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Research Article/ Araştırma Makalesi

Comparison of the Damage Results of Bullet and Pellet Ammunition in Firearm Injuries Causing Bone Fractures in the Extremities

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Purpose: The spectrum of firearm injuries (FI) is broad and challenging for physicians in terms of diagnosis and treatment. The bullets and pellet ammunition used in FI exhibit different ballistic patterns and cause quite different damage to the body. The aim of this study was to compare the outcomes of bullet and pellet injuries causing bone fractures in the extremities.

Method: The files of patients who were injured in their extremities due to civilian FI between 2016 and 2020 and who were followed up by the orthopedic clinic due to bone fractures were retrospectively analyzed. Age, gender, injured extremity, presence of infection, presence of vascular injury, presence of nerve injury, total number of operations, length of hospital stay and permanent sequelae were evaluated. Cases with missing files were excluded from the study. Evaluation criteria were compared under two main headings for bullet and pellet ammunition types.

Results: There were a total of 40 cases with a mean age of 43.5 years. The mean follow-up period was 41.5(24-61) months. 39 of the cases were male and 1 was female. There were 28 bullet injuries and 12 pellet injuries. Thirty-two of the cases were lower extremity injuries and 8 were upper extremity injuries. There were significant differences between ammunition type and number of operations (p=0.032). The length of hospital stay was significantly higher in the pellet group (p=0.024, p=0.024. Overall, 12.5% infection, 10% vascular damage, 17.5% nerve damage and 30% permanent sequelae occurred as a result of treatments. There were no significant differences between the groups in terms of infection, vascular injury, nerve injury and permanent sequelae.

Conclusion: It was concluded that pellet injuries require longer hospital stays and a higher number of surgeries compared to bullet injuries.

Keywords: Firearm injury, bullet, pellet, fracture, nerve damage

1.INTRODUCTION

The range of firearms injuries (FI) caused by bullets and pellets is quite broad, making diagnosis and treatment difficult for physicians.[1] FIs can range in severity from minor soft tissue injuries to vascular, nerve, and organ damage, and even death.[2,3] In FIs, the extremities are among the most affected areas.[3-5] Although the severity of the injury depends on the energy transmitted to the tissues rather than the type of weapon employed, the bullet's velocity, diameter, shape, orbital stability, and weight affect this energy.[2,5,6]

In FI, only a single bullet or ammunition containing multiple pellets may be fired at the target.[2] Typically, a single bullet is used as ammunition in pistols.[2] Shotguns often use capsule ammunition consisting of a large number of small pellets for hunting.[7,8] Shotgun bullets behave uniquely and exhibit complex ballistic patterns because they are composed of a variable number of small metal balls that disperse after leaving the gun.[9,10] Consequently, the evaluation of pellet injuries differs from that of bullet injuries.[1] There are few clini-

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cal studies on this subject and the debate continues.[5,11,12]

The aim of this study was to compare the clinical effects and treatment processes of bullet and pellet injuries in civilian FI causing bone fracture in the extremity and to reveal the differences.

2.MATERIAL and METHODS

The study was designed retrospectively. Ethics committee approval for the study was obtained from the scientific research ethics committee with the number 2022/264. The level of evidence for this study is level IV.

The files of the patients who were admitted to the emergency department of our hospital between 2016 and 2020 with extremity fractures due to FI and followed up by the orthopedics clinic were analyzed. Control examinations were performed and informed consent was obtained. Patients' age, gender, injured extremity, presence of infection, presence of vascular injury, presence of nerve injury, total number of operations, length of hospital stay, follow-up period, and presence of permanent sequelae formation criteria were collected and analyzed.[13] Patients with no missing data in their files were included in the study. The results of the values analyzed under two headings as bullet and pellet injury groups were compared statistically.

2.1.Patient Management

The Emergency Room handled the initial emergency management following the injury. Patients underwent physical examination, blood tests, and x-ray assessment. A consultation with an orthopedic surgeon was then requested. Patients underwent emergency surgery or ward hospitalization as needed. Bullets or pellets encountered during surgery or palpable during debridement are removed. No further removal or exploration was performed. Patients who had completed their orthopedic treatments were discharged. If there were any additional complaints or complications during the control examinations, the necessary operations or interventions were conducted out.

2.2.Statistical Analysis

Categorical variables were expressed as numbers (%) while continuous variables were expressed as median (range). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether continuous variables conformed to a normal distribution. The Man-Whitney U test was used to compare continuous variables between the two groups, and the Fisher Exact test was used to compare categorical variables. A $p < 0.05$ was considered statistically significant. The statistics were calculated using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA).

3.RESULTS

The study was performed in 40 cases with a mean age of 43.5 years. 39 of the patients were male and 1 was female. There were 28 bullet injuries and 12 pellet injuries. Of the cases, 32 were lower extremity injuries and 8 were upper extremity injuries. In the bullet group, lower extremity injuries were more common and upper extremity injuries were less common ($p=0.039$). The mean follow-up period was 41.5(24-61) months. Detailed general characteristics are shown in table 1. Case examples are shown in figures 1 and 2.The average hospital stay was 10(1-43) days. Those in the pellet group had significantly longer hospital stay when compared to the bullet group ($p=0.024$).

There was a statistically significant difference between ammunition type and number of operations ($p=0.032$). The effects of bullet and pellet injuries at similar sites on the ankle are shown in figures 3 and 4. The rate of one operation was higher in the

bullet group and the rate of multiple operations was higher in the pellet group. Figure 5 shows the excision of the remaining pellets in a patient four months after discharge due to discomfort. In this case some pellets were removed from the tendon sheath.

Nerve injuries occurred in a total of 7 patients, 4 in the bullet group and 3 in the pellet group. Of these injuries, 3 were related to the radial nerve, 1 to the median nerve, 2 to the peroneal nerve and 1 to the sciatic nerve. There was no significant difference between the groups in terms of nerve injuries. There was a significant difference in nerve injury rates between extremities (p=0.020). There were 4 (50%) nerve injuries in the upper extremity and 3 (9.4%) in the lower extremity. Two posterior tibial arteries, one anterior tibial artery, and one ulnar artery were injured. There was no significant difference between extremities in vascular injury (p=1). Table 2 shows the rates of vascular and nerve injury amongst the patients. In terms of infection, vascular injury and permanent sequelae, there was no significant difference between the

Table 1.

General characteristics

Characteristic	Total n=40 (%) median (range)	Bullet n=28 (%) median (range)	Pellet n=12 (%) median (range)	p
Age	43.5 (15-73)	43 (15-73)	48 (32-62)	0.124
Gender				1
Male	39 (97.5)	27 (96.4)	12 (100)	
Female	1 (2.5)	1 (3.6)	0	
Extremity				0.039
Upper	8 (20)	3 (10.7)	5 (41.7)	
Lower	32 (80)	25 (89.3)	7 (58.3)	
Permanent sequel	12 (30)	8 (28.6)	4 (33.3)	1
Infection	5 (12.5)	2 (7.1)	3 (25)	0.149
Vascular Damage	4 (10)	2 (7.1)	2 (16.7)	0.570
Nerve Damage	7 (17.5)	4 (14.3)	3 (25)	0.410
Numer of Surgeries	1 (1-4)	1 (1-4)	1 (1-4)	0.032
1	27 (67.5)	22 (78.6)	5 (41.7)	
2-4	13	6 (21.4)	7 (58.3)	
Length of hospital stay (days)	10 (1-43)	10(1-30)	13.5(4-43)	0.024

Table 2.

Characteristics of vascular and nerve damage

Characteristic	Extremity (n)		P
Number of injured nerves (%)	4 (50)	3 (9.4)	
Injured Nerves (n)	Radial (3) Median (1)	Peroneal (2) Sciatic (1)	0.020
Number of injured vessels (%)	1(12.5)	3(9.4)	1.000
Name of vessels (n)	Ulnar(1)	Posterior tibial (2) Anterior tibial (1)	0

groups (p=0.149, p=0.570, p=1). Overall, 12.5% infection, 10% vascular damage, 17.5% nerve damage and 30% permanent sequelae occurred as a result of treatments.

Figure 1.

Femur fracture due to bullet injury (A:Bullet entry hole, B:Femur radiograph after fracture, C,D:Femur radiographs after surgery, E:Femur radiograph after union)

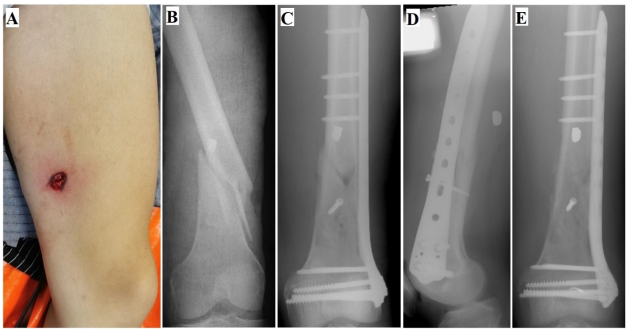


Figure 2.

Cruris injury and tibia fracture after pellet injury (A: View of injury site, B:Fluoroscopy image of tibia fracture and many pellets, C:After external fixator surgery)

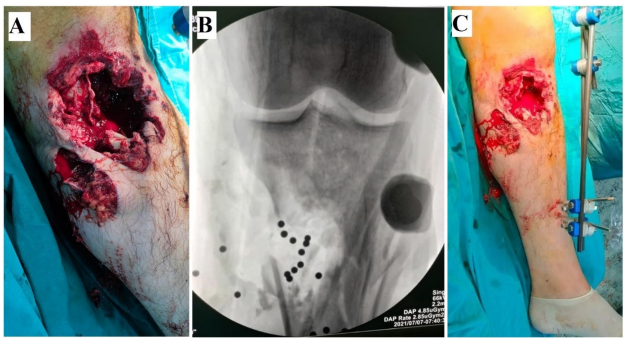


Figure 3.

Talus fracture caused by an ankle gunshot wound (A:Bullet entry hole, B:Computed tomography Horizontal section showing the course of the bullet, C:Computed tomography sagittal section showing talus fracture, D,E: Postoperative anterior posterior and lateral radiographs)

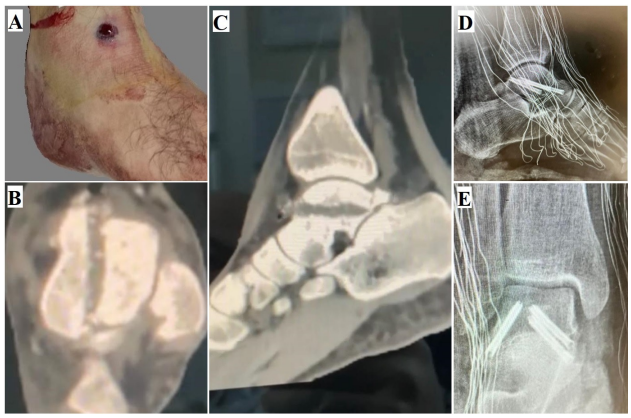


Figure 4.

Gunshot wound to the ankle with pellet (A: Ankle injury site, B: Ankle radiograph after pellet injury, C: Radiograph after ankle arthrodesis surgery, D: Radiograph after union)

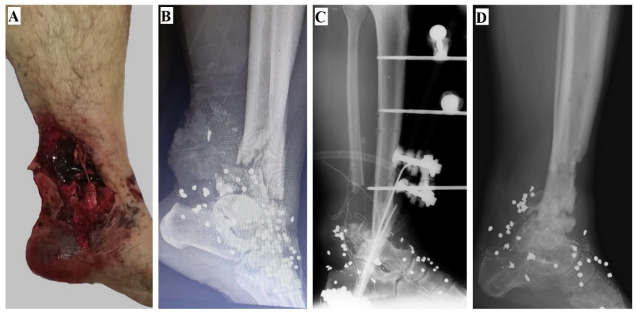
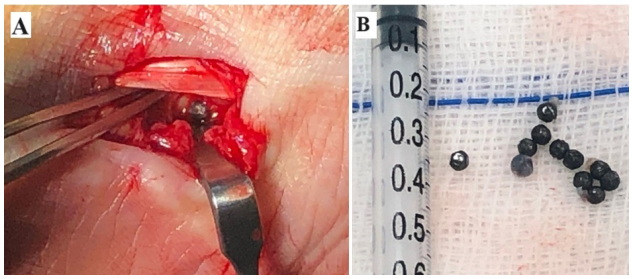


Figure 5.

The pellet that remained in the peroneus longus tendon sheath after a birdshot injury and the pellets removed from the same foot



4.DISCUSSION

When we compared the cases with single surgery and cases with multiple surgeries, it was determined that multiple surgeries were performed significantly in the pellet group. The fact that 78.6% of bullet injuries underwent a single operation in the treatment process after FI, while 58% of the pellet group underwent more than one operation is another indicator of the difference in severity of injury. In addition, a significant difference was observed in the duration of hospitalization. Therefore, it can be considered that the cost and morbidity expectation for pellet injury will be higher. According to the literature, shotgun injuries have significantly higher mortality and morbidity compared to bullet injuries.[1,14,15] Mortality in pellet injuries has been reported as 20-38%, 17% and morbidity as 38%.[1,14] Mortality in bullet injuries has been reported as 5-12%, 4% and morbidity as 17%.[1,15] Despite the results showing that the severity of injury was higher in the buckshot group, no difference was found between the groups in terms of infection rate, nerve injury, vascular injury and permanent functional sequelae in our study. In other words, in order to achieve the same recovery rate as the bullet group, the pellet group underwent more surgeries and stayed in the hospital longer. Despite all the advances, a morbidity rate as high as 30% reveals the importance of FI injuries.

Consistent with the literature, the majority of our cases (97.5%) were male.[1,5,12,16] In a study of FIs with extremity injuries, 75% of injuries were reported to involve the lower extremities.[17] In a study evaluating FI patients who underwent orthopedic surgery, 53.7% had lower extremity injuries, 37.1% had upper extremity injuries, and 9.2% had both lower and upper extremity injuries.[16] Similarly, 80% of the cases in our study were lower extremity injuries. This result may be due to the limb size difference, or it may be due to the fact that the weapon may have been fired for injury rather than fatal damage.

Although capillaries are susceptible to rupture in FI, they are extremely resistant to damage unless the large arteries are directly struck.[2,7] Although large nerve trunks are also susceptible to neuropraxia, they are usually not completely damaged, similar to vessels.[2,7] Burg et al. reported a nerve injury rate of 16.8%, with the deep peroneal nerve being the most affected (38%).[17] Tokyay et al. reported the incidence of vascular and nerve injury as 5.5% and 11.1% (3 radial, 1 ulnar, 1 median, 1 peroneal), respectively.[16] In another study examining low-energy lower extremity FI cases, the rates of vascular injury, nerve injury, and acute infection were 6.1%, 1.4%, and 5.3%, respectively.[18] In a study of civilian upper extremity FI, the rate of nerve injury in patients with fractures was reported to be 43.1%, with ulnar, median, radial, and brachial plexus injuries reported, in order of frequency.19 In a study evaluating high-energy upper extremity war injuries, the ulnar and radial nerves were reported to be frequently injured.[12] In the same study, 46.8% nerve injury, 12.9% artery injury and 37.1% infection rate were concluded.[12] In our study, 12.5% infection, 10% vascular damage, 17.5% nerve damage were determined in all cases. There was also no significant difference between the two groups in terms of vascular and nerve injuries. In terms of the number of nerve injuries, 3 radial nerve, 2 peroneal nerve, 1 median nerve, and 1 sciatic nerve injuries are generally similar to the values in the literature. However, there was a significantly higher risk of nerve damage in the upper extremity injury rate. The fact that the upper extremity has less soft tissue support and the bone and nerve neighborhoods are relatively closer may have increased the rate of nerve injury. For these reasons, the physician performing neu-

rologic examination in the emergency department should be more meticulous especially in upper extremity FI.

4.1.Limitations

Our study is limited by its retrospective design and small sample size. On a topic such as FI, whose treatment and outcomes are debatable, there is a need for in-depth studies involving a greater number of cases.

5.CONCLUSION

There are many differences in the damage and expectation of the treatment process when comparing bullet and pellet ammunition in an extremity FI with bone fracture. In this study, it was concluded that soft tissue damage would be high in pellet injury, the hospital stay would be longer and more than one operation would most likely be required during the treatment process. These injuries can result in a significant proportion of permanent sequelae. In addition, if the upper extremity is affected in FI cases, nerve damage can be seen at a high rate, so special attention should be paid during the first examination.

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