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Musculoskeletal pellet gun injuries; report from a conflict zone

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ABSTRACT

Background: Pellet gun used by law enforcement agencies have the potential to cause grevious or life threatening injuries as metallic projectiles fired at high speeds from pellet gun have potential to damage strongest structure like bone. The objective of the study was to evaluate musculoskeletal pellet gun injuries in patients.
Methods: This study was conducted over two years involving 88 patients.
Results: A significant number of patients had grevious musculoskeletal pellet gun injuries. 50 patients had superficial injuries, 11 patients had fractures, 5 had nerve injuries, 7 had tendon injuries and 15 had intra-articular pellets.
Conclusions: Pellet guns can cause grevious musculoskeletal injuries which can leave the victim with lifelong disability.

Keywords: Pellet, Pellet gun, Musculoskeletal

INTRODUCTION

The purpose of this study was to evaluate the musculoskeletal injuries which occurred due to pellet gunfire in Kashmir (A conflict zone).

Weapons used by law enforcement agencies in civil unrest can be divided into 1) lethal weapons including traditional sharp pointed fire arms like pistol or rifle. 2) Less lethal or non-lethal weapons including

i. Weapons which utilise chemical or electronic methods.
ii. Rubber bullets.
iii. Pellet gun.

Most of the pellet guns used worldwide use compressed air to propel a projectile. These fire a single projectile and are considered non-lethal.[1] Accidental injury to a delicate organ like eye or a blood vessel and some accidental paediatric injuries have been reported in the literature.[2-7] Other type of pellet gun commonly called toy gun/BB gun fires plastic or metallic pellets.[8] However the weapon which is the interest of our study is the pellet gun used by law enforcement agencies in crowd control (Figure 1a). This type of pellet gun uses metallic pellets (Figure 1b) in shotgun cartridges which are discharged by gunpowder detonation. The number of pellets fired in single shot is as high as 500.[9] Pellets shot from pellet guns do not have a predictable trajectory and can cause unexpectedly severe injuries. Although any part of body can be hit by pellet but most common sites of injuries involve extremities, abdomen back and chest. A delicate organ like eye is particularly vulnerable to devastating pellet injuries.[10] We in our study observed that a pellet gun can cause wide spectrum of injuries from superficial penetration of the soft-tissue to contusion of a vital organ or even a grade 3 open fracture of bones. While pellet

guns are considered "less lethal" but when used at a closer range can be lethal and can cause serious injury like any other standard fire arm injury. During crowd control the police are recommended to aim at limbs while using non-powder firearms to cause minimum damage.[11] However rules are not followed properly during crowd control causing lethal injuries with what are commonly known as non-lethal weapons.[12]

Objective

The objective of this study was to evaluate musculoskeletal pellet gun injuries in patients of a conflict zone by a so called non-lethal weapon as a mass control measure.

METHODS

The study was conducted in post graduate department of orthopaedics, Sher-I-Kashmir Institute of Medical Sciences Medical College Srinagar which is a tertiary care hospital located in Jammu and Kashmir. Our study was conducted between January 2014 to December 2016. A total of 88 patients with pellet injuries who met the inclusion criteria were taken up for study.

Ethical committee approval was taken before conducting the study.

Inclusion criteria

Inclusion criteria were patients with musculoskeletal pellet gun injuries without any immediate life threatening injury like head injury, cardiac injury or major vessel injury; patients willing to be part of study

Exclusion criteria

Exclusion criteria were patients who did not want to be part of study; patients with associated life threatening pellet injuries; patients on corticosteroids, immuno-suppressive agents, or chemotherapeutic agents.

All the patients were initially received in the accident and emergency (AE) department of our institute. Resuscitation whenever needed was done as per ATLS protocol.

Complete history was taken and examination of all the patients was done. Relevant investigations were ordered for all the patients.

All bleeding wounds due to pellet guns were thoroughly washed with saline and povidone iodine and pressure dressing was applied to stop the bleeding.

Radiographs of all the patients were studied. When needed CT scan was done. Records were maintained about the injury area, neurovascular status of the limb, when vascular injury was suspected vascular Doppler was done

Primary surgical procedures needed were done in emergency operating room (OR) and secondary surgical procedures whenever needed were done in the main OR of our institute. Opinion and required help was taken from the department of plastic surgery whenever needed.

RESULTS

88 patients with musculoskeletal pellet injuries who met the inclusion criteria were included in this study. Out of total 88 patients with pellet injuries 70 were males and 18 were females as shown in Table 1.

Table 1: Sex distribution of patients with pellet injuries.

Total pellet injuries	Male	Female
47	70	18

There was wide range in age of the patients (6 to 50 years). 57% of patients were in age group of 11 to 30 years as shown in Table 2.

Table 2: Age group of the injured patients.

Age group (in years)	No. of patients
< 10	11
11-20	22
21-30	28
31-40	19
41-50	8

Injury pattern of patients varied from simple puncture wounds to open comminuted fractures as shown in Table 3

Table3: Pattern of injuries in study group.

Injury pattern	No. of patients (%)
Soft tissue injuries (lacerations)	23 (26.13)
Tendon injuries	7 (7.95)
Nerve injuries	5 (5.68)
Fractures	11 (12.5)
Intra-articular pellets	15 (17.04
Puncture wounds	27 (30.68)

Surgical procedures in our study varied from simple dressings to multistage operative procedures as shown in Table 4.

Out of total 88 patients two patients were lost in follow-up as shown in Table 4.

78 patients were civilians injured by police and paramilitary personnel while protesting, 10 patients got injured by stray pellets at their home or hundreds of metres away from the place where pellets were fired.

Table 4: Injury pattern, treatment and outcome.

Injury	Part involved	Immediate procedure	Secondary procedure	Final outcome
Soft tissue lacerations (n=23)	Upper limb (n=10)	Wound lavage, debridement	Wound closure	Healed wound
	Lower limb (n=13)			
Fractures (n=11)	Small bone fractures (metacarpal, phalanx and metatarsal) (n=5)	Conservative	None	Complete fracture union
	Both bone leg fracture (3)	Wound lavage, debridement VAC and external fixation	Ilizarov ring fixator, flap coverage, corticotomy and bone transport	Fracture united in one patient
				One still under follow-up
				One patient lost in the follow-up
	Clavicle fracture (1)	Conservative	None	Complete fracture union
	Humerus fractures (2)	Wound lavage, debridement k wire and external fixation	Multiple debridements	stiff elbow
Nerve injuries (n=5)	1 sciatic nerve injury	Wound lavage, debridement and referred to plastic surgery	None	Reffered to plastic surgery
	3 common peroneal nerve injuries	Managed conservatively	None	Full recovery in 2 patients 1 lost in follow-up
	1 sural nerve injury	Managed conservatively	None	Full recovery
Tendon injuries (n=7)	2 ruptured tendoachilles	Wound lavage, debridement and primary repair with ethibond sutures	None	Full functional recovery
	3 Ruptured extensor tendons of fingers of hand	Wound lavage, debridement and primary repair with proline	None	Full functional recovery
	2 ruptured flexor tendons of fingers	Wound lavage, debridement and primary repair with proline sutures	None	Full functional recovery
Intra-articular pellets (n=15)	Knee (n=4)	Arthroscopic removal	None	Full functional recovery
	Elbow (n=3)	Arthroscopic removal		
	Small joints of hand and feet (n=8)	Manual Removal under C Arm		
Superficial pellet injuries with puncture wounds (n=27)	Multisystem involvement	Antiseptic dressing	None	11 reported back with abscess formation, all recovered well after incision and drainage

All the patients were received in ER, thoroughly examined, resuscitation if needed was done as per ATLS protocol, given broad spectrum antibiotics and anti-tetanus treatment as per the type of wound. Wounds were

thoroughly washed with saline and povidone-iodine, all the superficial pellets were removed in OR. The patients who needed admission in the hospital were put on 2nd generation cephalosporins, aminoglycosides and metronidizole at the outset before we got culture and sensitivity reports.

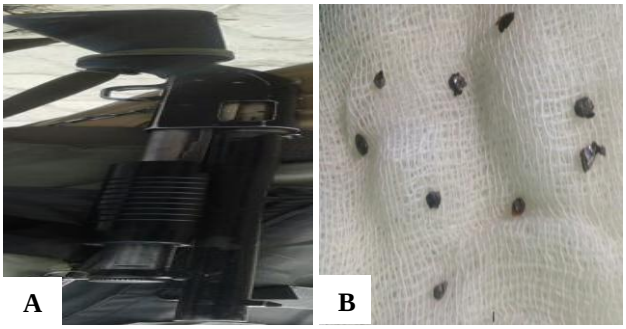

Figure 1: (A) Pellet gun used by law enforcement agencies (B) Metallic pellets removed from a patient.

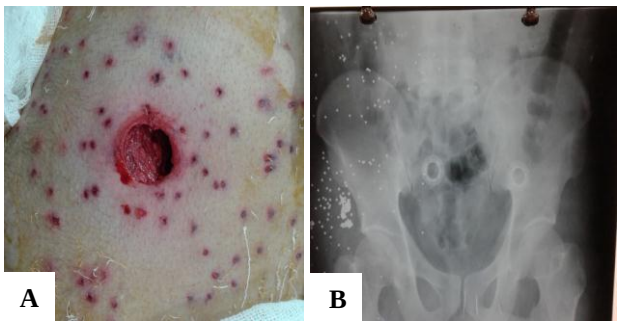

Figure 2: (A) showing lacerated wound around gluteal region, (B) X-ray of the same patient.

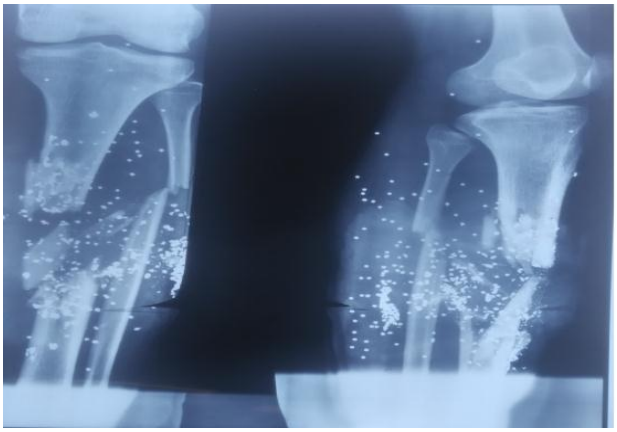

Figure 3: Patient with shattered leg bones with bone loss.

66 (75%) patients had lower limb injuries (isolated or associated), 28 (32%) had isolated or associated upper limb injuries. Almost all the patients had pellet injuries in other parts of body like abdomen, chest, neck, eyes or skull. 67 patients reported directly to our hospital, 21 were referred from peripheral hospitals. All the patients with bony injuries gave the history of getting short from a very close range or cartridge getting blasted while hitting the limb.

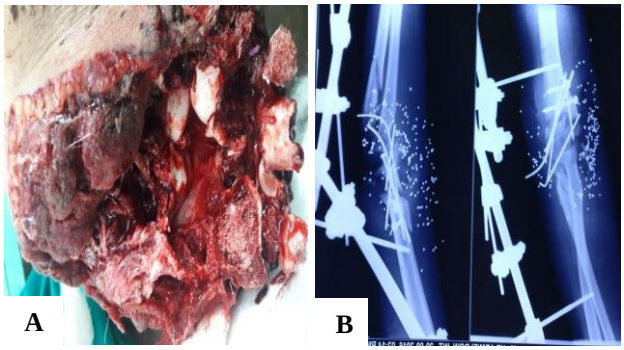

Figure 4: (A) Patient with shattered elbow, (B) X ray of the same patient.

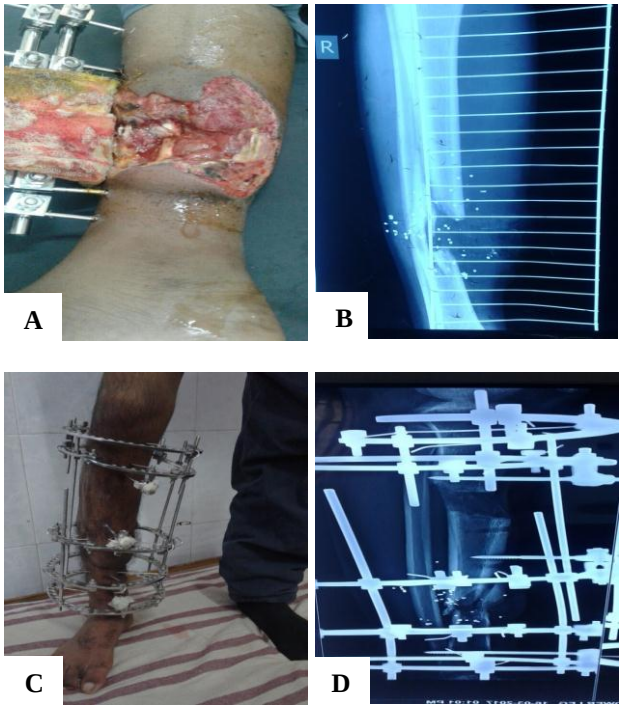

Figure 5: (A) Open bone leg fracture with external fixator in situ, (B) X-ray of same patient showing bone loss, (C) IRF and flap coverage of raw area done for the same patient, (D) callous formation at coticotomy site and gap closed at fracture site.

50 patients (56.81%) patients had puncture wounds to small lacerations (Figure 2a and 2b) at the sites were pellets got hit (Table 3). Superficial pellets in the skin and subcutaneous tissue which were visible to naked eye were removed. The pellets which had penetrated into deeper tissues were left as such. All such patients were discharged on the same day and regularly followed up in OPD. 11 patients reported back in OPD with abscess formation. One with thigh abscess, 7 with abscesses in the finger tips, 3 with foot abscesses. Abscesses were

drained and patients put on antibiotics. All the 11 patients recovered well (Table 4).

11 (12.5%) patients had fractures, 5 (5.68%) had nerve injuries, 7 (7.95%) had tendon injuries, 15 (17.04%) had intra-articular pellets as shown in table 3. The severest bony injury reported were patients with shattered tibia (n=3) (Figure 3) and humerus (n=2) (Figure 4a, 4b) with hundreds of pellets in the soft tissue around the bone with missing fragments of the bone. Multistage operative procedures were done for these patients (Figure 5a-5d). These patients were left with significant disability of the involved limb because of extreme severity of injury.

15 patients had intra-articular pellets (Table 4) involving knee, elbow and small joints of hand as shown in Table 4. All the patients with intra-articular pellets had lacerated or puncture wounds around the involved joint. After wound lavage and debridement pellets were removed arthroscopically from knees and elbows. Pellets from small joints of hand were removed under C arm. All the patients did well in the follow-up.

7 patients with tendon injuries (Table 4) were managed with thorough debridement of wound with primary repair of tendon injuries. The tendons involved were tendoachilles in 2 patients, extensors of hand in 3 patients and flexors of hand in 2 patients as shown in Table 4.

5 patients had various nerve injuries (Table 4). 1 patient with sciatic nerve injury was referred to plastic surgery. 3 patients had common peroneal nerve palsy. All were managed conservatively. 2 recovered well in the follow up, one patient was lost in the follow-up. 1 patient with sural nerve involvement recovered well in the follow up.

All the patients with large lacerated wounds were thoroughly washed, debrided and closed primarily or secondarily depending on the condition of wound. In Patients with small puncture wounds pellets were dispersed over a large area with variable degree of penetration in the soft tissues and it was not possible to remove all the pellets. A significant number of these patients were worried about the retained pellets and their side effects. Psychiatric consultation was sought for such patients to relieve their anxieties.

DISCUSSION

Most of the studies reported about pellet gun injuries are about air gun/toy gun/BB gun injuries.[2-9] The injuries reported by these weapons are mostly accidental injuries in paediatric age group and target organs are mostly delicate eyes, blood vessel.[7-9] However few case reports of fatal injuries are also reported because of these weapons.[10,11]

In our study we evaluated injuries caused by a pellet gun fire which is being used as riot control weapon by police. This weapon is commonly considered a less lethal or non-lethal weapon and is not expected to cause fatal injuries. A non-lethal or less lethal weapon is explicitly designed and used to incapacitate the people.[11] However several factors determine the severity of injury it can cause. These factors include the tissue which it is going to hit, the distance from which it is hit and the intention with which it is hit.[12] A pellet gun cartridge once fired from the gun breaks into hundreds of metal pieces.[12] The injury pattern because of these pellets varies from minor skin abrasions to serious life threatening injuries. To our knowledge there is not a single study on musculoskeletal injuries due to pellets.

The Kinetic energy of a moving projectile at the point of impact is (KE=½ mass×velocity^2).[13] The velocity of the projectile is quite higher as the projectile leaves a barrel. The energy with which it impacts the target is determined by its velocity. A safe distanced from the point of release of projectile will decrease the velocity of the projectile which reduces its energy at the time of impact which is supposed to cause less injury.

The injury caused will also be determined by the tissue a projectile is going to hit. For the lesser elastic tissues like eyes which cannot absorb energy, a pellet can be devastating. In fact most of the studies reported are about injuries to delicate organs like eyes.[14]

In our study the injury pattern and severity varied from patient to patient. Though most of the patients had minor injuries and were treated by local wound care in ER and discharged, some of the patients had suffered grevious injuries with severe long term morbidity like open type 111b fractures (Gustilo and Anderson) which normally are expected in lethal firearm injuries.[15] We observed that almost all the patients with pellet injuries had multisystem involvement. We recommend that all the patients with pellet injuries should be completely undressed and examined thoroughly as pellets usually are scattered over a large area of body. All the patients should be properly investigated for abdominal and chest injuries before being discharged from the hospital.

With muzzle velocities of 900 foot-pounds per second there are chances of serious injuries with non-powder fire arms.[16] At this velocity pellets can easily damage eyes and penetrate skin to damage deeper structures. Hence patients with pellet injuries should be evaluated for deeper injuries.

One of the challenging task for us was to answer the queries of the patients who had hundreds of pellets embedded in their body which could not be taken out due to wide spread distribution and variable degree of penetration in the soft tissue. A large Number of patients were so worried and anxious that psychiatric counselling was needed to relieve their anxieties. Except few superficial abscess formations we did not see any serious complication in the follow-up. However Sandler et al

have reported a case of bilateral amputation due to embolization of an intra-abdominal pellet.[17]

Wani et al have reported a number of vascular injuries due to non-lethal weapons like pellets and tear gas shells in a conflict zone.[18]

Mahajna et al in their study have observed that non-powder firearm can cause injuries like standard firearms when proper guidelines are not followed during crowd control and should not be considered non-lethal weapons.[19]

Non-lethal or less lethal nature of any weapon is determined by the guidelines that need to be followed while being used.[20] However during riot control rules and regulations are not followed by law enforcement agencies hence resulting in grevious injuries by these so called non-lethal weapons.

After seeing the pattern of injuries in this study we believe pellet gun is capable of causing injuries as lethal as standard fire arm weapons and should not be labelled as non-lethal or less lethal weapons.

CONCLUSION

In conclusion a so called non-lethal pellet gun used by law enforcement agencies has the potential to cause devastating musculoskeletal injuries. We in our study observed that even the strongest structure in our body can be shattered by pellets, hence pellet gun should not be labelled as a non-lethal weapon.

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