1.1 Terminology of Mechanical Injuries: the Birmingham Eye Trauma Terminology (BETT)

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1.1.1 If the Terminology Is Not Standardized

Akin to two people not speaking a common language (Fig. 1.1.1), ophthalmologists are unable to unambiguously communicate with each other if the terms they use to describe an eye injury are not standardized. If the terms used do not have straightforward definitions, practitioners cannot understand each other when discussing an ocular trauma case, nor can research be conducted, and its results published, without the risk of the data being misinterpreted.

There are very few publications in the literature that provide definitions for the terms used, and those that do may not enforce its own definitions [1]. Consequently, inconsistencies are often found even within the same publication. Common problems include:

- Use of different terms to describe the same injury ("double penetrating" [15], "double-perforating" [17] and "perforating" [7])
- Use of the word "blunt" without specifying whether it refers to the agent or to the resulting injury [8]
- Alternatively using, even within the same publication, two different terms (penetrating, perforating) to describe the same injury [11]
- Use of the term "penetrating" to describe any open globe injury [3]
- Use of the term "rupture" to describe any open globe injury [16]
- Lack of indicating the tissue of reference when using the term "perforating" [4]

These misnomers are summarized in Fig. 1.1.2, and in Tables 1.1.1 and 1.1.2.

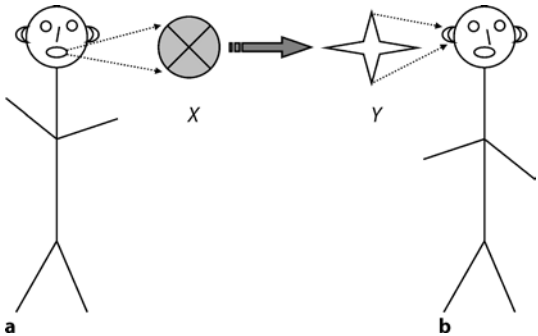

Fig. 1.1.1 Miscommunication if two people do not speak the same language. Individual "**a**" is communicating message "*X*"; however, this is understood by individual "**b**" as "*Y*." The reason for misinterpretation is the nonstandardized methods of coding and decoding the message

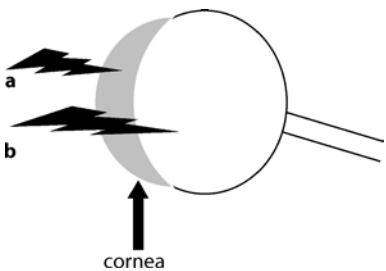

Fig. 1.1.2 The importance of indicating the tissue of reference when defining an eye injury term. Injury **a** is a *closed globe* injury but a penetrating injury of the *cornea* (i.e., not of the *globe*): the object violated the cornea but did not cause a through-and-through wound. Injury **b** is an open globe trauma; it is a *perforating* (through-and-through) injury of the *cornea* but a *penetrating* (into, not through) injury of the *globe*

1.1.2 Characteristics of an Ideal Eye Trauma Terminology System

In an ideal eye trauma terminology system, the following criteria must be satisfied:

- The tissue of reference must always be obvious.
- Each term must have a unique definition.

Table 1.1.1 A selection of confusing eye injury terms in the literature and their recommended substitutes

Term and reference	Controversy	Clinical implication	Recommendation
Blunt injury [8]	The inflicting object is blunt The consequences of the trauma are "blunt"	Open globe injury (rupture) Closed globe injury (contusion)	The word "blunt" should be replaced by one of the more appropriate terms: "contusion" or "rupture"
Blunt nonpenetrating globe injury [9]	Can an injury occur that is sharp but nonpenetrating?	Probably a closed globe injury	This term should be replaced by "contusion"
Blunt penetrating trauma [10]	How can an injury be both blunt and penetrating?	Open globe injury probably by a blunt object	This term should be replaced by "rupture"
Blunt rupture [13]	Are not all ruptures blunt?	Open globe injury by a blunt object	This term should be replaced by "rupture"
Contusion rupture [5]	How can an injury be both a contusion and a rupture?	Probably an open globe injury	This term should be replaced by "rupture"
Sharp laceration [2]	Is there a laceration that is not sharp?	An open globe injury caused by a sharp object	This term should be replaced by "penetrating" or "perforating"

- No term can be applied for more than a single injury type.
- No injury may be described by different terms.
- All injury types must be included.

1.1.3 The Birmingham Eye Trauma Terminology (BETT)

The key to this system is that all definitions refer to the entire globe, not to a specific tissue. (There is no need, therefore, to include reference to a

Table 1.1.2 Inappropriately used ocular trauma terms in the literature

Term and reference	Intended meaning by author	Likely interpretation by reader	Comment
Penetrating [3]	All types of open globe injury	Injury with an entrance wound	All penetrating injuries are open globe but not all open globe injuries are penetrating
Penetrating [6]	No distinction between penetrating and perforating trauma	Injury with an entrance wound	Penetrating and perforating injuries must be distinguished as they have different management and prognostic implications
Rupture [12]	All types of open globe injury, including IOFB injuries	Open globe injury caused by a blunt object	All ruptures are open globe but not all open globe injuries are ruptures
Perforating [4]	Injury with a single (entrance) wound [13]	Questionable	Unless the tissue of reference is also indicated, it is not possible to determine which injury type is described
	Injury with both entrance and exit wounds [14]	Questionable	

tissue in the term.) If a tissue is specified, it refers to *location* and is not a modifier of the term. In Fig. 1.1.2, injury "B" shows a penetrating trauma; if it is described as a "penetrating corneal injury", it means that the wound is corneal. (Prior to BETT, it could have meant either a *closed globe* injury (penetrating into the *cornea*) or an *open globe injury* (penetrating into the *globe*). BETT is described in detail in Table 1.1.3, and in Figs. 1.1.3 and 1.1.4. Traumatic enucleation of the eye is shown in Fig. 1.1.5.

There are cases in which the injury occurs by a complex mechanism. For instance, if the patient falls onto a glass table that has a sharp edge, the *wound* may be a laceration (penetrating injury), but the *injury* has a rupture component (major tissue loss) as well as a contusion ele-

ment (maculopathy). In such cases the worst injury type (rupture, in this example) is the one that best describes the consequences and implications of the case.

Table 1.1.3 Terms and definitions in BETT

Term	Definition	Comment
Eye wall	Sclera and cornea	Though the eye wall has three layers posterior to the limbus, clinical and practical purposes dictate that violation of only the most external tissue (sclera) is to be considered
Closed globe injury	No full-thickness wound of eye wall	The cornea and the sclera are not breached through and through
Open globe injury	Full-thickness wound of the eye wall	The cornea and/or sclera is breached through and through
Contusion	No wound of the eye wall	The damage may be due to direct energy delivery/shock wave by the object (e.g., choroidal rupture), or to changes in the shape of the globe (e.g., angle recession)
Lamellar laceration	Partial-thickness wound of the eye wall	The wound in the eye wall is not "through" but "into"
Rupture	Full-thickness wound of the eye wall, caused by a large blunt object	Since the eye is filled with incompressible liquid, the impact results in instant IOP elevation. The eye wall yields at its weakest point (rarely at the impact site, rather, for instance, along an old cataract wound); the actual wound is produced by an inside-out mechanism, and tissue prolapse is almost unavoidable

Some injuries have a complex mechanism and are thus difficult to classify (e.g., an intravitreal BB pellet is technically an IOFB injury, but since this blunt object requires great force to enter the eye, the wound is created as if it were a rupture; see the text for more details). In such situations, the ophthalmologist can describe the injury as "mixed" (i.e., rupture with an IOFB) and select the more serious type (rupture), or the one that dominates the acute management (IOFB). Complete destruction of the eye and traumatic enucleation (see Fig. 1.1.5) are not included in the system

Table 1.1.3 *(continued)* Terms and definitions in BETT

Term	Definition	Comment
Laceration	Full-thickness wound of the eye wall, caused by a sharp object	The wound is at the impact site and is created by an outside-in mechanism; since IOP elevation is unavoidable, tissue prolapse is common
Penetrating injury	An entrance wound is present	If more than one wound is present, each must have been caused by a different object
IOFB	One or more foreign objects are present	Technically a penetrating injury, but grouped separately because of different clinical implications (management, prognosis)
Perforating injury	Both an entrance and an exit wound are present	The two wounds caused by the same agent

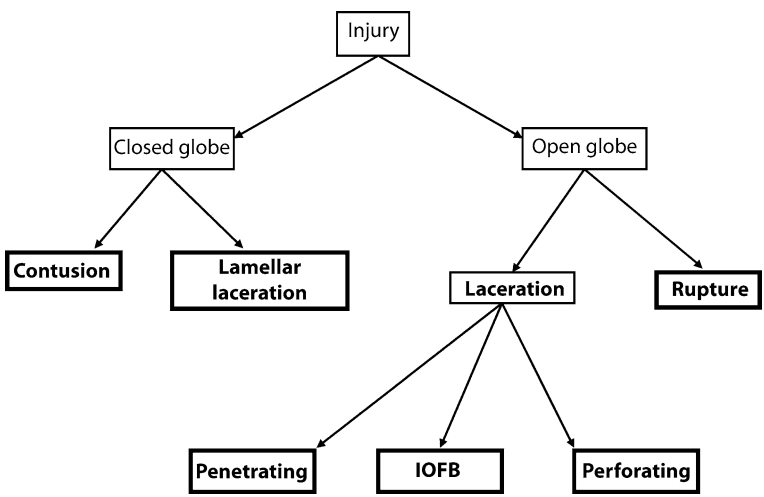

Fig. 1.1.3 BETT. The *bold boxes* indicate those diagnoses that are used as clinical entities

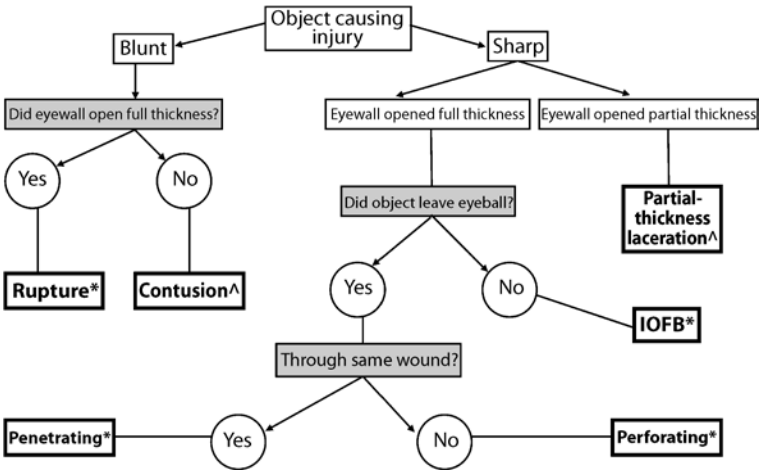

Fig. 1.1.4 Practical guide to classifying mechanical eye injuries in BETT. The *bold boxes* indicate those diagnoses that are used as clinical entities. Injuries marked with an *asterisk* are open globe, those with a *caret* are closed globe

Fig. 1.1.5 Enucleation caused by an animal attack. This 45-year-old man was attacked by his dog. A traumatic enucleation occurred, but the eye itself is intact. (Courtesy of Z. Slezak, Varasdin, Croatia)

DO:

- apply BETT in your clinical practice as well as in your research

DON'T:

- elect randomly the term to describe the eye injury

Summary

Using a standardized language in ocular traumatology is mandatory to avoid ambiguity between health care professionals, regardless of the type of communication.

References

[1] Alfaro V, Liggett P (1998) Vitrectomy in the management of the injured globe. Lippincott Raven, Philadelphia
[2] de Juan E, Sternberg P, Michels R (1983) Penetrating ocular injuries: types of injuries and visual results. Ophthalmology 90: 1318–1322
[3] de Juan E, Sternberg P, Michels R, Auer C (1984) Evaluation of vitrectomy in penetrating ocular trauma. A case-control study. Arch Ophthalmol 102: 1160–1163
[4] Eagling EM (1976) Perforating injuries of the eye. Br J Ophthalmol 60: 732–736
[5] Eide N, Syrdalen P (1987) Contusion rupture of the globe. Acta Ophthalmol 182S: 169–171
[6] Hassett P, Kelleher C (1994) The epidemiology of occupational penetrating eye injuries in Ireland. Occup Med 44: 209–211
[7] Hutton WL, Fuller DG (1984) Factors influencing final visual results in severely injured eyes. Am J Ophthalmol 97: 715–722
[8] Joseph E, Zak R, Smith S, Best W, Gamelli R, Dries D (1992) Predictors of blinding or serious eye injury in blunt trauma. J Eye Trauma 33: 19–24
[9] Liggett P, Gauderman W, Moreira C, Barlow W, Green R, Ryan S (1990) Pars plana vitrectomy for acute retinal detachment in penetrating ocular injuries. Arch Ophthalmol 108: 1724–1728
[10] Meredith T, Gordon P (1987) Pars plana vitrectomy for severe penetrating injury with posterior segment involvement. Am J Ophthalmol 103: 549–554
[11] Moisseiev J, Vidne O, Treister G (1998) Vitrectomy and silicone oil injection in pediatric patients. Retina 18: 221–227

[12] Pump-Schmidt C, Behrens-Baumann W (1999) Changes in the epidemiology of ruptured globe eye injuries due to societal changes. Ophthalmologica 213: 380–386
[13] Punnonen E, Laatikainen L (1989) Prognosis of perforating eye injuries with intraocular foreign bodies. Acta Ophthalmol 66: 483–491
[14] Ramsay R, Knobloch WH (1978) Ocular perforation following retrobulbar anesthesia for retinal detachment surgery. Am J Ophthalmol 86: 61–64
[15] Ramsay RC, Cantrill HL, Knobloch WH (1985) Vitrectomy for double penetrating ocular injuries. Am J Ophthalmol 100: 586–589
[16] Rudd J, Jaeger E, Freitag S, Jeffers J (1994) Traumatically ruptured globes in children. J Pediatr Ophthalmol Strab 31: 307–311
[17] Topping T, Abrams G, Machemer R (1979) Experimental double-perforating injury of the posterior segment in rabbit eyes: the natural history of intraocular proliferation. Arch Ophthalmol 97: 735–742