

Because the practitioners in this study were mostly junior residents with minimal ultrasound experience, it is conceivable that our data would be even better with more experienced operators.

Limitations

Our study was an observational study with several limitations. Our confidence intervals were wide and, despite having a large number of retinal detachments, a larger study would be necessary to decrease these intervals and strengthen our results. Another limitation was patient follow-up. Eleven (11%) patients either did not return for follow-up or their charts were not available for review. Additionally, our study suffered from potential bias in that practitioners who felt more comfortable with ultrasound may have been more likely to enroll patients. However, a large number of the trained practitioners ($n = 31$, 43%) did contribute to the study. A final concern was lack of blinding to the clinical presentation of the patient for both the emergency practitioner and ophthalmologist.

CONCLUSION

Our study shows that ocular ultrasonography by emergency practitioners is a potential adjunct in the evaluation of retinal detachment.

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ARTICLE SUMMARY

1. Why is this topic important?

This topic is important because retinal detachment is an emergency that is often difficult to diagnose in the Emergency Department.

2. What does this study attempt to show?

This study attempts to show if emergency practitioners can be trained to use ocular ultrasound to detect retinal detachment.

3. What are the key findings?

The study shows that emergency practitioners with minimal training can detect retinal detachment with a high degree of sensitivity and specificity.

4. How is patient care impacted?

Patient care would be impacted by allowing for proper disposition of ocular conditions, specifically separating emergent from non-emergent referrals to Ophthalmology. More patients with retinal detachment would receive timely treatment to save their vision.