



Ball bearing (BB) guns, ease of purchase and potential for significant injury

C GROCOCK¹, R MCCARTHY², DJ WILLIAMS³

¹Department of Surgery, The Royal Liverpool Hospital, Liverpool, UK

²Department of Vascular Surgery, Torbay Hospital, Torquay, Devon, UK

³Department of Vascular Surgery, The Royal Glamorgan Hospital, Llantrisant, UK

ABSTRACT

INTRODUCTION Ball bearing guns are used in the UK for war games, but they have the potential to cause severe injury if used incorrectly.

MATERIALS AND METHODS A search was made for availability of these weapons, the ease of purchase and the potential for tissue damage.

RESULTS These weapons are widely available on the Internet and are easy to purchase with no security checks. Once fully charged, an electric BB gun is capable of penetrating a cadaveric animal model at distances up to 5 m (1 m = 25 mm penetration, 3 m = 20 mm penetration, 5 m = 15 mm penetration).

CONCLUSIONS BB guns are not toys and have a significant potential to cause injury.

KEYWORDS

Ball bearing guns – Injury – Availability

CORRESPONDENCE TO

Mr David J Williams, Consultant General/Vascular Surgeon, Department of Vascular Surgery, The Royal Glamorgan Hospital, Ynysmaerdy, Llantrisant, Mid-Glamorgan CF72 8XR, UK. E: dave.williams144@btinternet.com

The UK has some of the most stringent legislation governing the ownership of firearms in Europe. This has largely been in response to the tragic massacres in Hungerford and Dunblane. At Hungerford on 19 August 1987, a single man armed with semi-automatic rifles went on the rampage resulting in the deaths of 17 people and the wounding of 15. On 13 March 1996 in Dunblane, a man armed with two revolvers and two automatic pistols murdered 16 children, their teacher and wounded 17 more. Not surprisingly legislation was introduced following both these events, the *Firearms (Amendment) Acts* of 1988 and 1997, which has removed the ownership of pump-action shot guns, semi-automatic rifles and large calibre handguns. Despite this, firearm-related crime has remained relatively unchanged,¹ although the new mandatory 5-year prison sentence for the possession of a proscribed or unlicensed firearm may impact upon this.²

During this same period, there has been a marked expansion in the participation in recreational sports involving the use of non-lethal weapons, such as paint balling and airsoft. The latter involves the use of an air-powered replica gun which fires ball bearings (BBs), usually made of plastic. They are powered in three different ways – mechanically by the use of a spring, by a gas cylinder or by the use of an electrically powered pump. As the BB gun becomes more sophisticated, the

cost rises, but so does the rate of fire and speed of the projectile.

Although considered toys by most, these weapons have been associated with serious injuries.^{3,4} Some types (*e.g.* Brocock) were capable of being illegally converted into firearms, leading to their ban in 2003.²

In the last 5 years, two major injuries have been sustained secondary to BB shootings in the regions where the authors have been working, with the likelihood that many others have occurred nationally.

Of particular concern is the lack of regulation of ownership of such a weapon. UK law states that one needs to be over 17 years to use an airgun without the supervision of an adult over 21 years of age, and that between the ages of 14 and 17 years you can use an airgun but may not buy one.⁵ Although laudable in their idea, the problem with this is that there is no licensing of air guns and, since many can be purchased mail order, the vendor does not know for certain who the recipient will be.

The legal limit on an air rifle is 12 ft.lb and 6 ft.lb for air pistols, but these weapons require reloading and, as such, the rate of fire is slow. With the advent of the newer generation of electric airsoft BB guns, which can fire 750+ pellets per minute, one can now buy an airgun firing about 10 pellets per second, each with a velocity of 90 m/s. The UK Government has not been concerned about these weapons since the energy per



Figure 1 MP5K BB gun.

pellet (kinetic energy = $1/2 mv^2$) is less than 1.55 J, which equates to 1 ft.lb; but with such a high rate of fire that can be sustained for several seconds the total energy load is much more than a single shot air rifle or pistol can deliver.

Knowing that these weapons existed and had been associated with significant injury we sought to identify routes of purchase, checks on intended recipient, ease of use of the weapon, and potential for tissue damage.

Materials and Methods

A search through glossy magazines aimed at the adult male (*FHM*, *Maxim*, *Loaded*, etc.) was made for adverts by suppliers of replica guns and airguns. An internet search using the Google search engine with the key words 'BB gun sales' and 'replica gun sales' was made. The abbreviated description of these sites were reviewed and those conducting business in the UK entered.

The BB guns for sale had 3 different propulsion methods: (i) spring fired (single shot, very low velocity); (ii) gas fired (single shot and semi-automatic, low velocity); and (iii) electric piston fired (single shot, semi-automatic and fully automatic, rated at legal UK limit for air guns). The chosen weapon was an electric air piston powered replica of the Heckler & Koch MP5K (Fig. 1).

Upon receipt of the gun, its battery power unit was fully charged. A series of tests in both single shot and fully automatic

Table 1 Comparative data, replica versus real MP5K

	MP5K (replica)	MP5K
Length	325 mm	325 mm
Weight	1.5 kg	2.0 kg
Barrel length	110 mm	115 mm
Bullet capacity	28 rounds	15 rounds
Bullet	6 mm BB pellet	9 mm bullet
Muzzle velocity	90 m/s	400 m/s
Fire rate	750–850 rounds/min	900 rounds/min

mode were conducted to assess the ability for the weapon to penetrate the skin and muscle of a fresh chicken purchased from a supermarket. In view of the likelihood that these weapons would be used at close range, either deliberately or by accident, the tests were conducted at 1, 3 and 5 m. In single shot mode, batches of 10 BB pellets were fired. In automatic mode it was not possible to count the rounds used accurately and so a full magazine of 28 BB pellets were fired at each distance. The process was repeated twice to assess reproducibility. The chicken was then examined and the number of penetrating injuries counted and assessed for depth of penetration.

Results

Adverts were only carried in 3 of 7 men's magazines, possibly representing the cost of advertising in such a medium. The Google search generated 18,500 potential sites for the phrase 'BB gun sales' and 12,100 for 'replica gun sales'. All vendors accepted credit cards, ensuring that the purchaser was over 18 years old, but with no check on the suitability of the person buying the goods. The company Airsoft Dynamics was chosen as the supplier due to its user-friendly web site and extensive range of weapons for sale. A credit card was used to purchase the MP5K and ancillaries, again with no kind of security screening of the purchaser.

The MP5K is the same size and shape as the real weapon on which it is based, although it is a little lighter (1.5 kg versus 2 kg), fires 6 mm pellets instead of 9 mm bullets, has a slightly lower rate of fire (750 pellets/min versus 900 rounds/min) and has a muzzle velocity of 90 m/s rather than 400 m/s (Table 1).

Table 2 Charge in penetration with mode of fire and distance

	Single shot	Automatic fire	Single shot	Automatic fire	Single shot	Automatic fire
	(1 m)	(1 m)	(3 m)	(3 m)	(5 m)	(5 m)
Accuracy (on target/shots fired)	17/20	16/56	12/20	13/56	0/20	6/56
Maximum penetration	18 mm	25 mm	15 mm	20 mm	NA	15 mm
Mean penetration	5.88 mm	12.81 mm	5.67 mm	11.08 mm	NA	5.19 mm

Mean and maximum penetration reduced with increasing distance in both the single shot and automatic fire modes (Table 2), with accuracy being greater in the single shot mode up to 3 m (17/20 versus 16/56 at 1 m and 12/20 versus 13/56 at 3 m) with single shot failing to penetrate at 5 m from the target. Penetration was deeper with automatic fire compared with single shot at all distances (maximum penetration 25 mm versus 18 mm at 1 m, 20 mm versus 15 mm at 3 m, and 15 mm versus no penetration at 5 m).

Discussion

Replica weapons are first purchased in the West by parents for their children, usually boys, during their infant years. These toy guns are poor copies and can in no way be confused with real weapons. They are not comparable with the modern, high-quality and expensive replicas which are available for purchase. These are the same size and shape as their real counterparts and can have additional features such as silencers and laser sights attached for added realism. Additionally, they weigh a similar amount. The only obvious differences with the MP5K we purchased was the fire selection switch had red symbols rather than the letters 'A', 'S' and 'R' and there was a battery pack visible in the area of the barrel, otherwise it would have been identical to its real counterpart. These differences would be easy to disguise and, at a distance or in poor visibility, may not have been noticeable in any case. What need there is for such a realistic copy is questionable.

The reduction in accuracy of the weapon when used in a fully automatic mode is to be expected since single, aimed shots allow for adjustments in aim and are more likely to hit the target.

The increase in tissue penetration with automatic fire when compared with single, aimed shots was unexpected since single, aimed shots are more likely to hit the target, but the rapid concentrated fire probably results in a large energy transfer into a small area of tissue resulting in disruption and penetration.

The kinetic energy (KE) of each BB can be calculated as follows:

$$\text{Mass} = 0.2 \text{ g} \quad \text{Velocity} = 90 \text{ m/s}$$

$$\text{KE} = (0.2 \times 90^2)/2000 = 0.81 \text{ J (approx. 0.6 ft.lb)}$$

$$\text{Total KE of 28 BB magazine} = 28 \times 0.81 = 22.68 \text{ J (}\approx 16.8 \text{ ft.lb)}$$

The decrease in penetration with distance is expected since the kinetic energy is dependent on velocity, which falls with distance travelled from the propelling source. The ability of automatic fire to penetrate at 5 m when aimed shots failed is probably due to multiple energy transfers in a small area leading to tissue disruption.

We used the small 28 pellet magazine for this study, but there is both a 200 pellet and a 1300 pellet magazine available, which could allow a very large number of projectiles to be fired at a person in a short period of time, increasing the likelihood of a penetrating injury.

Once a breach has occurred in the surface of the tissue, it is likely that further tissue penetration will be deeper since the underlying fat and fascia will be a less resilient barrier to the kinetic energy of the pellet when compared to the elastic skin which resists by deformation up to its breaking strain. Dependent on the anatomical region and the thickness of the overlying adipose tissue, the BB pellet may have the ability to enter a body cavity, the likelihood of this occurring being related to the size of the individual, the number of pellets fired and the distance from weapon to victim.

Experience from the US, which has less rigid gun control than the UK, has shown the number and nature of injuries which can occur, with a surprising number of fatalities.⁶ The fatalities seen in America should not occur in the UK because the guns sold in the US are much more powerful than anything legally purchasable in the UK and indeed can be adjusted to have muzzle velocities greater than police issue 0.38 calibre handguns.^{6,7} The risk of ocular injury is very real with UK specification BB guns, with manufacturers' literature recommending the use of toughened face masks.

Our model has severe limitations since there are many differences between a supermarket purchased fresh chicken and a human; however, having seen the damage that could be caused, we did not feel we could fire at a living person for fear of a potentially serious injury. Alternatives would have been cadavers or an anaesthetised live animal model, such as used by the Danish military. It is unlikely that the Home Office would have given approval to either of these and so, although flawed, we feel that this model is simple and reproducible and does give an indication of the potential for tissue penetration.

Conclusions

Replica weapons are easy to purchase with no age or security checks made on the recipient. Modern, electric-powered BB guns are almost indistinguishable from the weapon on which they are based and have the ability to fire pellets at a high rate and penetrate tissue. The continued ready availability of such devices is of some concern.

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