Clinical Profile of Gun Shot Abdominal Injuries and A Comparative Evaluation with Experimental Gun Shot Firings

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Abstract:

Of late, incidence of gunshot injuries are exhibiting a quantum leap owing to easy availability of firearms. Abdominal gunshot ranged from minor superficial pellet injuries to devastating soft tissues and visceral injuries.

The study included 30 cases of abdominal gunshot and other associated injuries admitted to surgery wards of SRN Hospital. Younger age group (21-30 yrs) was more commonly involved 7(23.33%). M: F ratio was 6.5:1. The rural-urban ratio was 1.5:1. Most cases 20(66.67%) were due to assault. 24(80%) received bullet injuries and 6(20%) shotgun injuries. In 19(63.33%) cases 0.315 mm bullet was responsible, of these 15(50%) were due to country made 'Katta'. 0.32 mm bullet was used only in 4(13.33%) cases. 28 were operated upon and in 2 cases of pellet injury (Type-I) conservative management was done. 22 patients of bullet and 5 pellet injuries were recovered and 3 cases expired.

The small bowel was the commonest organ involved 27 cases followed by large bowel 13 cases. Primary repair was done in 21 small bowel injury, in 9 stomach, 3 liver, 1 urinary bladder and 11 out of 13 large bowel and 4 out of 5 cases of duodenal injury.

In experimental firing with standard 12 Bore shotgun on hard contact scorching was noted up-to 30 cms, blast effect up-to 60 cms, blackening up-to 90 cms and central hole was observed up-to 5 meters 50 cms. The dispersal of pellet was observed at a distance of

180 cms and maximum diameter of dispersal was 5 cms. With country made pistol, scorching and blast effect was observed on hard contact upto 15 cms, blackening upto 30 cms and central hole up-to 90 cms. Dispersal of pellet began at a distance of 30 cms and was 5 cms in diameter. Our experimental findings are more or less well corroborated with the clinical profile of abdominal gunshot injuries in human beings.

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Introduction

With rapid strides in gun culture, gun shot injuries are creating havoc since gun is a favored weapon for heinous murder, assault and self defence. Incidence of gun shot injuries are increasing due to easy availability of arm and ammunition coupled with deteriorating law and order situation. Abdomen and chest are the favoured sites for assailants to incapacitate or kill. Gun shot injuries range from minor superficial pellet injuries to devastating soft tissue and visceral injuries. Multiple factors including ballistics of the missile, type of arm and ammunition, distance, position of the victim etc. are responsible for variety of clinical injuries.

Shotguns are more commonly used. These are smooth bored firearms (guns) i.e., the bore (inside the barrel) is perfectly smooth. The barrel length of the shot gun usually varies from 60 cms to 75 cms and either a single ball or charge of shots (pellets) acts as projectile or projectiles.[1,2] Firearm injuries are caused by high velocity projectiles called

bullets or pellets which produce punctured wounds. The capacity of the projectiles to penetrate the tissue depends on various factors including type of firearm weapon and ammunition used.[2] The knowledge of ballistics is very important to identify the bullet and gun used, regarding the extent of injury, likely management and the prognosis of the patient.[3] Limited literature concerning the spectrum of abdominal gun shot injuries is available considering moderate to low lethality of weapons used in this region; about extent of injury they cause, regarding different protocols of management and the final outcome of the injured victim.

The aim of the study is to evaluate clinical profile of gun shot abdominal injury patients, extent of injury inflicted by different types of fire arms, nature and type of bullet or pellet injuries caused by country or factory made guns, other related factors which affect extent of intra-abdominal injury along with protocols of management undertaken and their prognosis. An attempt has also been made to comparatively evaluate gun shot injuries in human beings with experimental gun shot injuries. The experimental firing was carried out with standard 12 Bore shot gun and 12 Bore country made pistol to compare the results.

Material and Methods:

This prospective study of one year duration comprised of total 30 cases of the gun shot injury of abdomen and other associated injuries if any, who were admitted to surgery wards of SRN Hospital attached to MLN Medical College, Allahabad.

All patients presenting with abdominal gun shot injuries, a detailed history pertaining to age, sex, religion, occupation, socio-economic status, residence, time of injury, reason behind injury, distance of weapon, position of victim and type of weapon used was taken

along with routine physical examination. Special emphasis was laid to locate entry and exit wounds with possible path of missile, scorching, blackening, tattooing, evisceration, hemorrhage, signs of peritonitis, shock, and associated neurological deficit if any. Besides per rectal examination, Ryle's tube content examination, signs of peritoneal and thoracic penetration and other injuries were also taken note of and managed accordingly.

Experimental firing was arranged by using

(a) 12 Bore standard gun and country made gun,

(b) Shot gun cartridges No 3 and 4,

(c) Table fixed with vice,

(d) 30 ft wire/rope,

(e) Targets comprising of

    (i) Wooden boards covered with cardboard sheets and white paper

    (ii) Padded white cloth on wooden board

    (iii) Stuffed goat skins with hair intact

Photographs were taken with the help of photography unit. Specifications of 12 Bore gun were mark- Popular Marshal, single barrel, length of barrel 79.5 cms, barrel diameter 2.2 cms, barrel bore diameter 1.8 cms; specifications of country made pistol were length of barrel 13.5 cms, diameter of barrel 2.5 cms; shot gun cartridges specifications were size 6.5 cms, Mark KF 12 Bore, Special long range cartridges No 3 and 4 loaded with smooth smokeless powder and chilled shot.

Shots were fired from standard 12 Bore gun in normal manner. Shots were fired from country made pistol by fixing the vice on a wooden table and then pistol was fixed in the vice ensuring tight grip. The table was placed in front of the target at different distances

and distance between muzzle end of the pistol and target measured. About 10 metre long rope/steel wire was tied with the trigger. The pistol cocked (ready to fire) and rope/steel wire pulled and thus the shot was fired.

The study of the effects like burning, blackening, tattooing and dispersal of pellets carried out and a comparison was made between results with standard gun and country made pistol.

Observation and Results:

Younger age group persons 21-30 years were more commonly involved 7 (23.33%) cases, followed by 31-40 years 6 (20%) cases and least 2 (6.67%) cases were observed in 11-20 years. Youngest patient was 13 year old and the eldest was of 65 years old. Males 26 (86.67%) outnumbered females. M: F ratio was 6.5:1. Most cases 18 (60%) belonged to rural population and 12 (40%) cases belonged to urban population. The rural urban ratio was 1.5:1. (Table-1)

Maximum cases 20 (66.67%) were due to assault. The causative factors more commonly observed for assault were family or property dispute 7(23.33%) cases, followed by rivalry and illicit relationship 4(13.33%) cases each. Out of 4 injured females 3 were injured in assault, one in illicit relationship and none were injured in exchange of fire or suicidal attempts. Accidental gunshot injury was the second most common cause with 6(20%) cases followed by caught in cross fire 3(10%) all 3 were male patients, and 1 male (3.33%) was of suicidal injury. (Table-2)

Regarding types of ammunition and arms used in gunshot injury, most patients 24(80%) received bullet injuries while 6(20%) received shot gun injuries. In 19(63.33%) cases 0.315 mm bullet was responsible, of these 15(50%) cases were due to country made

'Katta' which was found to be most common gun in present study, while in 4(13.33%) cases injury was due to factory made 0.315 mm guns. 0.32 mm bullet was used only in 4(13.33%) cases, all were fired by factory made guns. One male (3.33%) got injured accidentally by service carbine bullet. Of 6 shot gun injuries 4(13.33%) were due to country made shot gun and 2(6.67%) due to factory made shot gun (Table-3).

Regarding clinical profile of patients with abdominal shot gun injury, it was observed that out of total 6(20%) cases, 2 were of type I injury(pellet spread > 25 cms, wounds with penetration of subcutaneous tissue or deep fascia), 1 was of type II injury(pellet spread 10-25 cms, perforation of structures beneath deep fascia) and 3 were of type III injury (pellet spread < 10 cms, massive tissue destruction) (Table-4). 2 patients of type III injury presented with extensive injury and shock with 5 injured organs, and one patient died due to multi- organ failure on 14^{th} day. All type I and type II injury cases recovered completely and discharged. Of 19 cases due to 0.315 mm bullet, 18 were relieved and one expired, and of 4 cases of 0.32 mm bullet, 3 were relieved and one expired (Table –4).

In cases of abdominal gun shot injuries, an individual may have one or more organs involved. Thus small bowel was the commonest organ injured in 27 instances (90%), followed by large bowel 13 (43.33%) and stomach 9 (30%) cases. Of 9 patients who had stomach injury, 7 had hemorrhagic contents in Ryle's tube aspirates. Of 2 cases of spleenic injury, one was caused by direct injury by 0.32 mm bullet (Table-5).

Associated injuries of chest, extremities and head and neck regions were found in 9 cases, of these 6 were due to bullet injuries and 3 were due to pellet injuries. Of total 30 cases, 28 were operated upon and in remaining 2 cases of pellet injuries (Type-I) conservative management was done and patient discharged in 2 days.

Out of total 24 cases of bullet injuries, 22 patients were discharged with mean hospital stay of 12 days and only 2 cases (8.33%) died. Of 6 pellet injuries cases, one patient expired. Cause of death in all the 3 patients was multi organ failure. (Table-6)

Regarding organ specific management following laparotomy in abdominal gun shot injury, it was observed that of 27 instances of small bowel injury, primary repair was done in 21 cases, in 4 cases with illeostomy and in 17 cases without illeostomy. In remaining 6 cases resection and anastomosis was done (2 with ostomy and 4 without illeostomy). Of 13 large bowel injury cases, primary repair was undertaken in 11 cases (2 with ostomy and 9 without ostomy). In one patient colocolic resection with anastomosis was done and in other illeotransverse anastomosis without ostomy was done.

In 26 mesenteric tear cases, 21 cases were repaired and in remaining 5 cases resection and anastomosis (3 with ostomy and 2 without ostomy) was performed.

In 9 stomach injury, in 3 liver injuries and in one urinary bladder injury cases the primary repair was done. Of 5 duodenal injuries, 4 cases were primary repaired and in one case gastrojejunostomy was done. In 2 cases of spleenic injury spleenectomy was performed. No major complications were observed except in one case of liver injury which developed liver abscess.

In cases of experimental firing with standard 12 Bore shot gun on hard contact, scorching was noted upto 30 cms, blast effect upto 60 cms and blackening upto 90 cms. Tattooing was absent in hard contact. Tattooing was observed in loose contact upto a distance of 60 cms. Central hole was observed in all the shots on hard contact upto a distance of 5 meters 50 cms in reducing size and the hole disappeared at 7 meters 50 cms and beyond.

Regarding effects of wad, it was observed that wad produced hole between distances of 90 cms to 450 cms. The wad effect is not seen on hard contact. (Table-7)

The dispersal of pellets was observed at a distance of 180 cms and maximum diameter of dispersal was 5 cms and as the distance was increased the dispersal also gradually spread. At distance of 1100 cms the maximal diameter of dispersal was 42.5 cms with standard shot gun. (Table-8)

With country made pistol, scorching and blast effects were observed on close distances like hard contact to 15 cms and absent at 30 cms and beyond. Blackening was observed at close contact (hard contact) upto 30 cms. Tattooing was not seen on hard contact and was observed only between a distance of 15 cms to 30 cms and absent at 90 cms and beyond. Central hole was observed at hard contact only upto a distance of 90 cms. Hole by wadding was noted between a distance of 30 cms to 180 cms but was not observed at close or near close contact i.e. upto 15 cms. (Table-9)

Dispersal of pellets began at a distance of 30 cms and was 5 cms in diameter. Dispersal continued increasing as the distance was increased and at 180 cms the maximum dispersal diameter was 25 cms. (Table-10)

Discussion:

With both ‘mafia raj’ and violence at their peak coupled with rising curve of gun culture have culminated into quantum leap in gun shot injury cases. Gun shot injuries constitute a fascinating topic of interest. Presently the people, in particular, rural folks are heavily armed with fire arms than before owing to easy availability of cheap country made fire arms and with bribe they even get fire arm license which was previously difficult to achieve.

Most country made firearms are handguns using 0.315 mm bullet resulting in moderate lethality. Maximum registered firearms are of shotgun variety, which fire low velocity pellets with low kinetic energy resulting in moderate lethality. Shotguns are smooth bored firearms meant to cover a wider area with shot and thus used to kill birds and animals but of late, their criminal use on human beings is unfortunately more common. Moreover, the internal ballistics of the country made guns is very different from factory made guns hence the type and pattern of injury vary with the type of firearm used and from region to region.

Maximum involvement of younger age group individuals 23.33% reflect that this age group is more vulnerable to gun shot injuries owing to their active involvement during assault and they come into rage quite easily and early. Our findings of involvement of younger age group in abdominal gun shot injuries is in agreement with those of other workers in the field.[4,5]

Our findings that males are predominantly involved are in conformity with those of other studies.[4,6] A greater involvement of males is due to their active involvement in earning livelihood, outdoor activities, participation during assault process, quarrels, burglary , rivalry, crossfire etc.

A predominance of rural population as compared to urban class in abdominal gun shot injury is probably because rural populace is heavily armed with country made guns and incidences of land/farm field disputes, burglary, dacoities and rivalry are more frequent. Moreover, arms also serve as a self defence measure and are social status symbol in rural folks. Amongst various causes and factors leading to gun shot abdominal injuries, assault is the foremost followed by accidental injuries, the suicidal motive is observed in only

one case. Common factors which lead to assault in descending order include family or property related disputes, rivalry, illicit relationship, quarrel, burglary etc. Accidental firing occurred by firing of gun unknowingly or more commonly under the effect of intoxication especially in marriage party or festive occasions. Similar findings have been observed by other workers.[7]

Of total 19 cases due to 0.315 bullet injuries, 15 (50%) were due to country made guns, which were more commonly used by local rural individuals, while 4 (13.33%) persons were injured by factory made guns. 0.32 mm bullet injury was recoded in 4 (13.33%) cases and all were due to factory made guns.

In 3 cases the exit wound was not found in the expected axis of entry wound as the bullet ricocheted inside the body or it had traversed the path of least resistance. Thus several X-rays were required to locate the bullet. Other workers have also observed that sometimes whole body X-ray is needed to locate the bullet.[7] 6 persons received multiple pellet injuries, of these 4 (13.33%) were due to country made and 2 (6.67%) were factory made shot guns. Thus, there is a preponderance of injuries due to country made guns and shot guns because these are cheap and are easily available. In case of 0.315 mm country made gun, owing to low muzzle velocity, cavitation and collateral damage is not extensive as compared to rifle bullet injury however, these too can cause serious injuries and even death when fired from close range.

Extensive pellet scatter of more than 25 cms (Type-I injury) usually follow a benign course, whereas when pellet scatter in less than 10 cms (Type-III injury) massive tissue devastation is observed and signifies serious injuries. Similar findings were also observed by Glezer et al.[8]

Clinical findings of local wound examination of an entry wound such as presence of tattooing, scorching etc and pellet spread gives an idea about severity of injuries in relation to shot gun injuries and the distance from which a fire arm was fired. Thus, scorching, blackening and tattooing are observed when shotgun is fired from distance close to the body upto 180 cms. Where standard gun has been used, local examination of wound gives a sufficient idea about distance of firearm from the object, its direction etc. and that this knowledge can be used in the administration of justice. But the application of this knowledge in case of country made gun is not only wrong but misleading too.

Small bowel was the most commonly injured organ affecting 27 individuals followed by large bowel. Less commonly liver, spleen, kidney, were injured whereas uterus and urinary bladder were least involved.

It has been observed that survival rate following abdominal gun shot injuries is much better if the patient has been operated upon (exploratory laparotomy) as early as possible (less than 4 hrs) where a clear indication of laparotomy exists such as peritonitis or hemorrhagic gastric aspirate (signifying stomach injury). Presence of peritonitis was the most common sign in patients who underwent laparotomy. Our findings are in conformity to others, who have reported that most patients survive if they are operated in first 6 hours.[9]

All the patients with bowel injuries were managed either by primary repair or resection and anastomosis. Among these patients one group had decompressive enterostomy and the other without an illeostomy/ colostomy. There was no difference in outcome of these two groups of the patients and repairs healed without any complications. Our findings are in agreement with those of other workers.[5,10]

Regarding outcome of abdominal injury cases, out of 30 injured cases, 27 were relieved and discharged. It was observed that type-III pellet injuries were associated with more number of deaths, longs hospital stay and greater incidences of complications such as abdominal abscesses, dehiscence and multi organ failure compared to type-I and type-II injuries as well as bullet injuries. Our findings are in concurrence to those of Glezer et al[8] and Grimes et al.[6] Two patients sustained only superficial abdominal wall pellet injury (Type-I) and were managed conservatively and discharged within 48 hrs.

Mortality in pellet injury was 16.67% as compared to bullet injury 8.33%. Our findings are in agreement with those of other workers.[6] Mean hospital stay in operated patients of bullet and pellet injury is not significantly different 12 Vs 14.3 days respectively.

In the present study experiment firing has been undertaken to compare the results of firing from a standard 12 Bore shotgun with 12 Bore country made pistol at varying distances keeping other factors constant and whether these findings can be interpolated in actual situations of gun shot injuries in abdomen.

A country made pistol is more frequently used weapon may give a 13 cms pattern at 90 cms. The comparison of patterns or their spread does not present a problem when small shot size is used. For large shot the pattern has to be properly evaluated. In brief, in long distance firing the approximate distance of firing can be calculated by the maximum diameter of the skin wound in standard shot gun. However, any attempt to calculate the distance of firing in case of country made gun will give misleading results and there is no valid formula as each country made gun varies from the other regarding the barrel length, bore etc.Thus the only method of estimating the distances correctly in case of country

made guns is to carry out test firing from the particular gun and to compare the results of firing to those on the human victims.

With standard 12 Bore shot gun, the flame effects i.e., scorching was found upto 30 cms in comparison to 15 cms with country made gun. Tattooing with standard shot gun was observed between a distance of 5 cms to 60 cms and with country made pistol it was found between 15 cms to 30 cms. These findings were not in agreement with other workers[1] who observed flame effects upto a distance of 90 cms and tattooing between a distances of 90 cms to 270 cms. However, our experimental findings are more or less well corroborated with clinical profile of abdominal gunshot injuries in human beings.

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Table 1: Distribution of Age, Sex and Habitat of Gunshot Injury in Abdomen

Age Gp. (Years)	Males	Females	Total No.(%)	Rural No.(%)	Urban No.(%)
11-20	1	1	2(6.67)	0(0)	2(6.67)
21-30	5	2	7(23.33)	4(13.33)	3(10.00)
31-40	5	1	6(20.00)	4(13.33)	2(6.67)
41-50	5	0	5(16.67)	3(10.00)	2(6.67)
51-60	6	0	6(20.00)	4(13.33)	2(6.67)
61-70	4	0	4(13.33)	3(10.00)	1(3.33)
Total	26	4	30(100)	18(60)	12(40)

Table 2: Causes of Gunshot Abdominal Injuries

S. No.	Causes	Total No. (%)
1.	Assault	
(a)	Family/Property Disputes	7(23.33)
(b)	Rivalry	4(13.33)
(c)	Illicit Relationship	4(13.33)
(d)	Quarrel	3(10.00)
(e)	Burglary	2(6.67)
2.	Accidental	6(20.00)
3.	Crossfire	3(10.00)
4.	Suicidal	1(3.33)
	Total	30(100)

Table 4: Type of Gunshot Abdominal Injuries and Outcome

S. No.	Type of Injury	Total No. (%)	Outcome	
			Relieved	Mortality
1.	Shotgun Injury			
(a)	Type I	2	2	-
(b)	Type II	1	1	-
(c)	Type III	3	2	1
2.	Bullet Injury			
(a)	0.315 mm	19	18	1
(b)	0.32 mm	4	3	1
(c)	Carbine Bullet	1	1	-

Total 3: Types of Ammunition and Arms used in Gunshot Injuries

S. No.	Type of Ammunition & Arms used	Patient No. (%)
1.	0.315 mm Bullet Injury	
(a)	Country Made Gun	15(50)
(b)	Factory Made Gun	4(13.33)
2.	0.32 mm Bullet Injury	
	*Factory Made Gun	4(13.33)
3.	Service Carbine Bullet	1(3.33)
4.	Pellet Injury	
(a)	Country Made Shot Gun	4(13.33)
(b)	Factory Made Shot Gun	2(6.67)
	Total	30(100)

Table 5: Showing Specific Organ Involved and Total Number of Individuals Affected

S. No.	Organ Involved	Total Individuals Affected (n=30) (100%)
1.	Small Intestine	27 (90)
2.	Large Intestine	13 (43.33)
3.	Stomach	9 (30)
4.	Diaphragm	4 (13.33)
5.	Liver	3 (10)
6.	Spleen	2 (6.67)
7.	Kidney	2 (6.67)
8.	Urinary Bladder	1 (3.33)
9.	Uterus	1 (3.33)

Table 8: Showing Extent of Dispersal of Pellets at Different Distances with Standard Shot Gun

S.No	Distance	Maximum Diameter Of Dispersal
1.	Hard Contact	Absent
2.	3-30 cms	Nil
3.	30-90 cms	Nil
4.	180 cms	5 cms
5.	360 cms	12.5 cms
6.	450 cms	21 cms
7.	550 cms	22.5 cms
8.	750 cms	36 cms
9.	1100 cms	42.5 cms

Table 6: Management and Outcome of Various Gunshot Injuries Cases

Type of Injury	Associated Injury	Management of Abdominal Wound	Mean Hospital Stay	Outcome	
				Discharged n (%)	Mortality n (%)
Bullet Injury (n=24)	6	Operated (n=24)	12 Days	22 (91.67)	2 (8.33)
Pellet Injury (n=6)	3	Operated (n=4) Conservative (n=2)	14.3Days 2 Days	5 (83.33)	1 (16.67)

Table 7: Showing Distance upto which Scorching, Blast Effect, Tattooing and Blackening were observed with Standard Shotgun

S. No.	Distance	Scorching	Blast Effect	Blackening	Tattooing
1.	Hard Contact	Present	Present	Present	Absent
2.	5 cms	-do-	-do-	-do-	Present
3.	10 cms	-do-	-do-	-do-	-do-
4.	30 cms	-do-	-do-	-do-	-do-
5.	60 cms	Absent	-do-	-do-	-do-
6.	90 cms	-do-	Absent	-do-	Absent
7.	180 cms	-do-	-do-	Absent	-do-

Table 9: Showing Distances upto which Scorching, Blast Effect, Blackening and Central Hole were observed with Country Made Pistol

S. No.	Distance	Scorching	Blast Effect	Blackening	Tattooing	Central Hole	Wad Hole
1.	Hard Contact	Present	Present	Present	Absent	Present	Absent
2.	15 cms	-do-	-do-	-do-	Present	-do-	-do-
3.	30 cms	Absent	Absent	-do-	-do-	-do-	Present
4.	90 cms	-do-	-do-	Absent	Absent	-do-	-do-
5.	180 cms	-do-	-do-	-do-	-do-	Absent	-do-

Table 10: Showing Extent of Dispersal of Pellets at Different Distances with Country Made Pistol

S. No.	Distances	Maximum Diameter of Dispersal
1.	Hard Contact	Absent
2.	15 cms	Nil
3.	30 cms	5 cms
4.	90 cms	12 cms
5.	180 cms	25 cms