Ophthalmologists, suicide bombings and getting it right in the emergency department

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Abstract

Background The number and extent of worldwide suicide attacks has risen sharply in recent years. The objectives of this retrospective study are: to determine the prevalence and outcome of the victims who sustained ocular injury, to describe the activities of ophthalmologists in the setting of an emergency department (ED) receiving mass casualties of a suicide bombing attack and to illustrate some of the treatment obstacles that they encountered and the protocol. **Methods** A single-centre, retrospective, interventional case series.

Participants Participants were the victims of 13 suicide bombing attacks (2000–2004), treated at a level I trauma center of an Israeli tertiary care, municipal medical center. **Main outcome measures** The study includes a description of the ophthalmologist's role in the setting of mass evacuation to emergency facilities, prevalence and outcome of patients managed according to the recommended guidelines, and reemphasis of logistic and therapeutic guidelines for management of ocular injuries.

Results The trauma center database yielded information on a total of 352 casualties from 13 suicide bombing attacks, including 17 surviving patients with any ocular/periocular trauma resulting from suicide bombing attacks. Six eyes

required and underwent urgent primary closure of laceration for primary repair of open globe, one unsalvageable eye underwent primary enucleation, and two eyes underwent exploration of subconjunctival hemorrhage. Four eyes required additional surgical intervention, which was performed within 7 days (large intravitreal foreign bodies were extracted from three eyes whose final visual acuity was poor, and an intra-lenticular foreign body was extracted from the fourth eye whose final visual acuity was 6/12). The remaining eight patients received medical treatment as indicated and were continued to be followed up.

Discussion Ocular trauma management under conditions of mass injuries requires special utilization of manpower and resources. Guidelines for efficacious patient management, description of the ophthalmologist's role, and the experience of one emergency facility are presented.

Keywords Ocular trauma · Terror · Vitrectomy · Intra ocular foreign body

The number and extent of worldwide suicide attacks has risen sharply in recent years [1, 2]. The perpetrators typically mingle among crowds of civilians and detonate an explosive device that is usually strapped on their bodies with the intent of sacrificing their own lives in order to cause the death of as many others as possible. The injuries sustained by survivors of these well-planned attacks combine the lethal effects of penetrating trauma, blast injury, and burns [3]. Suicide attacks on civilians were historically confined to a limited number of countries, but the outrageous and devastating destruction of the Twin Towers in New York City on 11 September 2001 and the bombings in London and Madrid established the universality of such terrorism. With the rise in terror-related activities in urban settings, ophthalmologists worldwide may find themselves treating ocular trauma under

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conditions unlike any they had experienced before, and certainly remote from the relatively orderly setting of an emergency room in which traumatic ocular injuries can usually be counted on one hand at any given time.

Since the beginning of the latest Israeli-Palestinian Intifada on 29 September 2000, more than 4,600 people—mostly civilians—have been killed or injured by suicide bombings in that area [4]. The Tel Aviv Sourasky Medical Center (TASMC) is the largest hospital in the Tel Aviv metropolitan area. As such, most of the victims of the suicide bombing attacks in its catchment area are evacuated to TASMC, and a special treatment protocol has evolved for coping with the unusual logistic needs of such events. The objectives of this retrospective study are: to describe the activities of ophthalmologists in the setting of an ED receiving mass casualties of a suicide bombing attack, to illustrate some of the treatment obstacles that they encountered and the protocol that evolved for overcoming them, and to determine the prevalence and outcome of the victims who sustained ocular injury.

Methods

IRB approval was obtained for this retrospective interventional case series study. Clinical data on all casualties evacuated to the TASMC due to suicide bombing-related injuries were collected from the trauma registry records and reviewed. Their demographic data were obtained from the main admitting office records.

The senior surgeon stationed at the ED entrance is rapidly provided essential information on the type/location of injuries from the arriving ambulance's paramedical personnel. He/she pages the designated on-site specialist according to prioritization for urgent management.

Ocular injuries are defined as any blunt, penetrating, or perforating trauma or blast-related damage to the eye, orbit, or ocular adnexa. The terms we used to describe ocular injuries conform to the recommendations the United States Eye Injury Registry and the International Society of Ocular Trauma [5]. Individuals with nonpenetrating or non-lacerating ocular injuries, non-penetrating debris in their eyelids, or superficial burns of the eyelids were excluded from this study, as were victims who died of their injuries before undergoing ophthalmologic treatment for whatever ocular damage had been suffered.

The ocular injuries for each eye were categorized according to type: it was possible to have multiple occurrences of the same type (i.e., multiple corneal lacerations) and of several types (i.e., corneal laceration and retinal detachment) in the same eye.

All records of ocular- and orbital-related trauma that were documented in the trauma registry were collected and analyzed together with hospital and outpatient clinic records.

The analysis included age, gender, mechanism of injury, anatomic site of injury, Injury Severity Score (ISS) [6], length of stay, length of intensive care unit stay, and surgical procedures. Ophthalmic information included the initially diagnosed ocular condition, all surgeries performed during the ED stay and afterwards, and final ocular test findings. The data were entered using Excel spreadsheet (Microsoft Office) and a simple descriptive statistical analysis was performed.

Results

There were 13 suicide bombing attacks in the Tel Aviv metropolitan area between October 2000 and October 2004. A total of 352 patients were evacuated to the TASMC ED, and 198 of them were hospitalized. The other 154 patients suffered from minor injury or shock for which they were given appropriate treatment and instruction and sent home. The overall severity of suicide bomb-related trauma was very high: the mortality rate was 8.4% when the attack occurred in open spaces, 15.5% in closed spaces and 20.3% when the bomb exploded inside a bus. The ISS was 1–14 for 74% of the patients (non-hospitalized) and ≥ 16 for the remaining 26% of the patients (admitted to hospital). One of the prominent hallmarks of suicide bombing injuries is the extremely high prevalence of head injuries: among our patients, 49% suffered from head and neck injuries, 9% head and extremity injuries, 4% head and torso injuries, and 38% torso and other injuries (all data are taken from the experience with the 13 bombings in Tel Aviv).

Seventeen patients (4.8%) were listed in the trauma database as having any ocular or periocular trauma, and several had more than one type of injury. The types of recorded trauma were: open globe injuries ($n=7$), closed globe injury consisting of severe subconjunctival hemorrhage ($n=2$), partial thickness lamellar laceration of cornea ($n=8$) (lamellar flap) of which five were burn-related and three were due to small foreign bodies, and extraocular injuries ($n=6$), which included three orbital fractures due to primary blast injury and three eyelid lacerations. Primary repair of open globe was performed in six eyes that underwent primary closure of laceration. One patient who was diagnosed during the initial triage as suffering from open globe injury died during the initial trauma surgery, thus no ocular procedure was performed. Two other eyes underwent primary exploration of subconjunctival hemorrhage that was suspected as being open globe due to massive subconjunctival: no laceration was found intraoperatively, and contusion was diagnosed. The one eye that was found to be unsalvageable underwent primary enucleation.

After the initial eye surgery, two patients died from their other injuries within 24 h of the explosions.

Of the eight patients with partial thickness lamellar laceration of cornea, three were discharged and given instructions to return as outpatients on the following day. Five other patients who required and received medical treatment for non-ocular-related medical problems were hospitalized and continued eye treatment as inpatients. All patients in which superficial burns were found ($n=5$) were treated by manual removal of corneal foreign body and antimicrobial drops, and their recovery was uneventful.

Secondary surgical intervention was performed on four patients (all surviving patients who initially underwent primary closure of open globe) within 1 week of the initial trauma: large intravitreal foreign bodies were extracted in three of them, and an intra-lenticular foreign body was extracted from the fourth (Table 1). At final follow-up (≥ 2 years post-trauma), the visual acuity of the three patients who suffered from large intravitreal foreign bodies were finger counting (FM)-hand movement (HM). The silicone oil was removed in two of these patients and retained in the third; two of them are wearing large cosmetic contact lenses due to corneal opacities that were cosmetically disturbing. The patient who underwent surgery due to intra-lenticular foreign body and penetrating keratoplasty had final visual acuity of 6/12 (Table 1).

Discussion

The dynamics of an emergency receiving center of victims of a suicide bombing attack are alien to most ophthalmol-

ogists. Today, the setting is characterized by large numbers of victims who sustain injuries that are more complex and more severe than those that had occurred during earlier periods of terror activity [7, 8]. Importantly, suicide bombings are more likely to occur in closed spaces, unlike other mass trauma scenarios such as car bombs, train wrecks, and other outdoor explosions: over 62% of injuries that occur in closed spaces are to the face, head, and neck, thus posing a far greater risk to the ocular structures.

In our experience, 17/352 (4.8%) of the survivors of suicide bombing attacks sustained eye injuries, and 9/17 (52%) required urgent attention. This rate is surprisingly lower when compared to previous reports, which documented that close to 10% of survivors of terrorist blasts have significant eye injuries [13]. We have no explanation for the low rate, but we can speculate that because of their close proximity to the hospital together with the efficiency of the Israeli Magen David (Red Cross), almost all survivors are speedily brought to the hospital for examination after terror-related episodes and are listed as admissions in the trauma records, even those with no complaints or only minor ones. Thus, the large number of admitted individuals artificially decreases the percentage of eye victims. Importantly, 41% of all of the reported ocular injuries [9–13] were severe in degree.

The final visual outcome of all the surgeries we performed was poor: globe preservation was successfully achieved in most cases (6/7), but only one patient with an intra-lenticular foreign body had useful vision post-operatively.

Table 1 Relevant data of suicide bombing survivors who sustained open globe injury

No.	Age, years/ sex	Primary surgical intervention	Secondary surgical intervention	Foreign body extracted	Further surgery	Final outcome	Final visual acuity
1	17/f	Closure of open globe	Patient died within 24 h of trauma				
2	16/f	None	Patient died within 24 h of trauma				
3	62/m	Exnucleation					
4	17/f	Closure of open globe	Lensectomy, vitrectomy, removal of foreign body, endolaser silicone oil injection	Metal shrapnell (5 mm)	Silicone oil removal	Preserved globe flat retina	FC
5	18/f	Closure of open globe	Lensectomy, vitrectomy, removal of foreign body, endolaser silicone oil injection	Metal ball (2 mm)		Preserved globe flat retina	HM
6	19/f	Closure of open globe	Lensectomy, vitrectomy, removal of foreign body, endolaser silicone oil injection	Glass fragment (3 mm)	Silicone oil removal	Preserved globe flat retina	HM
7	27/m	Closure of corneal perforation	Penetrating keratoplasty, lensectomy, vitrectomy endolaser, intraocular lens implantation	Glass fragment (1 mm)			6/12

FC, finger counting; HM, hand movement

In order to provide the best treatment in such a complicated setting, special adaptations must be made to the treatment algorithm of the ophthalmology team. In terms of individual trauma cases, the victim of a suicide bombing attack is no different from any other eye trauma patient. The sudden presentation of large numbers of injured patients, however, presents two types of challenges: the logistical one of rapidly processing masses of casualties through the system and the medical one of providing the best possible trauma care to severely wounded patients [14]. According to our protocol, all patients who complain of eye symptoms and all unconscious patients who sustain head or face injuries must be checked by an ophthalmologist. This requires special disaster on-call lists of ophthalmologists who are able to arrive to the hospital on extremely short notice since, thanks to the highly efficient organization of our Red Shield ambulance facilities, blast victims usually arrive at the hospital within minutes and are hurried to either diagnostic tests or directly to operating theaters. Upon arrival to the ED, every victim of a terrorist attack is triaged by a senior surgeon who synchronizes the activities of the multifaceted operation. The ophthalmologists already present in the hospital and the ones on-call who arrive to the ED are in contact with that surgeon in order to expeditiously locate the victims with ocular injuries, examine them, and send them to the operation theaters, intensive care units, imaging studies or home. There is a directive in our department that all available staff members must contact the hospital immediately upon learning about any suicide bombing attack to check whether their services are required. In the event of large-scale attacks, they are prepared to be recruited to assist in triaging and in treating all the victims, not just those with ocular injuries. The triage procedure is the key to the successful management of large trauma events: the most important rule is that all patients must be checked by the ophthalmologist wherever they are located on the hospital premises. Trauma patients invariably require urgent treatment and some are sent directly from the ER to either imaging units or immediately to the trauma surgical unit. The senior ophthalmologist on the premises must contact trauma registration services, get a list of all admitted patients (usually assigned numbers upon admission) and make sure that each and every one of them is examined, even during emergency surgery or during imaging interventions for non-ophthalmological injuries. When an open globe is suspected, the eye is immediately patched, and the finding is reported to the surgeon in charge of the patient: the staff is instructed not to intervene in the treatment of the eye. Further evaluation is done only when it is certain that there is no danger of expulsive hemorrhage.

Only patients suspected as suffering from open globe injury undergo urgent primary closure of the wound. Since

that patient invariably presents with multiple injuries and may not be fit for transfer to the ophthalmology operating theater, however, special alterations to the surgical protocol may be required. For instance, no ophthalmological microscope is available in our trauma center because space is limited in the trauma room due to the concomitant performance of many surgeries and given the cumbersome structure of an ophthalmic microscope. There is, however, a high-quality neurosurgical microscope that has a long arm that can be placed at sufficient distance from the patient and the life-support machines so that it can be used without disturbing the anesthesiologists and other trauma teams as they work, and this microscope is used with great success during primary closure. Other eye surgery procedures are postponed, either until the patient has been stabilized or they are scheduled for a later date. This highlights the first critical responsibility of the ophthalmologist in the mass trauma setting, that of identifying which surgical procedures must be carried out immediately. The order of surgical intervention deserves special attention: due to the characteristic complexity of the injuries, most of the patients required multiple procedures immediately following the trauma. The established protocol adopted among our surgeons is (in descending order): trauma surgery (for life-threatening conditions, performed by either trauma surgeons or neurosurgeons), ophthalmologic interventions (immediate surgery or instructions for palliative care), and orthopedic and plastic surgery interventions.

Finally, terrorist bombings present a danger to the ED staff members that is never associated with any other mass casualty situation: there is a very real chance of explosion by a second-hit, either by explosive material remaining on the perpetrator's body, or, even more threatening, a second suicide bomber who infiltrates the ED disguised as one of the victims and detonates the bomb inside the crowded ED. Thus, a unique caveat in the ED protocol for terrorist bombing attacks is heightened vigilance, starting from the chaotic first minutes after the arrival of the victims.

Providing medical assistance in an ED to victims of suicide bombing attacks is a harrowing experience: physicians who work in an urban hospital are more and more likely to be exposed to such events [14]. In his excellent editorial, Hirshberg wrote "Urban terrorism, the scourge of the 21st century, is already at our doorstep and surgeons are called upon to play leadership roles in shaping the emergency response in their hospitals. Learning from the experience of those for whom the unthinkable has become a daily reality can help us develop and implement more effective answers to the threats in our own communities" [14].

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Précis

We present the logistic and therapeutic guidelines we established for the management of ocular injuries sustained after terrorist bombing attacks and describe the ophthalmologist's role in the setting of mass evacuation to emergency facilities.