ORIGINAL ARTICLE

Ocular complications of boxing

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Objectives: To investigate the prevalence of ocular injuries in a large population of boxers over a period of 16 years, in particular, the most severe lesions that may be vision threatening.

Methods: Clinical records of the medical archive of the Italian Boxing Federation were analysed. A total of 1032 boxers were examined from February 1982 to October 1998. A complete ophthalmological history was available for 956, who formed the study population (a total of 10 697 examinations). The following data were collected: age when started boxing; duration of competitive boxing career (from the date of the first bout); weight category; a thorough ocular history. The following investigations were carried out: measurement of visual acuity and visual fields, anterior segment inspection, applanation tonometry, gonioscopy, and examination of ocular fundus. Eighty age matched healthy subjects, who had never boxed, formed the control group.

Results: Of the 956 boxers examined, 428 were amateur (44.8%) and 528 professional (55.2%). The median age at first examination was 23.1 (4.3) years (range 15–36). The prevalence of conjunctival, corneal, lenticular, vitreal, ocular papilla, and retinal alterations in the study population was 40.9% compared with 3.1% in the control group ($p \leqslant 0.0001$). The prevalence of serious ocular findings (angle, lens, macula, and peripheral retina alterations) was 5.6% in boxers and 3.1% in controls (NS).

Conclusions: Boxing does not result in a higher prevalence of severe ocular lesions than in the general population. However, the prevalence of milder lesions (in particular with regard to the conjunctiva and cornea) is noteworthy, justifying the need for adequate ophthalmological surveillance.

Over the last few decades, the scientific community has shown increasing interest in physical problems due to boxing.[1–4] As the facial region is an important target in boxing, oculopalpebral lesions due to punches to the head are very common.[5] In Italy, a thorough medical examination is required to obtain a boxing license,[6 7] and most of the medical data are stored in the medical archives of the Italian Boxing Federation (Federazione Pugilistica Italiana, FPI).

The purpose of this retrospective study was to determine the prevalence and nature of ocular complications in boxers competing in Italy in the last two decades.

METHODS

Clinical and ophthalmological records of 1032 male boxers for the period February 1982 to October 1998 were analysed. This series was composed of both professional and amateur boxers. The professional boxers all fought in Italy in that period. The amateur boxers all had abnormal electroencephalograms at their routine neurological examination,[6] or had received two consecutive knockouts, or had boxed at national level.

All athletes were examined in the Federal Sports Medical Center of FPI in Rome. A complete ophthalmological history was available on 956 boxers (528 professional and 428 amateur), and these formed the study population. Each subject had at least one ocular examination, a total of 10 697 examinations. The following data were obtained for each boxer: when they started boxing; how long they had boxed competitively (calculated from the date of their first bout); weight category.

Eighty age matched male subjects examined at the Ophthalmic Department of the Catholic University composed the control group. None had ocular problems or had taken part in any form of boxing.

The ocular evaluation was comprehensive measurement of visual acuity and visual fields, anterior segment inspection by slit lamp, applanation tonometry, gonioscopy, and examination of the ocular fundus using Goldmann contact lens. As ocular injuries can range from cutaneous scarring to retinal detachment, we considered severe those possibly causing acute or delayed visual loss, such as lesions involving angle, lens, macula, and peripheral retina. Of the injuries involving the peripheral retina, even though considered to be an idiopathic lesion, lattice degeneration was taken into account, as it is most often linked to rhegmatogenous retinal detachment.[8–10]

Statistical analysis

Data are expressed as mean (SD) or as percentage. Student's t test for unpaired data and χ^2 test were used to evaluate the presence of significant differences between the two groups, where appropriate. A difference was considered significant when $p \leqslant 0.05$.

RESULTS

Of the 956 male boxers, 428 were amateur (44.8%) and 528 were professional (55.2%). Their mean age at first examination was 23.1 (4.3) years (range 15–36). Their mean age when they started boxing was 16.5 (2.6) for the amateurs and 22.8 (2.5) for the professionals, with a mean length of competetive career of 2.2 (1.5) years (range 1–9) for the amateurs and 4.3 (2.6) years (range 1–15) for the professionals.

The mean age of the 80 male controls was 26.5 (5.1) years (range 20–40).

Visual acuity

At the first examination the best visual acuity for the right eye was 1 in 942 boxers (98.5%), 0.8 in five (0.5%), 0.7 in seven (0.7%), and 0.4 in two (0.2%). For the left eye, it was 1 in 940 boxers (98.3%), 0.9 in six (0.6%), 0.8 in five (0.5%), 0.7 in one (0.1%), 0.5 in two (0.2%), and 0.3 in two (0.2%).

Table 1 Retinal findings in 956 boxers (1912 eyes)

	Right eye	Left eye
Normal	851 (89.0)	859 (89.8)
Microcystoid degeneration	28 (2.9)	23 (2.4)
Oedema	18 (1.9)	20 (2.1)
Pigment clumping	9 (0.9)	6 (0.6)
Thinning	8 (0.8)	6 (0.6)
Lattice degeneration	7 (0.7)	6 (0.6)
Paving stone degeneration	4 (0.4)	0 (0)
Small round retinal hole	4 (0.4)	8 (0.8)
Oral chorioretinal degeneration	4 (0.4)	3 (0.3)
Peripheral drusen	4 (0.4)	0 (0.0)
Detachment	4 (0.4)	3 (0.3)
Disinsertion	4 (0.4)	2 (0.2)
Paravascular attachments	3 (0.3)	4 (0.4)
Snowflake degeneration	3 (0.3)	4 (0.4)
Pseudomacular hole	3 (0.3)	4 (0.4)
Retinoschisis	1 (0.1)	0 (0)
Retinal scarring	1 (0.1)	2 (0.2)
White without pressure	0 (0)	4 (0.4)
Chorioretinal atrophy	0 (0)	1 (0.1)
Haemorrhage	0 (0)	1 (0.1)

Values in parentheses are percentages.

Visual field

One athlete showed a right homonymous quadrantopsia (0.1%).

Conjunctiva

No changes in the conjunctiva of the right eye were observed in 870 boxers (91.0%). In the remaining 86, the following were observed: subconjunctival haemorrhage in 75 (7.8%), pingueculae in five (0.5%), a nevus in two (0.2%), a wound in two (0.2%), a pterigium in one (0.1%), and chemosis in one (0.1%).

No changes in the conjunctiva were observed in the left eye of 875 boxers (91.5%). In the remaining 81, the following were found: subconjunctival haemorrhage in 72 (7.5%), pingueculae in seven (0.7%), a nevus in one (0.1%), and chemosis in one (0.1%).

Cornea

No changes in the cornea of the right eye were observed in 847 boxers (88.6%). In the remaining 109, the following were found: an ulcer in 98 (10.2%), a nubecola in five (0.5%), a deep sub-oedema in two (0.2%), a wound in two (0.2%), a leucoma in one (0.1%), and a loss of epithelial cells in one (0.1%).

No corneal alterations were observed in the left eye of 837 boxers (87.5%). In the remaining 119, the following were found: an ulcer in 107 (11.2%), a nubecula in five (0.5%), a sub-oedema in three (0.3%), a keratoconus in two (0.2%), a leucoma in one (0.1%), and a loss of epithelial cells in one (0.1%).

Lens

In the right eye, the lens was in situ and transparent in 906 boxers (94.8%). A complete or partial dislocation of the lens was observed in 35 athletes (3.7%), a nuclear opacity was present in eight (0.8%), a cortical cataract in five (0.5%), and a complicated cataract in two (0.2%).

The lens was in situ and transparent in the left eye of 905 boxers (94.7%). A complete or partial dislocation of the lens was observed in 34 athletes (3.6%), a nuclear opacity was present in 11 (1.1%), and a cortical cataract in six (0.6%).

Angle

No boxer had angle abnormalities in either the right or left eye.

Table 2 Comparison of ocular findings between boxers and controls

Injuries	Boxers (1912 eyes)	Controls (160 eyes)	p Value
Total ocular alterations	40.9	3.1	<0.0001
Vision threatening injuries	5.6	3.1	0.1

Values are percentages. Vision threatening injuries were angle, lens, macula, and peripheral retina.

Vitreous

In the right eye, the vitreous was clear and transparent in 949 boxers (99.3%), was corpusculated in four (0.4%), a vitreitis was observed in two (0.2%), and a posterior detachment was present in one (0.1%).

In the left eye, the vitreous was clear and transparent in 950 boxers (99.4%), was corpusculated in one (0.1%), was organised in one (0.1%), and a vitreitis was present in four (0.4%).

Ocular papilla

The disc area, the cup to disc ratio, and the neuroretinal rim of the optic nerve head of the right eye appeared normal on ophthalmoscopic examination in 920 boxers (96.2%), while an optic disc swelling appeared in 32 (3.3%). Congenital growth alteration was observed in two boxers (0.2%), in one there was an accentuation of the physiological papilla excavation (0.1%), and in one there was a drusen (0.1%).

When the left eye was investigated, the disc area, the cup to disc ratio, and the neuroretinal rim appeared normal on ophthalmoscopic examination in 920 boxers (96.2%), while an optic disc swelling appeared in 32 (3.3%). Congenital growth alteration was observed in two boxers (0.2%), one of whom had the same alteration in the contralateral eye. An accentuation of the physiological papilla excavation was present in one athlete (0.1%), and the papilla was slightly pale in one (0.1%).

Retina

No retinal lesions were observed in the right eye of 851 boxers (89.0%). In the remaining 105, the following were found: a microcystoid degeneration in 28 (2.9%), a retinal oedema in 18 (1.9%), pigment clumping in nine (0.9%), retinal thinning in eight (0.8%), lattice (or palisade) degeneration in seven (0.7%), paving stone degeneration in four (0.4%), small round retinal holes in four (0.4%), oral chorioretinal degeneration in four (0.4%), peripheral drusen in four (0.4%), retinal detachment in four (0.4%), retinal disinsertion in four (0.4%), paravascular vitreoretinal attachments in three (0.3%), snowflake degeneration in three (0.3%), a pseudomacular hole in three (0.3%), and a retinoschisis in one (0.1%). Retinal scarring was found in one boxer (0.1%), with morphological and topographical aspects of a previous chorioretinal congenital inflammation.

No retinal lesions were observed in the left eye of 859 boxers (89.8%). In the remaining 97, the following were found: microcystoid degeneration in 23 (2.4%), retinal oedema in 20 (2.1%), small round retinal holes in eight (0.8%), pigment clumping in six (0.6%), lattice degeneration in six (0.6%), retinal thinning in six (0.6%), snowflake degeneration in four (0.4%), paravascular vitreoretinal attachments in four (0.4%), a pseudomacular hole in four (0.4%), a white without pression (WWP) in four (0.4%), retinal detachment in three (0.3%), oral chorioretinal degeneration in three (0.3%), retinal disinsertion in two (0.2%), chorioretinal atrophy in one (0.1%), and a retinal haemorrhage in one (0.1%). Two instances of retinal scarring were found in two (0.2%) boxers, with morphological and

Table 3 Prevalence of conjunctival, corneal, angular, lenticular, vitreal, ocular papilla, and retinal alterations in 956 boxers (1912 eyes)

	Right eye	Left eye	Most common findings
Conjunctiva/cornea	20.4	20.9	Subconjunctival haemorrhage; corneal ulcer
Angle	0	0	No lesion found
Lens	5.2	5.3	Partial or total dislocation
Vitreous	0.7	0.6	Vitreitis; corpusculated
Ocular papilla	3.8	3.8	Optic disc swelling
Retina	11.0	10.1	Microcystoid degeneration; retinal oedema

Values are percentages.

topographical aspects of a previous chorioretinal congenital inflammation.

Table 1 summarises the type and prevalence of the retinal findings.

Severe ocular complications

A total of 108 eyes analysed (5.6%) had at least one vision threatening injury (table 2). No athlete showed angle or macula lesions. At slit lamp examination, a cataract was found in 13 eyes (two complicated), and a lens subluxation/dislocation in 69. At fundus examination, seven detachments and six disinsertions were found. Thirteen lattice degenerations were observed.

Ophthalmological examination in control subjects

Of 160 control eyes (80 subjects), five (3.1%) showed ophthalmological alterations (all severe), consisting of retinal lattice degeneration in three (1.9%), a cataract in one (0.6%), and a retinal hole in one (0.6%).

DISCUSSION

By the nature of the sport, boxers receive repeated physical traumas with the possibility of acute, as well as chronic, injuries. A high incidence of ocular injury related to boxing has been reported in a series of 74[11] and 234[5] athletes.

Three mechanisms have been put forward to explain ocular damage due to blunt trauma: direct (coup), indirect (countercoup), and equatorial expansion.[12 13] Coup injury is caused by a blow that causes damage at the point of impact (eyelids, conjunctiva, and cornea) with the possibility of palpebral lesion, corneal abrasion, subconjunctival haemorrhage, etc. This trauma can cause lesions to the sclera, the underlying ciliary bodies, and the retina, producing angle recession and retinal breaks.

The countercoup mechanism explains the damage that occurs away from the impact area. In the case of head traumas, it is possible to find severe brain damage localised on the opposite side to the point of impact, suggesting that a shock wave traverses the skull.[14] The lesion usually occurs at the interface between tissues of different density. This theory has been used to explain some ocular injuries such as anterior subcapsular cataract, traumatic maculopathy, and macular hole formation.[13]

The third mechanism is equatorial expansion, proposed to explain peripheral retinal damage due to blunt traumas.[15] With globe compression along the anterior-posterior axis, the equatorial diameter increases: this scleral expansion could cause sudden traction of the retina and pars plana from their attachment to the vitreous base. This traumatic separation can result in posterior vitreous detachment, retinal tears with ciliary epithelium detachment, and retinal dialysis.

Our series is unique because it is the first study involving a large number of boxers over a long period. The prevalence of ocular alterations was 40.9%, much higher than in the control group (3.1%) ($p \leqslant 0.0001$). The conjunctiva and cornea were greatly affected by traumatic injuries, with an overall prevalence of 20.5%. Only one case of posterior vitreous detachment was observed, although this kind of lesion is difficult to diagnose by ophthalmoscopy. The most common lesions to these structures were subconjunctival haemorrhage and corneal ulcers. Also noteworthy was the relatively high prevalence of retinal alterations (10.6%), the most common lesions being microcystoid degeneration and oedema (table 3).

However, when we considered the prevalence of severe ocular injuries (angle, lens, macula, and peripheral retina) that may result in a large reduction in visual function, no significant difference between boxers and controls (5.5% *v* 3.1%) was seen. All the lesions observed in the controls were severe (one cataract, three lattice retinal degenerations, and one retinal hole). Similar results were obtained by Hazar *et al*[16] in a paper on 20 amateur boxers.

Analysis of retinal lesions in our cohort of boxers showed disinsertion in six and detachment in seven eyes. Unlike disinsertion, it can be difficult to correlate ocular trauma with retinal detachment, especially if delayed.[17–19] On the other hand, lattice degeneration can be considered a primitive focal retinal alteration that can be found in both boxers and controls. If this degeneration was excluded from lesions considered severe, statistical analysis showed that vision threatening injuries were more common in boxers than controls (4.9% *v* 1.3%, $p<0.05$). Nevertheless, in our opinion, ocular trauma with subsequent vitreoretinal traction can cause retinal detachment more easily in the presence of rhegmatogenous lesions, such as lattice degeneration. In 1986, Maguire and Benson[20] documented a series of eight boxers treated for retinal detachments, all suffering from rhegmatogenous lesions. Therefore this kind of alteration, and lattice degeneration in particular, should be looked out for in the general population, but especially in boxers, because of the high risk of retinal complications. Even though our study does not show a clear relation between lattice degeneration and rhegmatogenous retinal detachment in the boxers, in our opinion it is very important for the sports physician to know about this link, so that athletes engaged in contact sports such as boxing are carefully monitored and treated in the presence of risk factors for rhegmatogenous retinal detachment.

A greater prevalence of severe lesions (58% in boxers *v* 7% in controls) was found by Giovinazzo *et al*[11] in a group of 74 athletes, a figure that is quite different from our results. A possible explanation for this difference is the fact that we analysed all the boxers examined in the Sports Medical Center of FPI during a period of about 16 years, including all the professional boxers who competed in Italy in that period. Moreover, Italian boxers possibly differ from American ones in the kind of training and intensity of their fighting career. A possible limitation of our study is that the amateur subgroup was composed of subjects with electroencephalographic abnormalities or who had received two consecutive knock-outs. However, this would have increased the probability of our finding ocular lesions, but no difference was encountered

What is already known on this topic

Boxing related ocular traumas are common, in particular those involving the conjunctiva and cornea. From previous studies, vision threatening injuries are also common.

What this study adds

This study, performed on a large number of active boxers over a period of 16 years, confirms a high rate of corneal and conjunctival lesions related to boxing. However, no clear differences were found between boxers and controls when severe ocular injuries were analysed. Ophthalmological surveillance, however, should be mandatory, particularly in the presence of rhegmatogenous alterations.

in prevalence and kind of ocular lesions between amateur and professional boxers.

In conclusion, there is a high prevalence of ocular lesions in boxers, in particular to the conjunctiva and cornea. However, if severe injuries are considered, boxing, even if practiced for several years and at the professional level, does not cause a higher prevalence of ocular lesions than that observed in control subjects. Nevertheless, we suggest that prevention strategies should be considered to attain greater ocular safety in the sport. It is possible to identify general and specific (sight function examination, use of ocular and facial protectors, trained and experienced ringside doctors) prevention measures. Among the former, we underline the importance of good physical and psychological training, as well as the need to respect the safety laws.

Among the ocular specific prevention measures, we recommend that a detailed sight function examination be required to obtain a professional as well as amateur boxing license, as happens in Italy.[6 7] We believe that it is appropriate that sport medicine doctors ask for an ophthalmological consultancy not only for conditions expected by protocols, but also in the case of a positive history of ocular disease or previous ocular injuries. Also the ringside doctor should understand the ophthalmological problems associated with a boxing match. Finally, a follow up study of boxers after their retirement would be useful, to determine the long term dangers to vision related to boxing.

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COMMENTARY

The conclusion of the authors that "Boxing does not result in a higher prevalence of severe ocular lesions than in the general population" is not supported by the data presented in this retrospective study.

The severe ocular lesions that result from boxing are caused by blunt trauma and include: tearing of internal ocular structures (sphincter pupillae, peripheral edge of the iris, anterior ciliary body, attachment of the ciliary body to the scleral spur, trabecular meshwork, zonules, attachment of the retina to the ora serrata, and Bruch's membrane) which are resistant to stretching when the globe undergoes the deformations induced by the force of the impact: traumatic uveitis, cataract, hyphaema, secondary glaucoma from angle recession, damage to the periorbital and intraorbital structures, and visual field defects secondary to injuries to the visual pathways.

Lattice retinal degeneration is a common lesion, occurring in 5.2–9.5% of the general population and up to 33% of people with myopia of more than 6 dioptres. Of an estimated 174 000 patients with lattice retinal degeneration in Kumamoto, Japan, there were only 110 patients (0.06%) with retinal detachment associated with lattice degeneration. Thus, although lattice retinal degeneration can predispose to retinal detachment, especially after trauma, lattice retinal degeneration in itself is usually clinically insignificant.[1–4]

If we compare serious ocular lesions caused by boxing with similar conditions in the control group, we find that boxers have ten times the incidence of serious ocular lesions (table 1).

The authors' own data and the results of several other studies confirm that boxing is a significant cause of serious ocular injury and that boxers require regular evaluations by an ophthalmologist, with emphasis on examination of the peripheral retina.[5–11] The methodology (comparing injuries in the exposure group with incidental findings in the control

Table 1 Serious ocular lesions in boxers and controls

	Boxer's eyes (n = 1912)	Control eyes (n = 160)
Retinal detachment	7	0
Retinal disinsertion	6	0
Retinal scarring	3	0
Lens dislocation	69	0
Cataract	33	1
Visual field defect	1	0
Total	119 (6.2%)	1 (0.62%)

group) used by the authors is a dangerous precedent in that it leads to the false conclusion that boxing is safer for the eye than is actually the case. The same methodology could be inappropriately applied to almost any potential health hazard (smoking, military combat) with the result of minimising the actual risk.

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ECHO

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Ethicist urges curb on doctors banning boxing

The medical profession should restrain itself on boxing to informing those in the sport of the dangers and advising how to cut the risk of serious injuries, says a UK medical ethicist, after a call by the Australian Medical Association to ban the sport and other proposals for compulsory brain scans and genetic tests to determine sensitivity to brain injury.

The consent that exists between the parties in boxing is the central argument, he says: to try to bring about a ban is to flout the principle of autonomy of the individual that the profession must abide by in other contexts—when dealing with patients.

The call for a ban may be founded on misguided notions, he believes. So it is untrue to state, as others have, that boxing is the only sport in which the contestants can kill or intend to do so in order to win without breaking any rule. Boxers set out neither to kill nor maim, whatever their pre-fight machismo and aggressive claims, but seek to outbox each other. A contest can be won without recourse to a knockout blow—on points, by surrender, or by the referee's decision—he argues.

Yet there are measures that could reduce risk of injury—cutting rounds from twelve to ten, say, or eight; extending the interval between rounds to permit more recovery time; encouraging referees to stop fights earlier; and introducing better head protection for the contestants. True, the darker side of the boxing world still prevails: boxing management needs reform, but that falls outside the remit of the medical profession.

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