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PENETRATING ABDOMINAL MISSILE INJURIES ANALYTIC STUDY IN RAMADI TEACHING HOSPITAL

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Abstract:

The aim of this study to the penetrating missile injuries to the abdomen was to analyze the organs affected by these injuries and to evaluate the efficacy and necessity of the current treatment modalities. This prospective clinical trial conducted in Ramadi Teaching Hospital, Accident and Emergency (A and E) Department and the surgical unit. Starting from the 1st of October 2017 to 30th of September 2019. for 174 patients admitted to the (A and E) department with abdominal missile injury, we categorized those with associated injuries to other anatomical body areas, lines of treatments, those underwent laparotomies and statistically analyzing intra-abdominal organs injuries. The results revealed that: The most vulnerable age group involved between 21-30 years comprised 54.02% of total. Male to female ratio = 6.90:1. It was observed that majority of the injuries were high velocity missile (HVM). and shrapnel (44.25%), while low velocity missile (LVM) as pistol (17.81%). It was seen that 84.84% of patients had positive findings during laparotomies. Small intestine was involved in majority of the patients (42.85%), followed by large intestine in 35.71%, then Liver in 19.04%. Majority of the patients had involvement of three organs (34.53%), followed by involvement of two organs (32.14%). Plain (alone) abdominal missile injuries were found in 56.89% of total patients. Associated injuries of two or more than two body regions/areas were found in minority of patients (7.47%). P. Value was 0.003. And the mortality was 1.14% also it was found that 65 (32%) of the patient with missile abdominal injuries were treated conservatively and 15 (8.6%) had negative laparotomies .so we concluded that about 40% of the patient with missile abdominal injury had no significant intra-abdominal injury which could be managed non-operatively ; Since unnecessary laparotomy is associated with morbidity and prolongation of hospital stay duration .

Keywords: Abdominal missile trauma, high velocity missile (HVM), low velocity missile (LVM).

INTRODUCTION

Historically, penetrating abdominal trauma was managed expectantly until the late 19th Century. In World War I, with the high mortality and morbidity associated with penetrating abdominal trauma, operative management had replaced expectant management. In civilian life, the majority of abdominal injuries are due to blunt trauma secondary to high speed automobile accidents. Penetrating injuries, although often associated with war time combat, are seen with increasing frequency in hospital emergency departments, particularly in urban areas[1].Penetrating injuries to the abdomen caused by firearms are more common than stab wounds and can cause more damage to different sites of the abdomen and far more associated injuries which accentuate the mortality. Such Injuries to the abdomen are not always isolated but often associated with injuries to other parts of the body like head, chest, spine, and extremities [2]. The mechanism of injury due to missile occur when the penetrating object transfers part or all of its energy along its path or even away from it. the amount of energy transferred may be expressed by the formula **KE=1/2M(V1-V2)** where **KE** is the kinetic energy**, M** is the mass, **V1**,**V2** are the velocities at entry and exit respectively.

In general bullets fired from hand guns & most modern fragments munitions are propelled at low

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relative velocity " up to 200 m/sec." with low available energy "100-500 J" and result in low energy transfer wounds, so its effect mainly will be laceration of the traversed structure.

While missiles with high available energy "2000-3000 J" including high velocity assault rifle bullets " 200-1000 m/sec." will accelerate the medium through which it passes with such a force that the medium will continue to move during and after the passage of the missile which will result in what is known as the cavitation effect " temporary and permanent " that will cause severe and wide spread bruising with tearing, stretching, and rupture of nearby viscera[3,4]. In spite of the early realization that not all penetrating abdominal injuries required an operation, as it was recorded that Since the 1960's, selective non-operative management of stab wounds to the anterior abdomen has become a standard of care, The gunshot wounds to the abdomen are still treated by mandatory exploration based on an allegedly high incidence of intra abdominal injuries and low rate of complications, if laparotomy turns out negative[5]. Authors recommend urgent treatment to the abdominal wounds and their point is that Early recognition of the injuries and immediate treatment are mandatory in saving the lives of many of these patients [6]. And due to the high risk of developing fatal consequences, every penetrating missile wound to the abdomen should be explored by laparatomy [7,8].

Keeping in mind that for the management to be competently offered to these cases, it is not sufficient just to master operative techniques, knowledge is required over a wider area, encompassing epidemiology, biophysics and pathophysiology, failure to understand the underling scientific basis of such injury has led to inappropriate managements [8].
In this study we aimed to analyze the abdominal organs injured due to penetrating missile injuries, and to evaluate the necessity of performing urgent laparotomy for these patients.

PATIENTS AND METHODS

Materials for the present study were prospectively analyzed from patients, subjected to abdominal missile injuries, admitted to the A & E department then to the surgical unit of Ramadi Teaching Hospital, from 1st October 2017 to 30th September 2019. The total number was 174 patients. All the patients having abdominal missile injuries included in the study, with or without other associated body injuries. All were hospitalized following injury. Death on arrival was not included in the study. The relevant informations obtained in every patient were recorded in a detailed Performa specially prepared for the evaluation of abdominal missile injury patients. This detailed performa is enclosed in Appendix I. Every patient was studied under these headings.

a) History: (from patients or witnesses) including name, age, gender, , type of missile (HVM or LVM).

b) Examination: to record the anatomical site of injury conducted in body figure drawn in the Performa.GCS ,vital signs,abdominal examination

c) Lines of treatment: including early resuscitation to laparotomy and recording findings found in the laparotomies. The patients treated conservatively were followed for up to 48 hours. treatment lines had included local wound exploration that in some patients extended to formal laparotomy when the peritoneum cavity found to be violated by the missile.

d) Labarotory investigations included Blood grouping,cross matching,Blood Urea and packed cell volume.

e)Imaging study: abdominal ultrasonography done for all patients , C.T scan done for patients treated conservatively initially (when the clinical and ultrasonic examinations were equivocal and the patients conditions were stable) .

e) Complications were recorded.

f) Mortality were recorded.

g) Resuscitation with intra venous fluids and blood transfusions for those who were hemodynamically unstable.

RESULTS

Detailed observations for 174 patients with evidence of abdominal missile injuries during the period from the 1st of October 2017 to the 30th of September 2019 were carried out and various statistical results were drawn from them. These are described as follows:

1. AGE INCIDENCE

The most vulnerable age group involved between 21-30 years comprising 54.02%(94) of the total patients followed by the age group of 31-40 years comprised 22.41%(39) of total patients. Children below 10 years constituted only 0.57%(1) of total patients. Persons above 80 years (81-90 years age group) constituted only 1 patient, i.e., 0.57% of total patients. The age wise distribution of patients is shown in the Table-1

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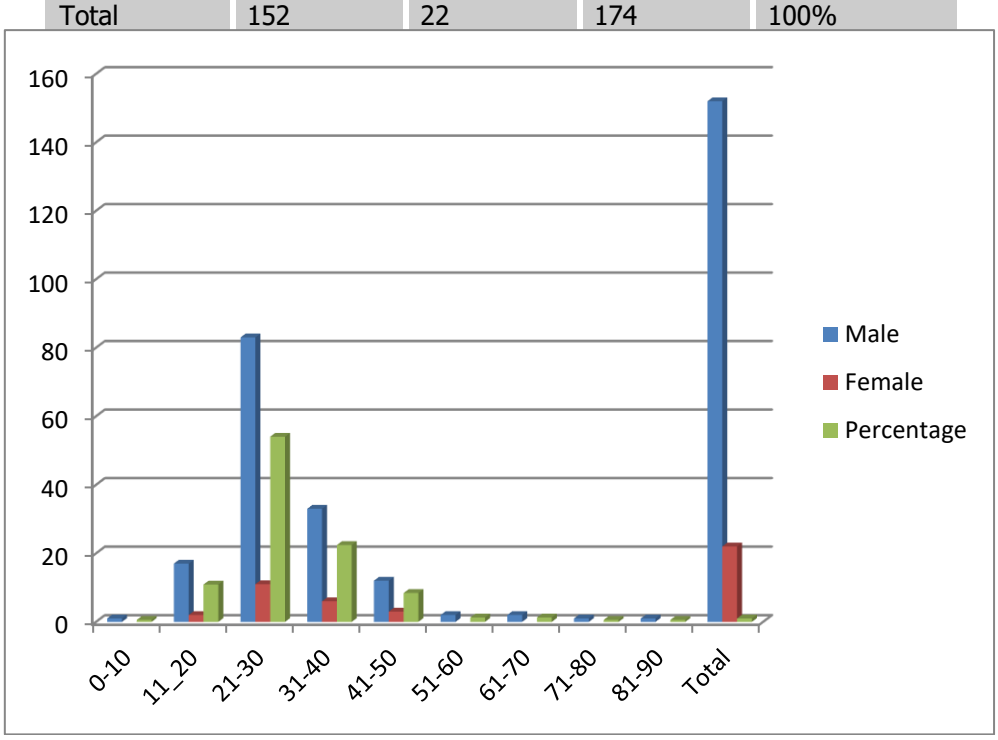
Table-1: Age incidence for 174 patients

Age\years	Male	Female	Total	Percentage
0-10	1		1	0.57
11-20	17	2	19	10.90
21-30	83	11	94	54.02
31-40	33	6	39	22.41
41-50	12	3	15	8.42
51-60	2		2	1.27
61-70	2		2	1.27
71-80	1		1	0.57
81-90	1		1	0.57
Total	152	22	174	100%



2. GENDER INCIDENCE

Among those 174 patients studied, males comprised 152 patients, i.e., 87.35% of patients, while females were only 22 in number, i.e., 12.65% of patients as is shown in the Table-II , male to female ratio=6.90:1.

Table-2: Gender incidence

Gender	No. of patients	Percentage
Male	152	87.35
Female	22	12.65
Total	174	100%

Male to female ratio = 6.90:1

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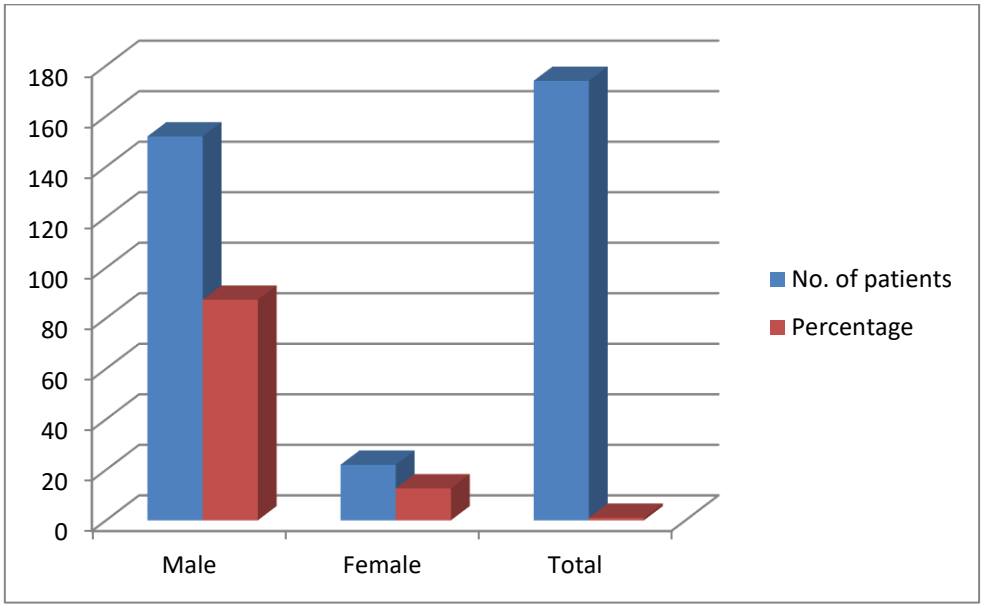

3. DIURNAL VARIATION

The distribution of the incident time of the patients by the various time periods of the day is shown in the Table-III. On analyzing the data, it was observed that most of the missile injuries occurred during the period between 9.01 A.M. - 12 P.M. (noon) which accounted for 44.25%(77) of total patients. This was followed by the period of 12.01 P.M. - 3 P.M. during which 28.75%(50) of all missile injuries occurred, as is shown in Table-III

Table-3: Diurnal variation

Time period interval of injury	No. of patients	Percentage
12.01am-3 am	3	1.73
3.01am- 6 am	2	1.14
6.01am-9 am	32	18.39
9.01am-12 pm(noon)	77	44.25
12.01pm-3 pm	50	28.75
3.01pm-6 pm	3	1.73
6.01pm-9 pm	3	1.73
9.01pm-12 am	4	2.28
Total	174	100%

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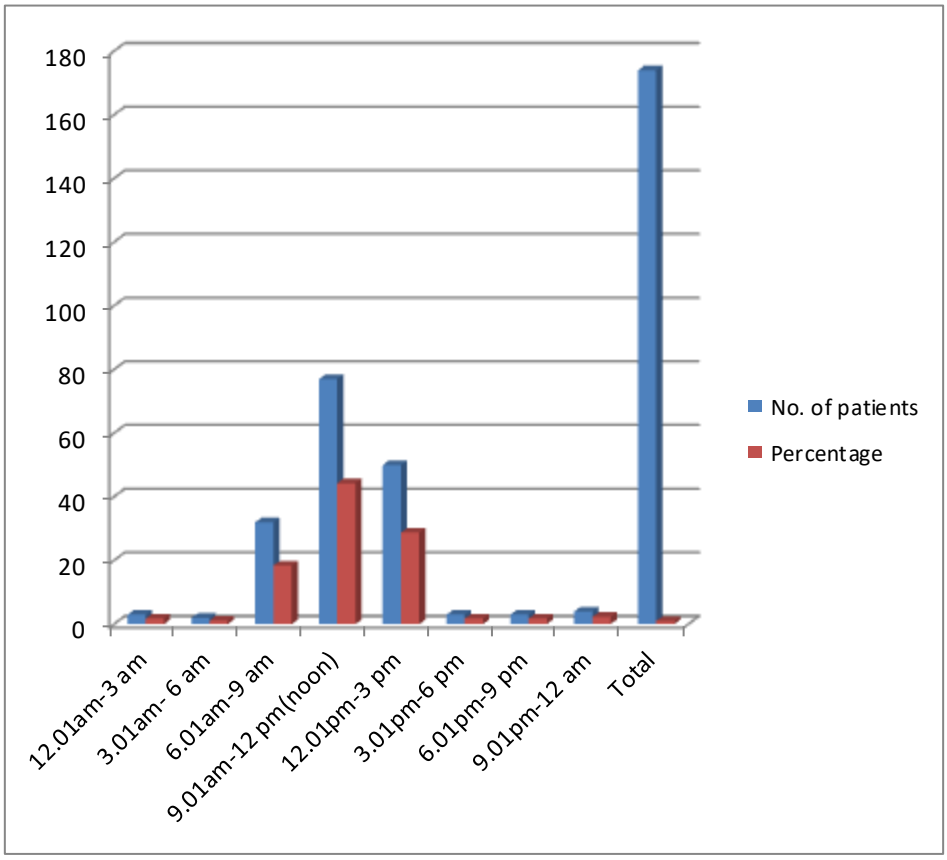

4. INCIDENCE OF MISSILE INJURY TO THE ABDOMEN

It was observed that the majority of the injuries were HVM shrapnel (44.25%)(77) and , missile (36.79%)(64), while LVM, pistol (17.81%)(30). Other causes of missile injuries includes shotgun 3 patients(1.15%), as shown in Table-IV.

Table-4: Incidence of missile injury to the abdomen

Age	**HVM**		**LVM**		
	shrapnel	Missile	Shotgun	Pistol	total
0-10		1			1
11-20	4	6		9	19
21-30	43	35	2	14	94
31-40	21	15		3	39
41-50	7	5	1	2	15
51-60	1			1	2
61-70		1		1	2
71-80	1				1
81-90		1			1
total	77	64	3	30	174
percentage	44.25	36.79	1.15	17.81	100

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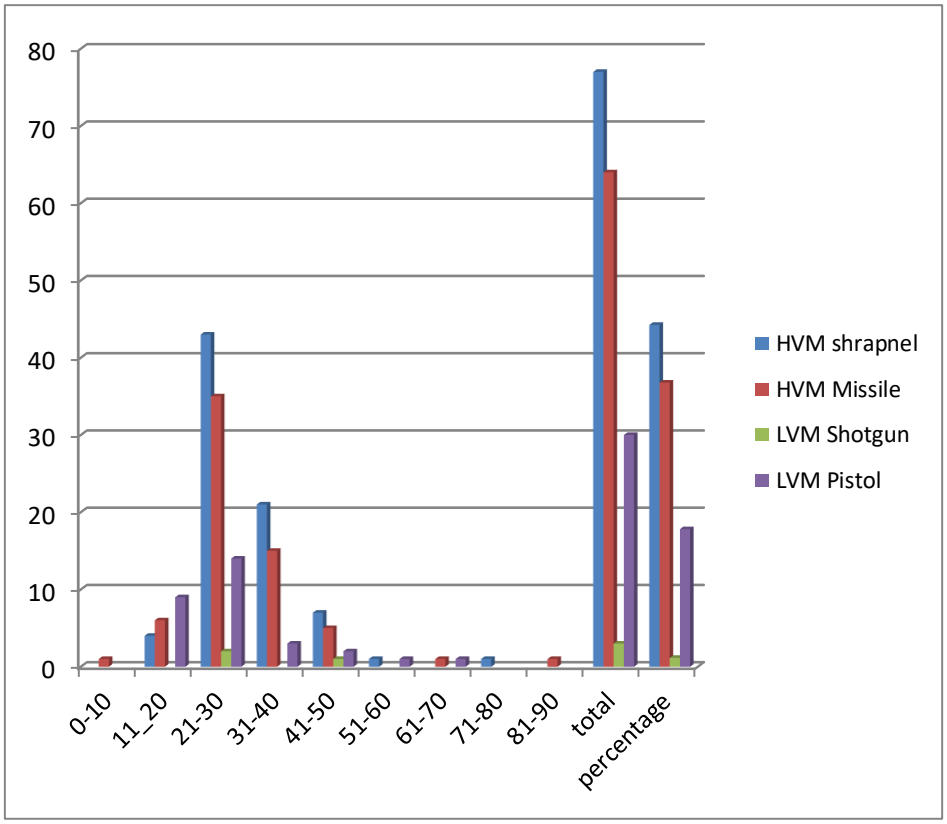

5. LINE OF TREATMENT IN 174 PATIENTS

All patients admitted to the A & E department with missile injury to the abdomen. 56 (32.18%) patients required only conservative treatments, while local wound explorations (LWE) were done in 19(10.91%) patients and 6(3.44%) patients underwent LWE and laparotomies . In 66(37.99%) patients laparotomies were done immediately after resuscitation, and late explorations were done in 27(15.54%) patients as shown in (Table-V).

Table-5: Line of treatment in 174 patients

Type of treatment		No. of patients	Percentage
Conservative		56	32.18
Surgical Intervention	LWE only	19	10.91
	LWE + laparotomy	6	3.44
	Laparotomy immediately	66	37.93
	Late exploration	27	15.54
total		174	100%

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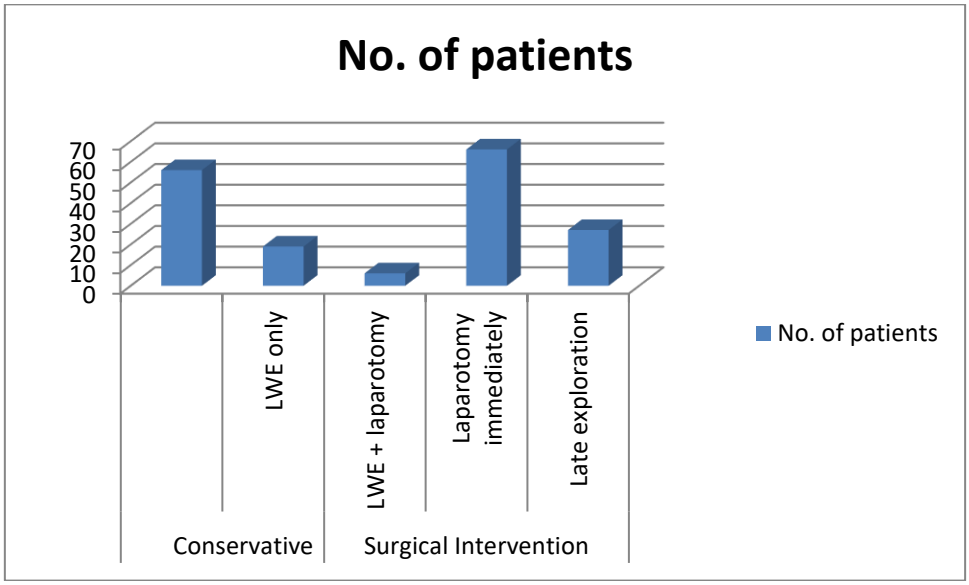
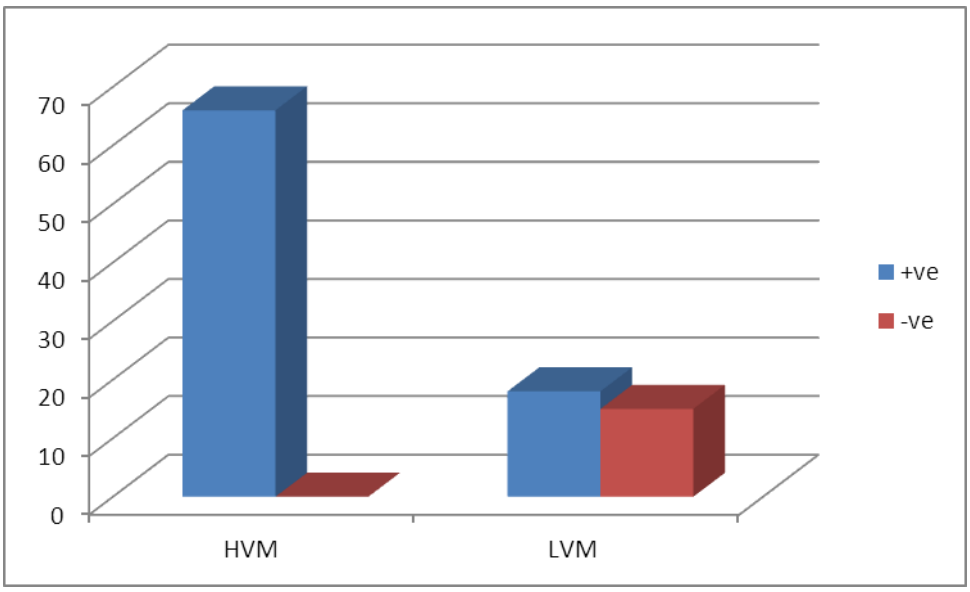


6. LAPARATOMY FINDINGS IN 99 PATIENTS

It was seen that 84.84%(84) of patients had positive findings during laparotomy caused by HVM and LVM. and remainder 15.16%(15) had no intra abdominal organs injury (-ve). **(**Table-VI).

Table-6 : Incidence of laparatomy findings in 99 patients

findings	HVM	LVM	Total	%
+ve	66	18	84	84.84
-ve		15	15	15.16
Total	66	33	99	100



7. INCIDENCE OF VARIOUS ORGANS INJURED IN 84 LAPARATOMIZED PATIENTS WITH SIGNIFICANT FINDINGS

Small intestine was involved in majority of the victims (42.85%)(36), followed by Large intestine in 35.71%(30) and then Liver in 19.04%(16). (Table-VII)

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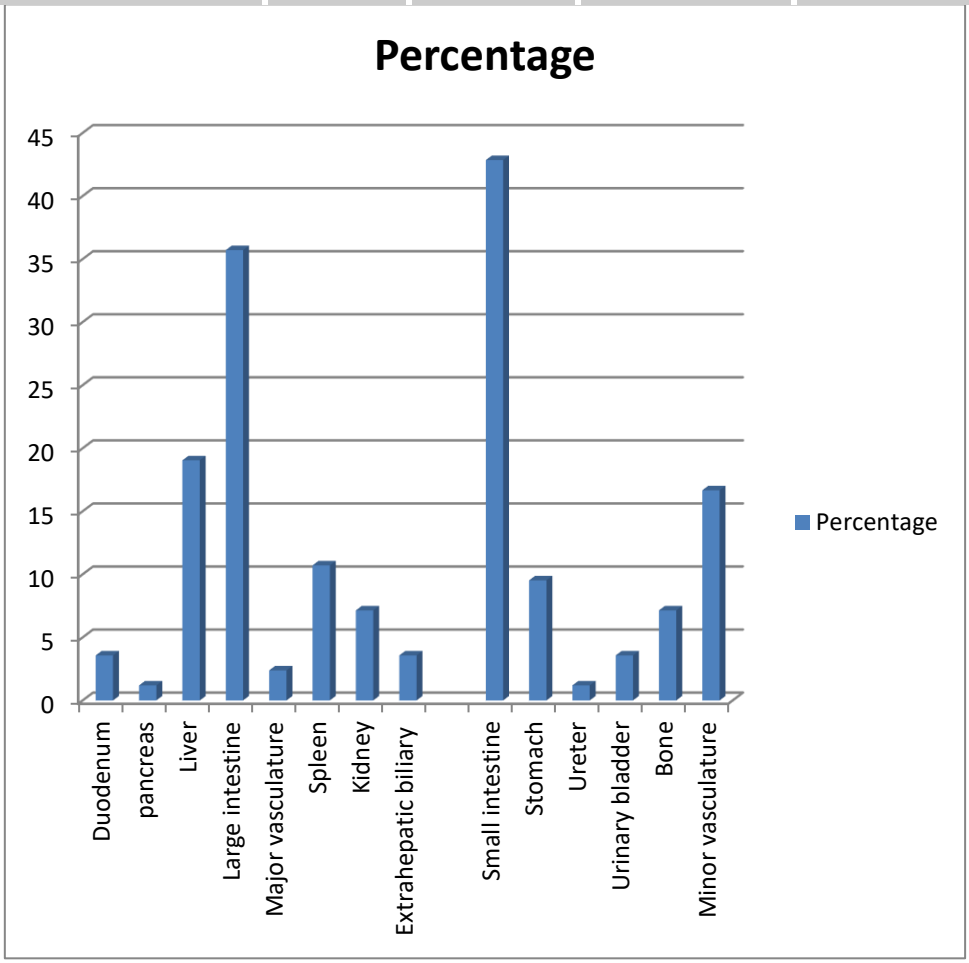
Table-7: Incidence of various organs injured in 84 laparatomized patients with significant findings

Injured organ	HVM	LVM	Total	Percentage
Duodenum	3		3	3.57
pancreas	1		1	1.19
Liver	12	4	16	**19.04**
Large intestine	28	2	30	**35.71**
Major vasculature	2		2	2.38
Spleen	8	1	9	10.71
Kidney	6		6	7.14
Extrahepatic biliary	3		3	3.57
Small intestine	26	10	36	**42.85**
Stomach	7	1	8	9.52
Ureter	1		1	1.19
Urinary bladder	3		3	3.57
Bone	6		6	7.14
Minor vasculature	11	3	14	**16.66**
Diaphragm	10		10	11.90



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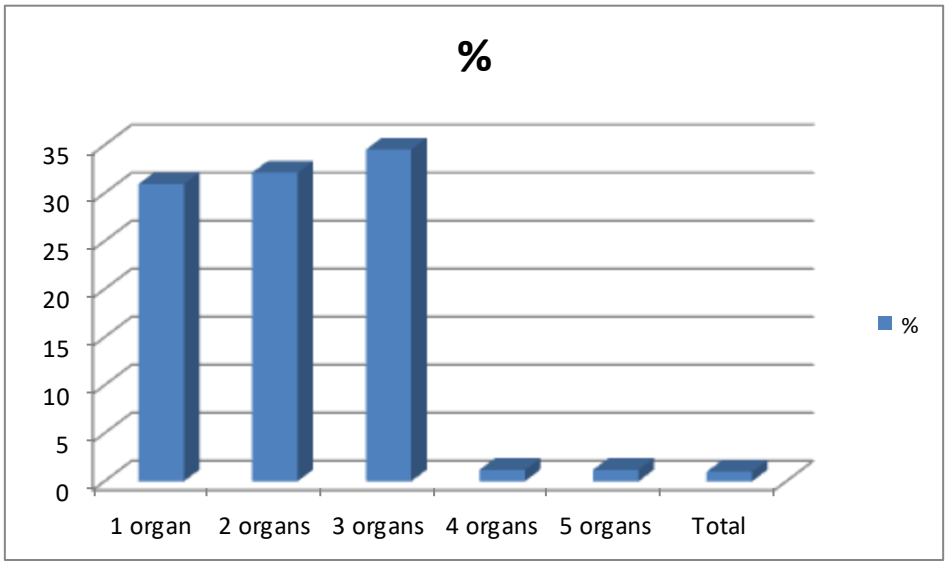
8. FREQUENCY OF MULTIPLE INTRA ABDOMINAL INJURIES IN 84 PATIENTS

Majority of the patients had involvement of three organs (34.53%)(29), followed by involvement of two organs (32.14%)(27). (Table-VIII).

Table-8: Frequency of multiple intra abdominal injury injuries in 84 patients

No. of organs	HVM	LVM	total	%
1 organ	9	17	26	30.95
2 organs	22	5	27	32.14
3 organs	29		29	34.53
4 organs	1		1	1.19
5 organs	1		1	1.19
Total	63	21	84	100%



9. ASSOCIATED INJURIES IN ABDOMINAL MISSILE INJURY PATIENTS

Plain abdominal missile injuries (alone) were found in 56.89%(99) of total patients. Associated injuries of two or more than two body regions/areas were found in minority of patients (7.47%)(13) as shown in Table-IX.

Table-9: Incidence of abdominal missile injuries alone and associated body injuries

Type of injury	No. of patients	percentage
Abdomen alone	99	56.89
Abd. & head	18	10.35
Abd. & chest	26	14.94
Abd. & limbs	18	10.35
Abd. & 2 or more than 2 body regions	13	7.47
Total	174	100%

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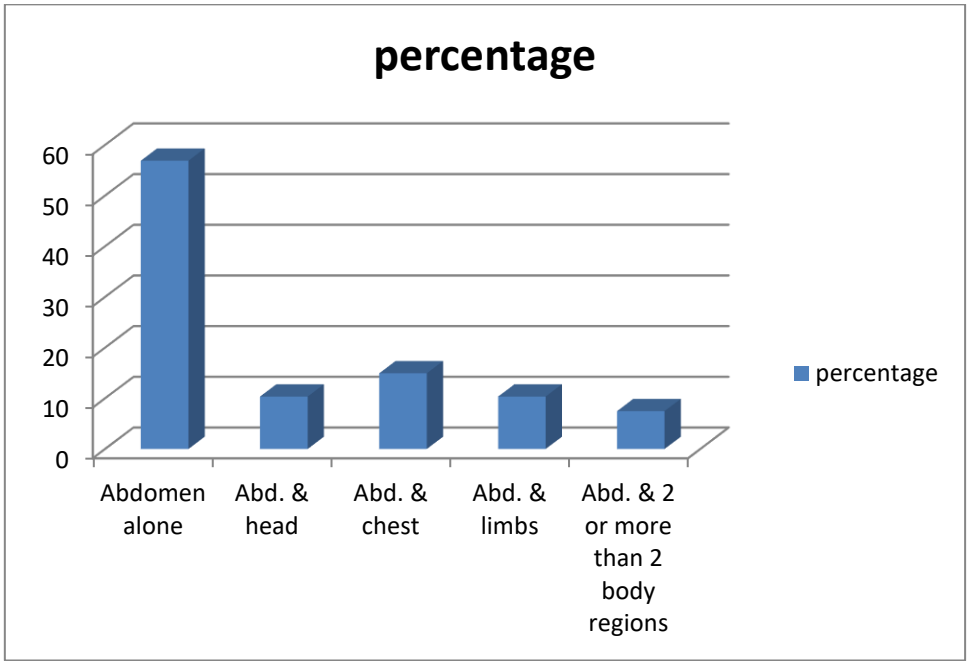

10. INCIDENCE OF SURGICAL PROCEDURE DONE IN 99 PATIENTS

Laparotomy alone was done in 59.59%(59) of patients, laparotomy and limb surgery was done in 14.14%(14) of patients, laparotomy and neurosurgical intervention was done in 6.06%(6) of patients, and lastly laparotomy with thoracic intervention was done in 20.21%(20) of patients as shown in Table-X.

Table-10: Incidence surgical procedure done in 99 patients

Type of surgery	No. of patients	Percentage
Laparatomy alone	59	59.59
Laparotomy+limb surgery	14	14.14
Laparotomy+neurosurgical operation	6	6.06
Laparotomy+thoracic operation	20	20.21
Total	99	100

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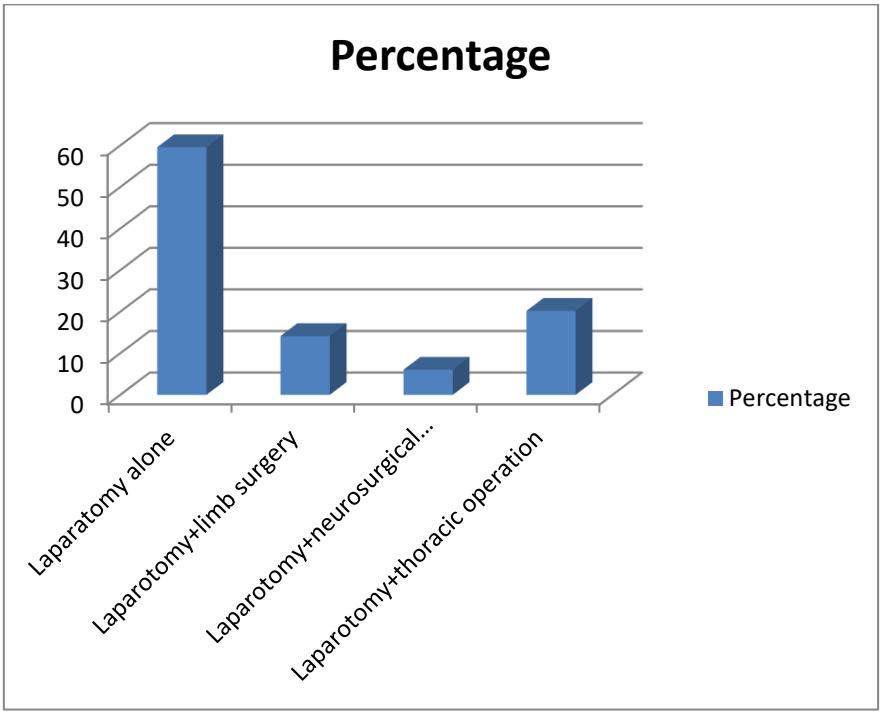

11. DETAILS OF ORGANS INVOLVED (LAPAROTOMY FINDINGS):

1- **Duodenum:** it was involved in 3 patients (3.57%) of patients, all were of HVM injuries. It was associated with pancreatic injury in one patient and stomach injury in 2 patients.
2- **Pancreas:** it was involved in 1 patients (1.19%) of patients, all due to HVM injuries.
3- **Liver:** it was involved in 16 patients (19.04%) of patients. 12 patients (14.28%) were due to HVM and 4 patients (4.76%) of patients were due to LVM. Right lobe injured in 13 patients (15.47%), while left lobe in 2 patients (2.38%) and both lobes in 1 patients (1.19%).
4- **Large intestine:** it was involved in 30 patients (35.71%), 28 patients (33.33%) were due to HVM , 2 patients (2.38%) due to LVM. Caecum was involved in 2 patients, ascending colon in 6 patients, transverse colon in 11 patients, descending colon in 4 patients, sigmoid in 4 patients, and rectum in 3 patients.
5- **Major vasculature:** they were involved in 2 patients (2.38%). Those patients had IVC injury with central hemtoma.
6- **Spleen:** it was involved in 9 patients (10.71%), 8 patients (9.52) injury was due to HVM, 1 patients (1.19%) injury was due to LVM.
7- **Kidney:** was involved in 6 patients (7.14%), all due to HVM. The right kidney was injured in 2 patients, while left kidney was injured in 4 patients.
8- **Extra hepatic biliary:** it was involved in 3 patients (3.57%). Gallbladder injured in all the 3 patients.
9- **Small intestine:** jejunum and ileum were involved in 36 patients (42.85%), 26 patients (30.95%) due to HVM and 10 (11.90%) patients due to LVM.
10- **Stomach:** it was involved in 8 patients (9.52%), 7 patients due to HVM, 1 patients due to LVM.
11- **Ureter:** it was involved in 1 patients (1.19%) all were due to HVM.
12- **Bladder:** it was involved in 3 patients (3.57%).
13- **Bone:**
    - **Pelvic bone:** it was involved in 3 patients (3.57%) all were due to HVM, associated injury to rectum and bladder injury in one patient.
    - **Vertebral injury:** Lumber spine fractures were observed in 3 patients (3.57%) all due to HVM. Injuries to spinal cord occur in all patients.
14- **Minor vascular:** it was involved in 14 patients (16.66%), they are of non-named branches of

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SMA or SMV,omental vasculature, lumber, gonadal arteries and others.

15- **Diaphragm:** It was involved in 10 patients (11.90%). In the present study, HVM accounted for all the patients. Left hemidiaphragm injured in 4 patients, right hemidiaphragm injured in 6 patients.

16- **P. Value** was 0.003. And the mortality was 1.14%(two patients).

DISCUSSION

In the present study, it was observed that majority of the patients were in the age group 21-30 years (54.02%). This observation agreed with Bergvist D et. al results were they reported that the most common age group of their 30 years study was between 20-30 years [9]. This fact can be explained by the fact that young persons are at the peak of their creativity and have the tendency to take undue risk, subjecting themselves to the hazards of injuries.

In our series, males dominated females in the ratio of 6.90:1, this dominance of male was in agreement with various other reports too [9,10].

Regarding timing of the accidents, we noticed that the maximum number of the abdominal missile injuries occurred between 9 am -12 pm accounting for 44.25% of the patients, this can be contributed to curfew which is started from the midnight till the sunrise.

It was observed that most of our patients insults were due to HVM injury, (shrapnel constituted 44.25% and missile constituted 36.79 % of patients), this observation could be related to the use of rifle gun and increasing blast accidents. Pistol injury (17.81 %) was relatively low in comparison with that of other weapons (missile) [11].

In our study patients, 84.84% of them had positive findings during explorative laparotomy which was caused by HVM and LVM, while 15.16% were negative at laparotomy. Fakhry et. al. regard as the mere presence of a gunshot wound to the abdomen with potential violation of the peritoneum equals a laparotomy [12]. According to Shah R et al this approach have been explained by 4 reasons: (a) There is a high incidence of intra-abdominal organ injury, which approaches 90%; (b) many centers have limited experience with gunshot wounds; (c) negative laparotomy is not particularly morbid; and (d) physical examination is unreliable. However, there is an overwhelming evidence that the two latter statements are not true [13]. Unnecessary laparotomy is associated with morbidity ranging from 12 to 40% and prolongation of hospital stay [14].

For the incidence of significant intra-abdominal injuries following a gunshot wound to the abdomen, different studies have been reported incidences of 89 to 94% [15,16]. Whereas others have found much lower incidences, ranging from 68 to 75% [18,19].

For the organ involvement, we found that the majority of the patients had involvement of 3 organs (34.53%) followed by 2 organs injuries (32.14%), similar findings have also been reported by G. Regel et al 3organs (35%) and 2 organs (31.98%) [19], this high incidence can be explained by the fact that penetrating wounds of the abdomen often causes widespread visceral damage because of missile's capricious course, ricocheting effect and burning effect as a result of thermal injury.

In the present study, plain abdominal injuries were found in (56.89%) of total patients, while associated injuries of two or more than two body regions were found in (7.47%) of patients. Similar finding reported by Scot Anderson et al were (13.8%) in more than 2 body regions [20].

In our management plan, of the total 174 patients admitted to the A & E department as missile injury to the abdomen, 32.18% demand only conservative treatments, most of them had injury to the back and anterior abdominal wall whereas local wound exploration (LWE) was done in 10.91% of patients without laparotomy, and 3.44% under went laparotomy, due to penetration to the abdominal wall and peritoneum, 37.93% of patients require immediate laparotomy after resuscitation to those who were hemodynamically unstable, or had bowel evisceration, whereas late exploration have been done in 15.54% patients following serial physical examinations.

Selective non operative management of gunshot wounds of the anterior abdomen and back was adopted by different workers [21,22,23,24].

Regarding the type of surgery of our study, laparotomy alone was done in 59.59% of patients, laparotomy and limb surgery was done in 14.14% of patients, laparotomy and neurosurgical operations was done in 6.06% of patients, and lastly laparotomy with thoracic operations was done in 20.21% of patients, this incidence was similar to the reports by G. Regel et al and Scot Anderson et al [19,20].

Of the intraabdominal organs involved we found that duodenum was involved in 3.57% of total patients. All due to HVM injuries. Similarly Cuddington G. et al & Snyder W. et al also reported that penetrating injury was the main cause of duodenal injury [25,26]. Moreover, the pancreas was involved in 1.19% of our total patients. All due to HVM injuries. This low incidence of pancreatic injury can be explained by its deep and well protected

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anatomical position. Similar findings has also been reported by Ivatury RR et al [27].

Of the liver injuries that were observed in 19.04% of our patients, the majority were due to HVM (14.28%). Similar findings have also been reported by Renz RM, Feliciano DV [28]. In majority of the patients, we found that the right lobe of liver was involved, a finding that also confirmed by Demetriades D. et al [29].

For the mechanism of large bowel injuries, we noticed that HVM (33.33%) represented the majority of patients. Similar findings have also been reported by Burch JM et al (1986) [30].

It was noted that the most common type of intraabdominal major vascular injury which represent (2.38%) was the inferior vena cava injury in (2.3%).

The spleen was involved in 10.71% of patients, majority due to HVM (9.52%). Similar findings (8.40%) by Shweiki E. et al (2001) [31].

The kidneys were involved in 7.14% of our patients, all due to HVM injuries. Similar incidence of the kidney injuries has also been observed by D. Bergvist et al, and G. Regel et al [8, 18].

Injury to gall bladder was observed in only 3 patients (3.57%). This low incidence can be explained by the fact that gall bladder lies well protected by the liver and costal margin. This agreed with the reported findings of Feliciano DV[32].

Of concern is that small bowel was involved in 42.85% of our patients. Majority due to HVM injuries (30.95%). Similar corresponding penetrating injuries of the small bowel have also been reported by Guarino J et al [33].

In the present series, stomach was involved in 9.52% of the patients, majority (8.33%) of stomach injuries were due to HVM injuries. This relatively low incidence can be explained by the well protected position of stomach behind the left lobe of liver and lower left rib cage.

In the present series, urinary bladder was involved in 3.57% of patients,all patients of bladder injuries were due to HVM .

In the present study, regarding ureteric injuries they constituted 1.19% of our patients, all following HVM injuries, similar pattern of such injuries have been reported by Perez-Brayfield MR et al [34]

Diaphragmatic injuries were seen in 10 of our patients (11.9%). HVM accounted for all the patients. Left hemidiaphragm (6) patients ,right hemidiaphragm (4) patients ,this agreed with Murry JA et. al.[35].

CONCLUSIONS

In this study 65 (32%) of the patients with missile abdominal injury were treated conservatively(active neglection) and 15 (8.6%) had negative laparotomies (no significant intra abdominal injuries)

So about 40% of the patient with missile abdominal injury had no significant intra abdominal injuries which could be managed non-operatively ; Since unnecessary laparotomy is associated with morbidity and prolongation of hospital stay duration .

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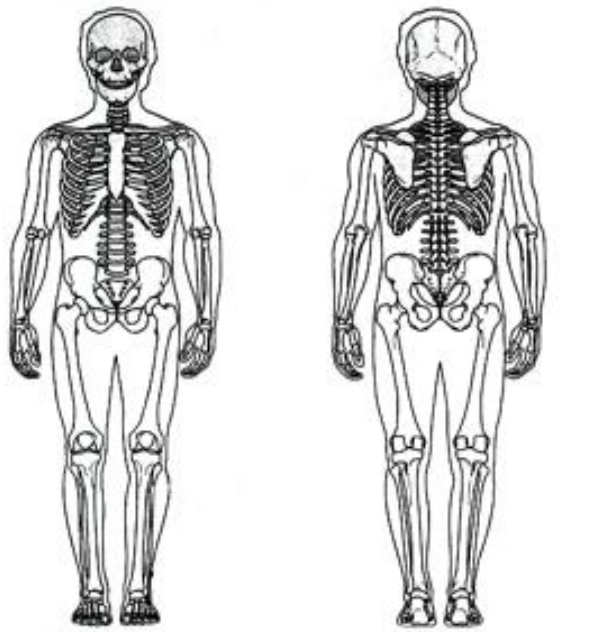
Appendix I:

Patient name:	**Age…….** **Gender:** ☐ M ☐ F
Date of injury : …./…../….. Time of injury…..**:**…..am/pm	
Mechanism of injury: **HVM** ☐ missile ☐ shrapnel **LVM** ☐ shotgun ☐ pistol	
	

Lines of treatment:
☐conservative:
☐ laparotomy alone
☐ laparotomy and neurosurgical intervention
☐ laparotomy and orthopedic intervention.
☐ laparotomy and cardiothoracic intervention
☐ late explorative laparotomy:(within 48 hours)

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Laparotomy findings through exploration of the abdomen

No internal bleeding and injury
☐ Mesentery SI
☐ SI (☐ duodenum ☐ jejunum ☐ ileum)
☐ LI (☐ caecum ☐ C ☐ C ☐ C ☐ Sigmoid Rectum)
☐ Stomach (☐ anterior wall ☐ posterior wall) ☐
☐ Liver ☐ Lt lobe ☐ Rt lobe ☐ extrahepatic biliary
☐ Spleen
☐ Pancreas
☐ Kidney (☐ Lt ☐ Rt)
☐ Ureter (☐ Lt ☐ Rt)
☐ Bladder
☐ Great vessels (☐ aorta ☐ IVC ☐ thers)
☐ Bones ☐ pelvis ☐ vertebra
☐ Diaphragm ☐ Lt ☐ Rt