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Ocular Trauma Caused by Airgun Pellets: A Ten Year Survey

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Summary

Forty-one consecutive cases of ocular injury related to air gun pellets occurring over a ten year period have been reviewed retrospectively. The male to female ratio was 7:1 and the average age was fifteen years. Hyphaema was the most common injury (78%) while the main cause of poor final visual outcome was retinal detachment. Thirty-eight percent of the involved eyes had a final corrected visual acuity of less than 6/60 including four eyes (10%) which were enucleated following severe perforating injuries. Neither sympathetic ophthalmitis nor lead poisoning was detected in this study. The fact that these injuries are largely of an accidental nature, predominantly involve young people and appear to be occurring more frequently suggests that present legislation does not offer adequate protection. The authors suggest that the best method of prevention is through a public education campaign aimed at children and their parents.

There is a wide range of airguns and air-rifles with an accompanying variety of pellets currently available on the market and despite the potentially devastating injuries caused by these weapons[1–6] there appears to be a widespread belief among children and their parents that airguns are relatively harmless and have little penetrative power. However, a standard airgun pellet (0.345 gm) will penetrate the globe at speeds higher than 236 feet/second (72.0 metres/second).[7] Significantly most airgun rifles advertised for sale in magazines have a muzzle velocity of 620 feet/second (189.0 metres/second) which is well above the required velocity for penetration of skin, bone and deeper tissues.[8]

This study was stimulated by the admission of four children in August 1988 with severe ocular injuries due to airgun pellets and associated reports in local newspapers of a sharp rise in airgun pellet related injuries in the Greater Glasgow area. Therefore a retrospective analysis of all airgun related ocular injuries presenting to two major ophthalmological units over a ten year period was conducted.

Patients and Methods

The patient population was defined by reviewing the admission records of the two centres involved in this study; the ophthalmological departments of the Southern General Hospital, Glasgow and the Western Infirmary, Glasgow. These are large teaching hospitals responsible for the ophthalmological care of a large sector of the population of Glasgow as well as the Western Isles and both provide a 'walk in' eye casualty service and a

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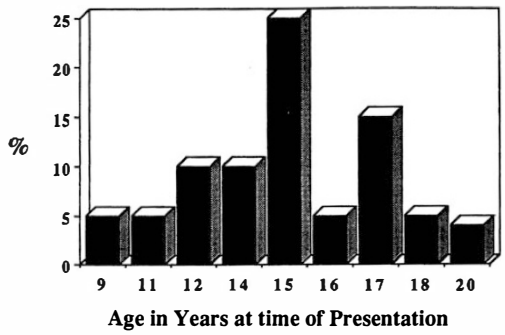

Fig. 1 *Bar graph illustrating the number of cases of airgun pellet injury to the eye in each age group (years) expressed as a percentage of the total number of ocular airgun injuries (n = 41) over the ten year period 1979–1989.*

secondary referral facility. Forty-one patients requiring admission to these hospitals with ocular injuries related to airguns (BB guns) were identified over the ten year period September 1979 to August 1989. The presenting case records, theatre notes and outpatient follow-up data for each of these patients were obtained and analysed with regard to age/sex of the patient, circumstances surrounding the injury, presenting ocular signs, subsequent management and final visual outcome.

Results

A total of 41 airgun related ocular injuries presented to the two ophthalmology units involved in this study during the ten year period under review. Seventeen of these cases presented in the seven year period September 1979—August 1986 (mean of 2.4 cases per annum), whereas, twenty four patients presented in the three year period September 1986 to August 1989 (mean of 8.0 cases per annum). Review of the age and sex of these patients demonstrates that the 'typical' airgun pellet casualty is a teenage boy. The 36 males and five females represent a 7:1 male to female ratio. The youngest child in our study was nine years old and the eldest patient 20 years of age, notably 75% of those injured were below the age of 17 years at the time of injury and the mean age was 15 years (Figure 1). There were no subjects with a pre-injury history of ipsilateral amblyopia or previous ocular trauma and all of the patients presented to an ophthalmologist on the same day as the injury.

A wide spectrum of both anterior and posterior segment injuries were encountered (Table I). Fifteen cases had a lid laceration with the pellet usually traversing the lid to reach the globe or become lodged in the orbit. Hyphaema was by far the most common ocular injury (78%) and it was associated in most cases with a degree of iridodialysis. Traumatic cataract was less common (12%) but vitreous haemorrhage was frequently encountered (63%). Commotio retinae (58%) and choroidal rupture (30%) were also common posterior segment injuries. Intraocular penetration by a pellet with severe rupture of the globe led to enucleation of the eye in four cases. In five cases a pellet was located in the orbit (Figure 2) and in a further two cases the pellet had penetrated the orbital wall to become lodged within the ethmoidal sinus. Extraction of these pellets was not performed as the procedure was considered both difficult and hazardous in asymptomatic patients.

The visual acuity on admission is shown in Figure 3 and the final corrected visual acuity is demonstrated in Figure 4. The follow-up period for these patients ranged from one month to six years with the majority having a minimum of two years follow-up post injury. Although 57% of cases presented with visual acuity less than 6/60 on admission final visual acuity corrected to better than 6/60 in 62% of the patients. The commonest causes of permanently reduced visual acuity, in the order of frequency were: retinal damage, cataract, choroidal rupture, optic nerve damage and

Table I *This data demonstrates the extensive nature and severity of ocular involvement in airgun pellet injuries of the eye. Obviously some individual cases appear in more than one injury category. (Total number of eyes = 41).*

Form of ocular trauma	*No. of Eyes (N = 41)*
Lid Laceration	15
Hyphaema	32
Marked Iridodialysis	8
Cataract	5
Vitreous Haemorrhage	26
Retinal Haemorrhage/Oedema	24
Choroidal Rupture	12
Rupture of the Globe	6
Intra-ocular pellet	4
Intra-orbital pellet	5

Fig. 2 *Lateral plain skull roentgenogram showing an airgun pellet at the apex of the orbit following a double penetration of the globe. Note the additional small metallic fragment lying anterior to the pellet.*

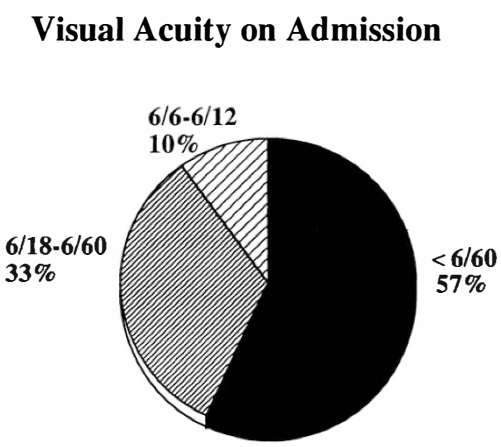

Fig. 3 *Pie diagram representing the best visual acuity in eyes injured by airgun pellets at the time of admission to an ophthalmological unit (n = 41). Note that more than half of the eyes had an initial visual acuity poorer than 6/60.*

severe perforation of the globe. Direct damage to the optic nerve by an intraorbital pellet occurred in four patients and all were characterised by no perception of light from the first day of presentation (Figure 5). Late sequelae were not commonly encountered although the length of follow-up was short in the subjects presenting in the latter part of the ten year period under scrutiny. Nonetheless angle recession glaucoma developed in five cases all of whom had sustained moderate to marked hyphaema at the time of injury. A subretinal neovascular membrane presenting as a disciform lesion associated with a pre-existing choroidal rupture occurred in one case two years after the initial injury. No cases of sympathetic ophthalmitis were encountered. Despite the retention of intraorbital or intraethmoidal pellets in five cases there were no symptoms nor clinical signs of lead poisoning, therefore in view of the small pellet mass and absence of clinical indications, estimations of serum lead were not performed.

Where an accurate history of the incident was obtainable there was only one episode of alleged criminal intent. The majority of subjects sustained their injuries while 'playing' with airguns; either being struck by a ricochet or by being 'shot at' deliberately or accidentally by other children.

Discussion

Almost 60% of the cases in this ten year survey occurred in the three year period 1986–1989 suggesting an alarming rise in the incidence of these injuries. The presented data clearly indicate the potential severity of ocular injuries from airgun pellets. It is disturbing that the extent of these injuries resulted in enucleation of the eye in four cases (10%) and ultimately more than one third of the subjects had a final corrected visual acuity less than 6/60. Indeed, since the follow-up period for the later cases was less than 12 months the longterm complication rate may be higher than we have documented and some authors have reported late sequelae up to eleven years after such airgun injuries.[2] We encountered no cases of lead poisoning despite the retention of the pellet in five cases. This may be due to the relatively small mass of a single pellet and the newer insoluble lead amalgams[9] since lead poisoning and elevated serum lead levels have been documented in earlier cases with retained airgun pellets.[10]

The spectrum of ocular injury in this series is similar to other studies, but perhaps the most important feature to appreciate is the severity of this type of injury. In a large series of penetrating ocular injuries from the Wilmer Institute[11] the worst visual prognosis, regardless of the size or position of the penetrating wound, was associated with such intraocular BB pellets. We have noted hyphaema with a degree of iridodialysis to be the most common

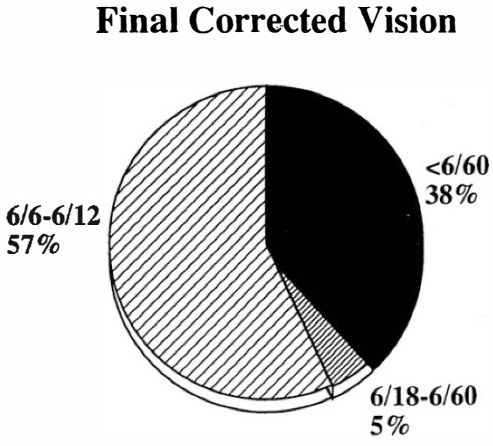

Fig. 4 *Pie diagram representing the best visual acuity in the eyes injured by airgun pellets at final follow-up review (n = 41). Note that 38% of these eyes eventually obtained less than 6/60 corrected acuity.*

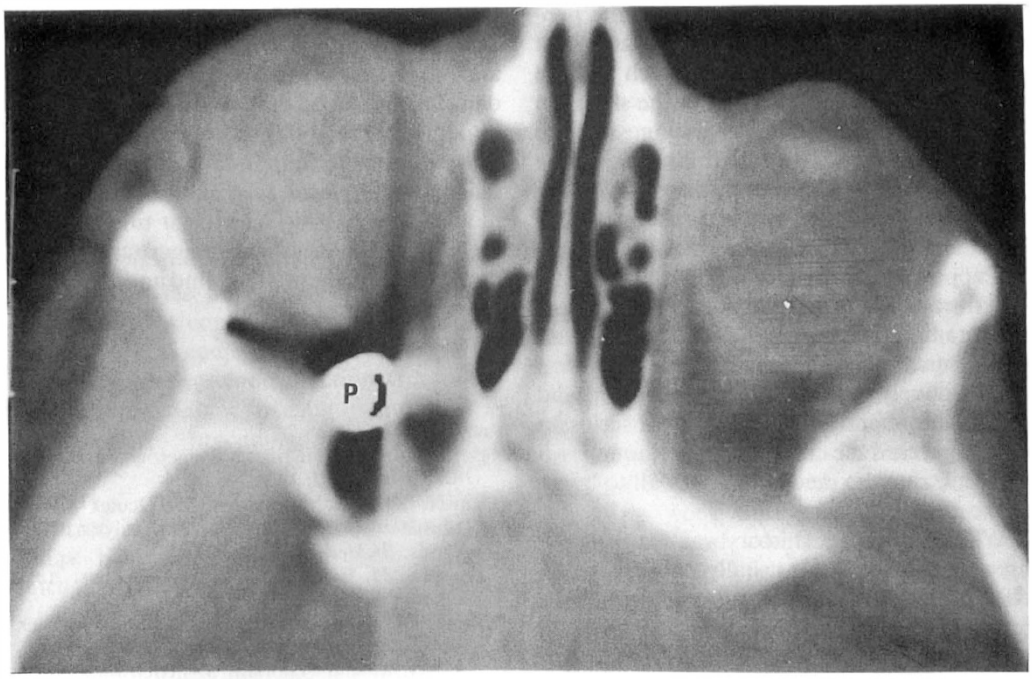

Fig. 5 *Axial CT-Scan cut through the orbits demonstrating an airgun pellet (P) lodged against the right optic nerve. Compare position of optic nerve in left orbit. (Note streak artefacts radiate from the metallic pellet, being most prominent through the medial right globe).*

manifestation of airgun injuries (78%) a presentation previously noted by Kreshon,[3] however, penetrating injuries were common (25%) and in four of our subjects (10%) these ultimately led to removal of the eye. Ocular penetration of the globe by the blunt nosed airgun or BB pellet results in the transferance of considerable energy to the eye and primary or secondary enucleation of the eye is an unfortunately common sequel with an incidence of between 33–86%[3,4,6] in cases of globe penetration. Even if one considers the overall enucleation rate for all airgun related injuries, both penetrating and non-penetrating, it is still remarkably high at 12–18% in the larger series.[2,3] The final visual acuity is a significant indicator of the extensive, disruptive nature of these ocular airgun injuries and despite improved microsurgical techniques, in the present study 38% of injured eyes had a final visual acuity of less than 6/60, which does not appear to be a dramatically improved outcome compared to the 29–42% of cases in this acuity category noted by earlier authors.[2–4] Whereas small sharp metallic intraocular foreign bodies (IOFB) following penetrating trauma do not necessarily adversely affect the visual prognosis[11,12] the presence of an airgun pellet as an IOFB carries a very poor visual prognosis.[11]

The United Kingdom and many states in the United States of America have long since enacted legislation to prevent airgun (BB) related injuries by restricting sales of these weapons to adults older than sixteen years of age.[6,13,14] Our results suggest that this is an inadequate method of preventing injuries to young children, indeed the mean age of 15 years in our series is similar to data from other major studies in which the majority of those injured were in the age range 10–16 years[1,2,4,6] although the mean age of those injured by airguns was as low as ten years of age in one series.[3]

It has previously been noted that airguns and air-rifles are often regarded as a form of 'toy' and many such weapons while bought by adults are primarily for use by children.[3] That these weapons are far from 'toys' is evident to ophthalmologists dealing with the relatively

vulnerable structure of the eye, but the penetrative power of these pellets is such that even relatively tough tissues such as the abdominal wall[1] and the vault of the skull can be penetrated.[4,5] The relative thinness of the roof of the orbit means that penetrating wounds of the upper lid may also involve the anterior cranial fossa[15] and in one series of five intracranial airgun pellet injuries two were via the upper lid and orbital plate.[5] It is of note that the authors recorded in these five cases of intracranial pellets that, 'each had a small clean puncture wound giving the impression of a relatively trivial injury, yet two died and one is permanently disabled'.[5] In our series no pellets entered the cranial cavity although two did penetrate the medial orbital wall to lodge in the ethmoidal sinus.

Where an accurate history was available the presented cases were usually subsequent to children 'playing' with airguns, although in a few cases the gun had been deliberately aimed with foolhardy if not malicious intent. Johnstone[16] in a large series of penetrating ocular injuries noted that 38% were sustained by 'children at play' and 20% were sustained while playing with 'toys' including airguns. He concludes that 'from these findings the parents lack of awareness of potential danger to their childrens' eyes is the important factor, rather than childrens' natural curiosity'. Yet despite this suggestion and the call by Kreshon[3] and subsequently by Bowen and Maugauran[2] in 1973 for physician led programmes aimed at the education of parents and children to the inherent danger of airguns, subsequent studies, including the present one, demonstrate that young, inexperienced and unsupervised children continue to be frequently exposed to these serious and potentially blinding injuries.[1,4,5,6]

Although recent moves in the House of Commons[17] to tighten up the legislation with regard to the purchase and use of airweapons are most welcome, it is our duty as ophthalmologists to become involved with educational campaigns to enlighten the public to the considerable risks associated with these guns. It has already been noted that stricter legislation does not prevent such guns getting into the hands of children and we believe that the only way to decrease the incidence of these devastating injuries is to promote gun instruction, adequate parental supervision and to increase public awareness of the dangers. It is our responsibility as ophthalmologists involved in the primary care of these injuries to help in launching such campaigns in our local communities and in the media, thus passing on a clear message that these so called 'toys' are dangerous weapons that have the potential to blind and the potential to kill.

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