The Birmingham Eye Trauma Terminology system (BETT)

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La Birmingham Eye Trauma Terminology (BETT) : un système de classification standardisé pour la traumatologie oculaire

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Introduction : L’utilisation inadaptée du vocabulaire en traumatologie oculaire peut conduire à une mauvaise interprétation à l’origine d’une description erronée de la lésion en clinique ou de confusion lors de la présentation des résultats d’une étude clinique. C’est à la suite de ces constatations qu’il a semblé nécessaire de faire le point sur les conceptions actuelles en traumatologie oculaire afin de proposer une terminologie standardisée pour les lésions oculaires d’origine mécanique.

Matériel et méthode : Une enquête anonyme chez plus d’une centaine d’ophtalmologistes confrontés à la description de trois cas cliniques différents de traumatisme oculaire, ainsi qu’une revue de la littérature internationale concernant la traumatologie oculaire ont été réalisées. Ce travail préliminaire a ensuite permis le mise au point de la Birmingham Eye Trauma Terminology (BETT) à partir d’une approche clinique raisonnée.

Résultats : La classification élaborée pour la BETT réunit les critères suivants : 1) à chaque situation clinique correspond un terme précis et un seul ; 2) le globe oculaire pris dans sa totalité sert de tissu de référence unique ; 3) la terminologie utilisée englobe tous les types de traumatismes oculaires mécaniques.

Conclusion : La BETT permet une description et une classification simple, sans ambiguïté, cohérente, détaillée et complète pour tous les types de lésions traumatiques mécaniques du globe oculaire. La BETT est déjà adoptée comme unique système de classification en traumatologie oculaire par plusieurs sociétés savantes et journaux avec comité de lecture. Elle devrait constituer la terminologie privilégiée pour classer les lésions oculaires en pratique courante.

Mots-clés : Lésion oculaire, traumatisme oculaire, traumatisme à globe fermé, traumatisme à globe ouvert.

The Birmingham Eye Trauma Terminology system (BETT)

Purpose: To evaluate the international eye injury scene and design a standardized terminology for mechanical eye injuries.

Methods: Surveys of practicing ophthalmologists and an extensive review of the international ocular trauma literature. Development of the Birmingham Trauma Terminology (BETT) using a logic-based approach.

Results: BETT always uses the entire globe as the tissue of reference. Its well-defined terms encompass all types of mechanical eye injury. A one-to-one relationship exists between terms and clinical conditions.

Conclusion: BETT provides an unambiguous, consistent, simple, and comprehensive system to describe any type of mechanical globe trauma. Endorsed by several societies and peer-reviewed journals as the standardized international language of ocular traumatology, BETT is expected to become the preferred terminology for categorizing eye injuries in daily clinical practice.

Key-words: Ocular injury, ocular trauma, closed globe injury, open globe injury.

Without a standardized system unambiguously defining the type of mechanical trauma an eye sustains, it is impossible for ophthalmologists to properly communicate the globes condition. The use of standardized terms is required in daily practice as much as in publications and presentations. Inconsistent use of ocular trauma terms leads to misinterpretation, rendering it impossible to describe the injury to a colleague or present the research results of a clinical study.

With a lack of a standardized terminology, ophthalmologists rely on using terms that have no clear definitions determined by factors such as place of training, place of practice, personal experience, peer pressure, etc. This makes unbiased data comparison from various authors, or even by the same ophthalmologist over time, unattainable. Medline searches are also difficult to conduct since any eye injury term used as a keyword will identify articles that should not have come up and miss others that should have been identified.

Based on surveys conducted at different locations, an extensive review of major trauma-related articles and textbooks published in several countries, and personal experience, we developed a system (Birmingham Eye Trauma Terminology, BETT) aimed at standardizing the terms used to describe mechanical eye injuries.
METHODS

Surveys

Over 100 ophthalmologists from different backgrounds were asked to anonymously indicate how they would classify three cases of mechanical eye injury (table I). We wanted to find out whether the rather straightforward case reports we presented would be termed identically by the responders.

Literature review

We analyzed over 120 major articles and 11 books dedicated solely to the topic of eye injuries. Our goal was to try to identify whether definitions were included in the publications for the terms used and whether identical injuries were described using the same term. We also wanted to determine whether the authors were consistent in the usage of their own terms.

RESULTS

Surveys

Even though several ophthalmologists had been working together for considerable length of time, their answers varied widely, and it was very rare to find identical responses (table I).

### Table I

<table>
<thead>
<tr>
<th>Injury type</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetrating</td>
<td>65</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>Perforating</td>
<td>47</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Rupture</td>
<td>47</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>Blunt rupture</td>
<td>6</td>
<td>47</td>
<td>88</td>
</tr>
<tr>
<td>Laceration</td>
<td>6</td>
<td>47</td>
<td>24</td>
</tr>
<tr>
<td>Full-thickness wound</td>
<td>41</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Open globe injury</td>
<td>76</td>
<td></td>
<td>88</td>
</tr>
</tbody>
</table>

* The numbers do not add to 100 because multiple answers were allowed. 

Case 1: a patient presents with a history of a large nail hitting the eye. A scleral wound of 10mm in length is seen with uveal prolapse. There is a small vitreous hemorrhage but no vitreous prolapse or retinal defect is seen. Case 2: a patient presents with a history of falling into bushes. A small thorn is still visible poking out from the cornea. Descemets membrane seems intact. Case 3: a patient presents with a history of falling onto a couch. A corneoscleral wound of 12mm is seen with retinal prolapse.

Designing and testing the new terminology system (BETT)

Based on the results of the surveys and literature reviews, we designed a system we considered as simple, logical, and comprehensive. We conducted tests over a 3-year period, polling ophthalmologists from a large number of countries from several continents to determine whether the obvious compromise within the system was acceptable. The goal was to design a practical system, one that would be used in clinical practice as well as in research, rather than a sterile, purely academic system based on semantics. For this reason, we did not use the traditional interpretation of the term laceration. It originally means A linear or jagged tear resulting from overstretching of the skin and underlying tissues [1], whereas in BETT it describes a wound that was caused by a sharp, as opposed to a blunt, object.

Literature review

We found that virtually no publication provides a definition of the terms it uses. The reader therefore remains uncertain whether interpretation of the type of injury is identical to that intended by the authors. Furthermore, inconsistencies are common even within the same publication: different terms may be used to report the same injury in the title, abstract, and body of the article. The situation is all the more confusing because of authors trying to use individually invented terms such as blunt penetrating trauma (table II).

DISCUSSION

The development and clinical application of any management strategy for a certain type of eye injury is based on a critical evaluation of prior treatment options on as large a number of cases as possible. It is fundamental that the type of injury analyzed for making clinically relevant conclusions be unambiguously defined.

Unfortunately, the analysis of the literature shows that this is not the case. As the many examples shown in table II demonstrate, the injury types are often labeled arbitrarily.
trarily. One can rarely be sure by reading the articles (book chapters) title or abstract what types of injuries are discussed. In an ideally designed terminology system, several criteria must be met and BETT was designed with these criteria in mind.

First, there has to be an unambiguous definition for each term. This means that no term can describe more than a single clinical condition and, conversely, no clinical condition can be described by more than a single term.

Second, the reference tissue must always be determined. If the reference tissue is in question, a term such as “corneal penetrating injury” cannot be unambiguously tied to a single injury type: one must know whether “corneal” is the tissue in question or the location of the injury (fig. 1).

Third, all terms must be part of a comprehensive system, which provides an overview so that the ophthalmologist can easily determine in which category the encountered injury belongs.

The primary task is to determine whether an injury is open or closed globe: is there a full-thickness breach of the eyewall? For this, one must define what makes up the wall of the eye. Although books on anatomy and pathology usually include the choroid and the retina as part of the eyewall, this is impractical for the practicing ophthalmologist. Even if the retina is not injured, trauma involving the total width of the sclera technically means that the inside of the eye has been violated; furthermore, in many cases it is not possible to determine whether there is accompanying choroidal and retinal injury, much less whether these are indeed full-thickness injuries. An open-globe injury in BETT thus means that there is a full-thickness wound of the sclera and/or cornea (eyewall), regardless of the presence or absence of choroidal or retinal involvement.

Within the closed-globe category (no injury to the eyewall), a distinction had to be made based on whether a lamellar (partial-thickness) laceration has occurred or the trauma is a contusion. A contusion is caused by a blunt object that transfers its kinetic energy without creation of a full-thickness wound.

Within the open-globe category, the key issue is to differentiate between ruptures and lacerations. The underlying cause of a rupture is elevated intraocular pressure that is the result of energy transfer from a blunt object. Consequently, the injury occurs through an inside-out mechanism, and frequently there is loss of the globes contents: tissue prolapse/extrusion. The wound is not necessarily at the impact site but commonly at the locus minoris resistenciae. A typical example is an eye after cataract surgery: if hit by a blunt object such as a fist, the wound is most likely to form at the original surgical incision rather than at the point of impact.

In case of a laceration, a sharp object is the culprit. A laceration always occurs at the impact site by an outside-in mechanism and is usually caused by a sharp object. The object typically enters the inside of the eye, temporarily or permanently (retained intraocular foreign body). Lacerations, however, may involve different injuries,

Table II
Selected examples to demonstrate the confusion in lack of a standardized system to describe mechanical eye injuries.

<table>
<thead>
<tr>
<th>Same term used to characterize two different clinical conditions</th>
<th>Perforating</th>
<th>Injury with entrance wound [4]</th>
<th>Injury with both entrance and exit wounds [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single term used to describe all injury types</td>
<td>Rupture [9] = Penetrating</td>
<td>= Perforating</td>
<td></td>
</tr>
<tr>
<td>Penetrating [10] = Rupture</td>
<td>= Perforating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individually developed terms</td>
<td>Blunt nonpenetrating globe injury [11]</td>
<td>Is there a sharp nonpenetrating injury?</td>
<td>Is this a contusion?</td>
</tr>
<tr>
<td>Blunt penetrating trauma [12]</td>
<td>Is this a rupture?</td>
<td>Is this a contusion?</td>
<td></td>
</tr>
<tr>
<td>Sharp laceration [13]</td>
<td>Is there a blunt laceration?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blunt rupture [14]</td>
<td>Is there a sharp rupture?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior penetrating trauma [15]</td>
<td>Is the penetration occurring posteriorly?</td>
<td>Is the penetration so deep as to reach the posterior of the eye?</td>
<td></td>
</tr>
<tr>
<td>Closed rupture [16]</td>
<td>Contusion?</td>
<td>Occult rupture?</td>
<td></td>
</tr>
<tr>
<td>Blunt trauma</td>
<td>Contusion [17]</td>
<td>Rupture [18]</td>
<td></td>
</tr>
<tr>
<td>Contusion rupture [16]</td>
<td>Which?</td>
<td>Both?</td>
<td></td>
</tr>
</tbody>
</table>
based on whether the object also causes an exit wound or whether foreign material is retained inside the globe. In the simplest case, only a single (entrance) wound is present: this is a penetrating injury. If an exit wound is also present, a perforating injury is encountered (a through-and-through injury). An intraocular foreign body injury is distinguished (it is technically a penetrating injury) because of its special management and prognostic implications.

To avoid ambiguity, BETTs key element is its consistency: the reference tissue is always the globe as a whole. The term corneal penetrating injury in BETT describes a penetrating injury with the cornea as the single wounds location (fig. 1b). The individual definitions are listed and explained in table III; the overall system is shown on (fig. 2).

BETT is not perfect. There are injuries of a mixed nature: certain objects such as an air-gun pellet can penetrate the eye and cause rupture; an object may result in a posterior impact site that is technically not an exit wound but behaves as one in terms of the potential for extensive reparative proliferation. Individual decisions by the ophthalmologist therefore still have to be made in rare cases, but BETT provides a platform that standardizes the description of eye injury types regardless of the ophthalmologists nationality, place of practice, or training.

BETT has been essential in developing projects such as the Ocular

### Table III

**Definitions in BETT**.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyewall</td>
<td>Sclera and cornea</td>
<td>Though technically the wall of the eye has not one but three tunics (coats) posterior to the limbus, for clinical purposes it is best to restrict the term eyelid to the rigid structures of the sclera and cornea</td>
</tr>
<tr>
<td>Closed-globe injury</td>
<td>The eyelid does not have a full thickness wound</td>
<td>Rarely, a contusion and a lamellar laceration coexist*</td>
</tr>
<tr>
<td>Lamellar laceration</td>
<td>The eyelid has a partial thickness wound</td>
<td>The energy transfer from object to globe causes damage inside the eyelid</td>
</tr>
<tr>
<td>Contusion</td>
<td>There is no wound</td>
<td></td>
</tr>
<tr>
<td>Open-globe injury</td>
<td>The eyelid has a full thickness wound</td>
<td>The cornea and/or the sclera sustained a through-and-through injury. Depending on the objects characteristics and the injury circumstances, ruptures and lacerations are distinguished. The choroid and the retina may be intact, prolapsed, or damaged.</td>
</tr>
<tr>
<td>Rupture</td>
<td>Full-thickness wound of the eyelid, caused by a blunt object. The impact results in a momentary increase in IOP and an inside-out injury mechanism</td>
<td>The eye is a ball filled with incompressible liquid. A blunt object with sufficient momentum creates energy transfer over a large surface area, greatly increasing IOP. The eyeball gives way at its weakest point, which may or may not be at the impact site. The actual wound is produced by an inside-out force; consequently, tissue herniation is very frequent and can be substantial.</td>
</tr>
<tr>
<td>Laceration</td>
<td>Full-thickness wound of the eyelid, usually caused by a sharp object. The wound occurs at the impact site through an outside-in mechanism</td>
<td>Further classification is based on whether an exit wound or an IOFB is also present. Occasionally, an object may create a posterior (exit) wound while remaining, at least partially, intraocular (IOFB)*</td>
</tr>
<tr>
<td>Penetrating injury</td>
<td>Single laceration of the eyelid, usually caused by a sharp object</td>
<td>No exit wound has occurred. If more than one entrance wound is present, each must have been caused by a different agent</td>
</tr>
<tr>
<td>Intraocular foreign body injury</td>
<td>Retained foreign objects causing entrance lacerations</td>
<td>An IOFB is technically a penetrating injury but is grouped separately because of different clinical implications (treatment modality, timing, endophthalmitis rate, etc.)</td>
</tr>
<tr>
<td>Perforating injury</td>
<td>Two full-thickness lacerations (entrance + exit) of the eyelid, usually caused by a sharp object or missile</td>
<td>Both wounds must have been caused by the same agent</td>
</tr>
</tbody>
</table>

* Rarely, the injury is so atypical that characterization is very difficult; the clinician should use his or her best judgment, based on the information provided here. IOP, intraocular pressure; IOFB, intraocular foreign body.
Trauma Score (OTS) [2] and the standardized description of mechanical injuries [3]. BETT has been officially recognized and endorsed by international organizations such as the American Academy of Ophthalmology, the American Society of Ocular Trauma and its more than 30 affiliates worldwide, the American Society of Retina Specialists, the International Society of Ocular Trauma, and the Retina Society. BETT has been mandated for submissions to journals such as *Graefes Archiv für Klinische und Experimentelle Ophthalmologie*, *Journal of Eye Trauma*, *Klinische Monatsblätter für Augenheilkunde*, and *Ophtalmology*. We look forward to the day when BETT is universally used, both in daily practice and research reporting, eliminating all potential for misinterpretation.

REFERENCES


Figure 2 : Overview of BETT*. *IOFB, intraocular foreign body. The shaded boxes represent the actual diagnoses that are used clinically.