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A Case of Air-bag Associated Severe Ocular Injury

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Air-bags have received widespread support as an effective means of enhancing automotive safety, and they are becoming more common as standard automobile equipment on many cars. Although air-bag induced ocular injuries are rare, they present a serious concern because of the possibility of permanent damage or visual impairment. To date, most reports have investigated ocular injury from high velocity motor vehicle accidents and reports of ocular injury from low speed motor vehicle accidents have been rare. We describe a patient who sustained severe ocular injury, including periorbital fracture, hyphema, vitreous hemorrhage, and choroidal rupture of the macular area, due to an inflated air-bag in a low speed motor vehicle accident.

Key words: air-bag, motor vehicle accident, ocular injury

INTRODUCTION

Air-bags have been shown by several studies to be highly successful at decreasing the severity of injuries from motor vehicle accidents.[1-8] They therefore currently come as standard-equipment in most new cars.

Unfortunately, even safety devices manifest side effects. With the increasing number of air-bag equipped vehicles, there has been a corresponding increase in the incidence of air-bag associated ocular and facial trauma. To date, reports of air-bag induced ocular injury have mostly been from high velocity motor vehicle accidents and those from low velocity motor vehicle accidents have been relatively rare. However, in the present study the authors show that low velocity motor vehicle accidents can also cause serious ocular injury.

We report a case of air-bag associated severe ocular injuries, including periorbital fracture, hyphema, vitreous hemorrhage, and choroidal rupture in a low speed motor vehicle accident.

CASE REPORT

A 43-year-old woman with a previously unremarkable ocular history lost control of her vehicle while driving at approximately 45 km/h (28 miles per hour) and crashed into a concrete barrier, thereby inflating the driver's air-bag, which struck her on the right side of the face. Car damage was limited to the bumper on the right. She was wearing a seatbelt and was not wearing glasses or contact lenses.

In the hospital emergency department, she complained of periorbital pain and decreased vision in the right eye. External examination showed an upper eyelid abrasion, ecchymosis, and periorbital edema in the right eye with slight limitation at up gaze. Pupillary examination showed a normal,

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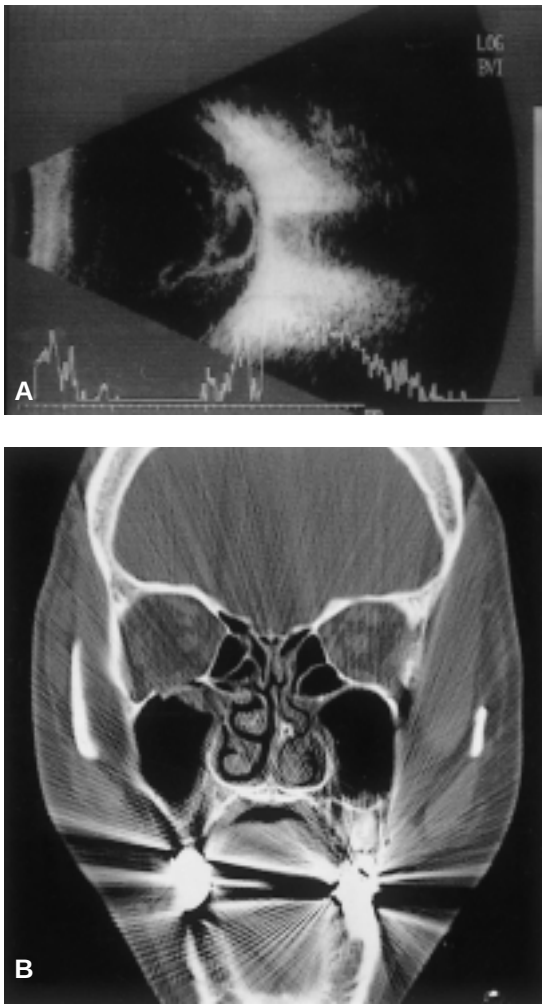

Fig. 1. A. B-scan ultrasonogram showing vitreous hemorrhage without retinal detachment. B. Coronal CT scan of a right orbital floor blow-out fracture.

round, reactive left pupil. The right pupil was fixed at 6 mm. Visual acuity without correction was hand motion, OD and 20/20, OS.

On slit lamp examination, the right eye had a mild corneal abrasion, conjunctival injection with chemosis, and the anterior chamber showed hyphema. The anterior chamber had 4+ cells with 10% layered hyphema. Intraocular pressure measured by applanation tonometry was 20 mmHg in the right eye and 17 mmHg in the left eye.

Dilated funduscopic examination was limited by the dispersion of blood in the anterior chamber of the right eye. B-scan ultrasonography showed vitreous hemorrhage with no evidence of retinal detachment (Fig. 1A). A computed tomographic scan demonstrated orbital fracture of the right inferior wall (Fig. 1B).

Treatment with topical steroids and cycloplegics was begun. Five days later the hyphema was resolved completely but a moderate vitreous hemorrhage, which obscured the posterior pole including the macula was still present in the right eye. There was no limitation of eyeball movement, with no treatment being required, and no diplopia at any gaze when the periorbital edema had subsided. Therefore, blow out fracture of right eye was not treated.

During follow-up over the next 2 weeks, the vitreous hemorrhage gradually cleared without any improvement in visual acuity (Fig. 2A).

Six months after the original injury, fundus examination showed a fibrotic membrane at the posterior pole, choroidal rupture and pigment epithelium degeneration of the macular area in her right eye with a visual acuity of hand motion (Fig. 2B). Fluorescein angiographic finding showed hypofluorescent vertical streaks involving the macular area from early phase to late phase and confluent hyperfluorescence at the posterior pole (Figs. 2C, D).

DISCUSSION

Motor vehicle accidents are a significant cause of morbidity and mortality.[9-11] Air-bags have gained widespread popularity as an effective means of reducing severe injury and death during motor vehicle accidents since the late 1980s.[1-8] The rationale for equipping passenger vehicles with air-bags was to introduce a mechanical cushion between the occupants and the car's hard interior surfaces. Despite their overall protective effect, air-bags can cause fatal and nonfatal injuries if the driver's head, neck, chest, or arms are too close to the deploying air-bag.[12,13] Among the most severe air-bag associated injuries are those in the ocular region.

Eye injuries during motor vehicle accidents accounted for 8% of the total eye injuries reported to the Unites States Eye Registry between 1982 and 1989.[14] Only 7% of these eye injuries were air-bag related.[15] With the increasing number of air-bag

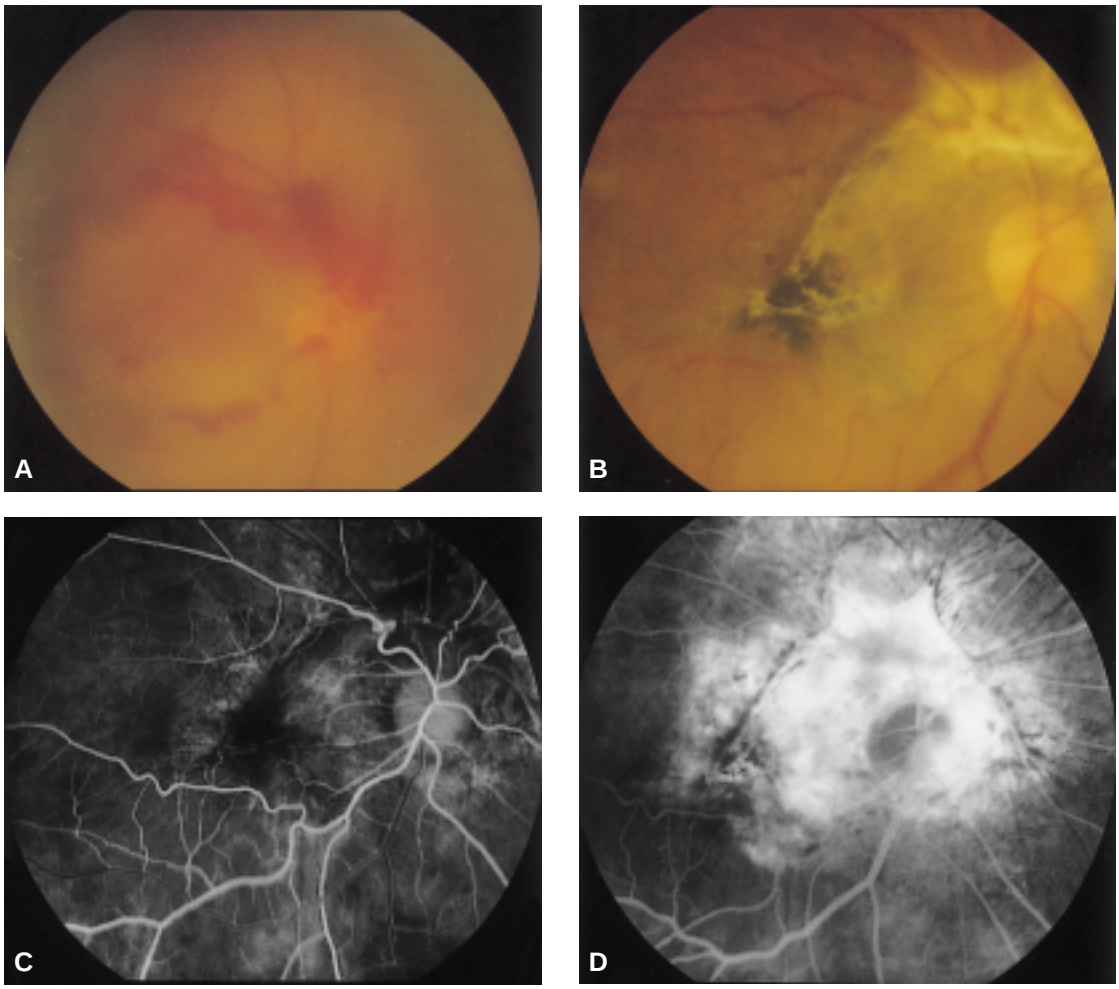

Fig. 2. A. Fundus photography showing vitreous and retinal hemorrhage at 2 weeks after trauma. B. Fundus photography showing choroidal rupture at the macular area and fibrotic membrane at 6 months after trauma. C. Fluorescence angiography at 6 months after trauma. Early venous phase showing vertical streak hypofluorescence at the macular area. D. Fluorescence angiography at 6 months after trauma. Later phase showing hyperfluorescence at the posterior pole.

equipped vehicles, there has been a corresponding increase in the incidence of air-bag induced eye injuries and they still present a serious concern because of the possibility of permanent damage or visual impairment.

A variety of air-bag associated ocular and periocular injuries have been reported, including periorbital contusion and fracture,[16-17] corneal abrasion,18 chemical keratitis,[19,20] hyphema,[21-26] angle recession,[21,22,27] vitreous hemorrhage,[25,28,29] lens injury,[16,30] anterior iridocyclitis,[31,32] corneal endothelial cell loss,[30,31] intraretinal16 and subretinal hemorrhages,[16] retinal tears and detachment,[16,32,33] choroidal rupture,[25] and corneal rupture in a patient who had previously undergone radial keratotomy.[34]

Air-bag induced eye injuries can be divided into two categories. The first stems from the mechanical aspects of the deploying air-bag and includes injuries such as periorbital contusion, fracture, abrasion, vitreous hemorrhage, hyphema, and retinal tear and detachment. Corneal endothelial cell loss as a

result of eyeball deformation during impact is also included in this category. These impact-related injuries are due to the rapid inflation of the bag, which is propelled out of the storage compartment at a speed of between 100 and 200 mph in a whip-like motion with an average speed of 144mps.[36] With such rapid inflation in one direction, and with the head moving in the opposite direction, it is easy to understand the potential for sustaining blunt ocular trauma. This mechanical action may be responsible for most of the air-bag related, ocular injuries reported.

The second category is alkaline chemical keratitis that is caused by the deposition into the eye of sodium hydroxide.[19,20] This results from the venting of the burnt sodium azide that is used to produce nitrogen for air-bag inflation.[19,20,35] Sodium hydroxide is highly alkaline, and the release of this compound is presumed to be responsible for the reported cases of alkaline chemical keratitis following air-bag deployment.

Many of these accidents occurred at high speed, but a few, including our patient's accident, occurred at relatively low speeds.[37,38] The air-bags presently in use are likely to strike the face strongly. They may be effective in violent motor vehicle crashes, but when the crash is not so violent, or when they are deployed at the wrong time (for example, by the jolt when a car runs over an uneven surface), the risk of air-bag associated injury can be greater than their benefits.

This case illustrates that even low-speed, motor vehicle accidents with minimal automobile damage may produce air-bag associated ocular injuries that result in permanent visual loss. Therefore, it is important for eye-care providers and car manufacturers to cooperate in research aimed at modifying air-bag design and deployment to minimize the risk of ocular injury even in low speed motor vehicle accidents.

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