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MACROSCOPIC AND MICROSCOPIC FEATURES OF FIREARM PENETRATING ABDOMINAL INJURIES WITH DAMAGE TO THE APPENDIX

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Summary

Introduction. In the structure of combat abdominal trauma during all periods of hostilities (according to ATO/JFO data), gunshot wounds dominated, accounting for 87.1 %. An analysis of the distribution of those injured with gunshot wounds by the type of projectile causing the injury showed a prevalence of shrapnel injuries over bullet wounds – more than 80 %.
The aim of the research was to analyze the macroscopic and microscopic changes in firearm penetrating abdominal injuries with damage to the appendix.
Materials and methods. Eight appendectomies were performed due to firearm penetrating abdominal injuries with damage to the appendix. Complaints, medical history, examination data, ultrasound examination according to the FAST protocol, and radiological examinations were studied in all injured patients. To refine the diagnosis and determine the scope of surgical intervention, the WOLF videoendoscopic system was used.
Histological examination of the removed appendices was performed, which were stained with hematoxylin and eosin and with the Van Gieson stain. A complex of pathomorphological studies was conducted using the Primo Star microscope (Carl Zeiss) at a magnification of ×140.
Results. All injuries occurred while wearing a bulletproof vest and were characterized as blind, with 1 (12.5 %) being gunshot wounds and 7 (87.5 %) being shrapnel wounds. The entrance wound in firearm blind penetrating abdominal injuries with appendix damage was located in the right hypochondriac region – 4 (50 %), right flank – 1 (12.5 %), right inguinal region – 2 (25 %), and mesogastric region – 1 (12.5 %) cases. The average size of the entrance wound on the skin was 23.3±0.4×12.4±0.3 cm. All skin wounds were outside the bulletproof vest protection area.
The injuries to the appendix had an average size of 15.4±1.2×9.3±0.1 cm. All removed foreign bodies were larger than 1 cm in their largest dimension.
Conclusions. In most cases of firearm penetrating abdominal injuries, damage to the appendix is noted with an entrance wound predominantly on the right side. Macroscopically, in firearm blind penetrating abdominal injuries with appendix involvement, the wound on the skin is larger than on the appendix. All foreign metal bodies removed from the abdominal cavity after firearm shrapnel blind abdominal injuries with appendix involvement were of large size. Contusional injuries to the appendix tend to undergo destructive transformation, requiring surgical treatment – appendectomy. The increased frequency of appendix injuries can be explained by the widespread use of shrapnel ammunition in abdominal injuries when personal protective equipment does not provide protection for this area.

Key words: **firearm abdominal injury, appendix injury, pathomorphosis, gunshot fragment, bullet wounds**

INTRODUCTION

The number of abdominal injuries in the overall structure of combat injuries varies from 1.9 % to 9.8 %, according to data from the first year of the Anti-Terrorist Operation (ATO), it accounted for 4-7 % (in different directions and depending on the nature of military operations). In the structure of combat abdominal trauma during all periods of hostilities (according to ATO/JFO data), gunshot wounds dominated, accounting for 87.1 %. An analysis of the distribution of those injured with gunshot wounds by the type of projectile causing the injury showed a prevalence of shrapnel injuries over bullet wounds – more than 80 % [3, 5, 7, 9].

By their size, foreign bodies of gunshot origin are divided into small, medium, and large [4]. The presence of different body builds among military personnel leads to the existence of areas that are not covered by body armor [2, 10].

According to clause 5.2 of State Standards of Ukraine 8782:2018, body armor, classified by strength against means of injury, is divided into those with basic and special protection classes classified from I to VI. By size, body armor is divided into: M – torso height 44 cm; L – torso height 45 cm; XL – torso height 45 cm; XXL – torso height 48 cm. The use of body armor helps reduce the number of injuries in military personnel [8].

The issue of gunshot wounds to the abdomen with damage to the appendix is not well-documented in the literature, so the study of the characteristics of macroscopic and microscopic changes in the appendix will be of interest to practicing surgeons.

THE AIM is to analyze the macroscopic and microscopic changes in gunshot wounds to the abdomen with damage to the appendix.

MATERIALS AND METHODS

From the available and studied material, the appendix was damaged in 0.18 % of cases. All the injured individuals were male, with an average age of 32±0.4 years. All injuries occurred in the presence of body armor, and they were of a blind nature, with 1 (12.5 %) being gunshot wounds and 7 (87.5 %) being shrapnel wounds. In all the injured cases, complaints, medical history, physical examination data, ultrasound examination following the FAST protocol (SONOSITE MICROMAXX, 2017), and radiological examinations (X-ray diagnostic complex OPERA RT20, 2018) were evaluated. A videoendoscopic system WOLF (Germany, 2021) was used to refine the diagnosis and determine the scope of surgical intervention.

Eight appendectomies were performed due to gunshot abdominal penetrating injuries with damage to the appendix. Appendectomies were performed using laparotomy in 6 (75 %) of the injured individuals and laparoscopy in 2 (25 %) of them. The duration of surgical interventions, depending on the complexity of the injury, averaged 60±10 minutes.

Tissue fragments from the thick intestine were fixed in 40 % neutral formalin for histological examination and underwent paraffin embedding using the standard technique employed by pathological anatomy laboratories [1]. After paraffin embedding, 5-6 μm thick sections were prepared, stained with hematoxylin and eosin, and Vin-Hizon staining was also performed. The complex of pathomorphological studies was conducted using a Primo Star microscope (Carl Zeiss) at a magnification of ×140. For image documentation, a high-resolution 8-bit digitizing digital camera AxioCam (ERc 5s) with a pixel size of 2.2 μm and Carl Zeiss AxioCam (ERc5s) Configuration Tool software was used.

Data analysis and statistical processing were performed on a personal computer using the software packages «Statistica 10.0» and «Microsoft Excel 2010» [6].

The complaints, medical history, and examination findings were specific for gunshot penetrating abdominal injuries and not specific for appendicular injuries. All injuries were transported to the level II medical facility within 1 hour after the injury.

The entry wound locations for gunshot blind penetrating abdominal injuries with appendicular involvement were as follows: right hypochondriac area – 4 cases (50 %), right flank – 1 case (12.5 %), right inguinal area – 2 cases (25 %), and mesogastric area – 1 case (12.5 %). The average size of the entry wound on the skin was 23.3±0.4×12.4±0.3 mm. All skin entry wounds were located outside the area protected by the body armor.

The external skin entry wound following a gunshot fragment penetrating abdominal injury with involvement of the appendicular area is shown in Figure 1.

The injuries to the appendix had an average size of 15.4±1.2×9.3±0.1 mm, indicating that the majority of kinetic energy, when the projectile passed through the body, was absorbed by the soft tissues of the abdominal wall. All removed foreign bodies were larger than 1 cm in their largest dimension.

In cases of appendix injuries, microscopic examination reveals hemorrhagic infiltration of the appendix wall with total necrosis of all layers and tissues, along with the presence of soot and debris (Figure 3).

Macroscopically, the changes in gunshot wounds to the appendicular area correspond to gunshot injuries of various sizes with dissemination of contents and tissue necrosis of the appendix (Figure 2).

Contusional injuries to the vermiform appendix tend to undergo destructive transformation (Figure 4) due to microcirculation disturbances and the presence of necrotic foci, justifying radical surgical treatment – appendectomy.

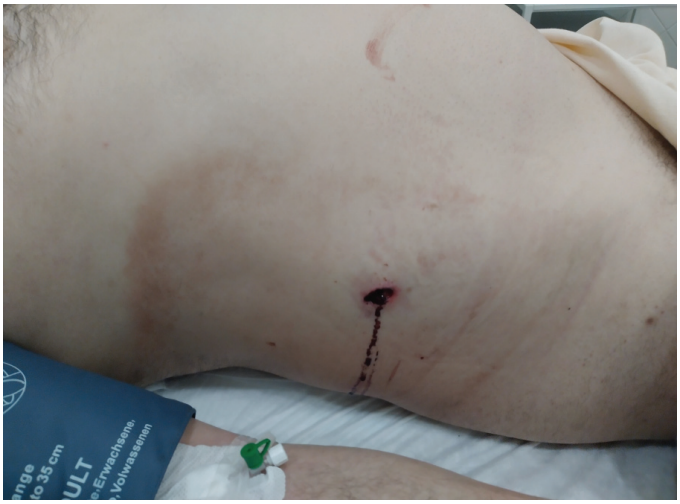

Fig. 1. Injured patient, 33 years old. The first day after the injury. Gunshot fragment penetrating abdominal injury with involvement of the appendicular area. Entry wound in the right lateral abdominal region

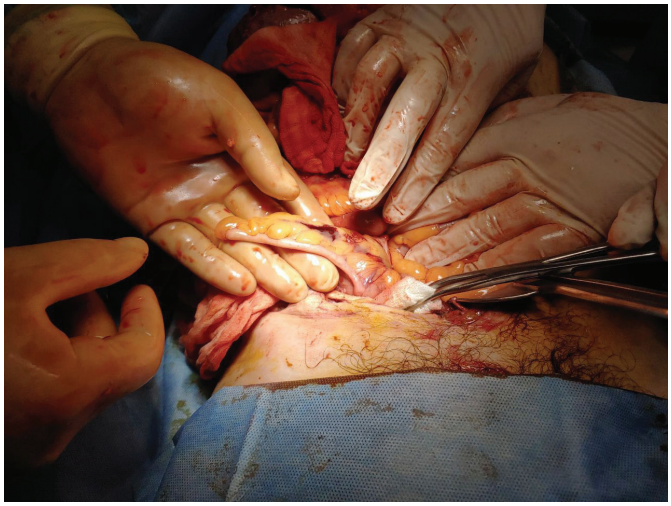

Fig. 2. Patient D, 35 years old. The first day after the injury. Gunshot wound to the abdomen with damage to the appendix. Damage to the tip of the appendix

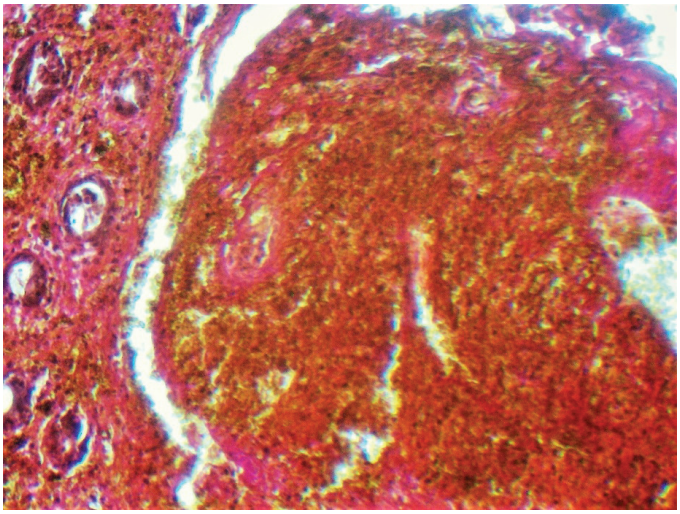

Fig. 3. Appendix infarction. Hemorrhagic infiltration of the appendix wall with total necrosis of all layers and tissues. In a few glands devoid of epithelial lining, wall necrosis is evident. In the upper right corner, there is fibrinoid necrosis, and at the bottom, the presence of soot and debris. Van Gieson staining. ×140

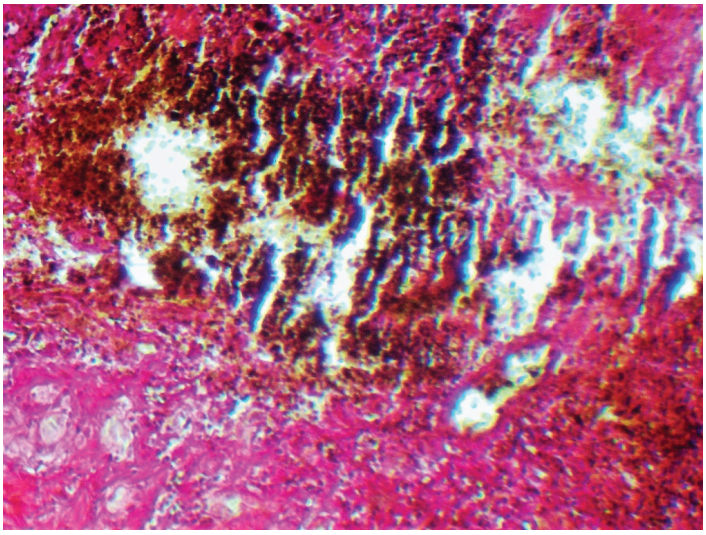

Fig. 4. Contusion of the vermiform appendix. Disorganization and dissociation of the appendix glands. Total fibrinoid necrosis of the wall, marked dilation of capillaries and small vessels. Hematoxylin-eosin staining. ×140

DISCUSSION

In recent years, the majority of cases of firearm penetrating abdominal injuries with vermiform appendix involvement consist of shrapnel injuries, which are associated with the more frequent use of explosive projectiles [3, 5, 7, 9]. According to statistics, the vermiform appendix is more frequently located in the right iliac region, and its injuries are also associated with trauma to this abdominal area or adjacent areas [3, 7]. The use of individual protective gear significantly reduces the number of injuries [8], but this does not occur in cases of damage outside the protection zone of the body armor. An analysis of the size of the entry wound, foreign bodies, and the wound on the vermiform appendix has allowed us to establish that injuries occur due to large foreign bodies with greater skin damage than the vermiform appendix itself.

Microscopic changes in the vermiform appendix in cases of injury are characterized by hemorrhagic infiltration and necrosis of all layers, microcirculation disturbances, which cannot be restored in this organ, justifying its removal.

CONCLUSIONS

1. In most cases of gunshot penetrating abdominal injuries, vermiform appendix injuries are characterized by an entrance wound on the right side.

2. Macroscopically, in gunshot blind penetrating abdominal injuries with vermiform appendix involvement, the wound on the skin is larger than on the vermiform appendix itself.

3. All foreign metallic bodies removed from the abdominal cavity after gunshot fragmentary blind abdominal injuries with vermiform appendix involvement were of large sizes.

4. Contusion injuries to the vermiform appendix tend to undergo a destructive transformation, necessitating surgical treatment – appendectomy.

5. The increased frequency of vermiform appendix injuries can be explained by the widespread use of fragmentary ammunition in abdominal injuries when individual protective equipment does not provide protection for this area.

The prospects for further research lie in a more in-depth study of changes in the vermiform appendix wall in gunshot injuries.

FUNDING AND CONFLICT OF INTEREST

The study received no funding. The authors declare that they have no competing interests.

COMPLIANCE WITH ETHICAL REQUIREMENTS

Ethics approval and consent to participate This study was approved by the Ethical Committee at the Kharkiv National Medical University (Kharkiv, Ukraine). The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent was obtained from participant.

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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Резюме

МАКРО- ТА МІКРОСКОПІЧНІ ОСОБЛИВОСТІ ВОГНЕПАЛЬНИХ ПРОНИКАЮЧИХ ПОРАНЕНЬ ЖИВОТА З УШКОДЖЕННЯМ ЧЕРВОПОДІБНОГО ВІДРОСТКУ

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Вступ. У структурі бойової травми живота за всі періоди бойових дій (за даними АТО/ООС) переважали вогнепальні поранення, які становили 87,1 %. Аналіз розподілу поранених з вогнепальними пораненнями за типом снаряда, що спричинив поранення, показав переважання осколкових поранень над кульовими – понад 80 %.

Мета роботи – проаналізувати макро- та мікроскопічні зміни при вогнепальних пораненнях живота в ушкодженому червоподібному відростку.

Матеріали та методи. Було виконано 8 апендектомій з приводу вогнепального проникаючого поранення живота з ушкодженням червоподібного відростку. У всіх поранених вивчалися скарги, анамнез, данні огляду, ультразвукового дослідження за FAST-протоколом та рентгенологічні обстеження. Для уточнення діагнозу та визначення об'єму оперативного втручання була використана відеоендоскопічна система WOLF. Проведено гістологічне дослідження видалених червоподібних відростків, які забарвлювали гематоксиліном і еозином та за Він-Гізоном. Комплекс патоморфологічних досліджень проводився на мікроскопі Primo Star (Carl Zeiss) зі збільшенням ×140 разів.

Результати. Всі поранення були при наявності бронежилета та характером були сліпі, з яких 1 (12,5 %) – кульове та 7 (87,5 %) – осколкових. Вхідний отвір при вогнепальних сліпих проникаючих пораненнях живота з ушкодженням червоподібного відростку був в правій здухвинній ділянці – 4 (50 %), в правій боковій поверхні живота – 1 (12,5 %), правій паховій ділянці – 2 (25 %) та мезогастральній ділянці – 1 (12,5 %) випадків. Середній розмір вхідного отвору на шкірі склав 23,3±0,4×12,4±0,3 см. Всі отвори на шкірі були поза зоною захисту бронежилету. Ушкодження червоподібного відростку були в середньому розмірами 15,4±1,2×9,3±0,1 см. Всі видалені сторонні тіла були за розмірами великих розмірів більш 1 см в найбільшому вимірі.

Висновки. У більшості випадків при вогнепальних проникаючих пораненнях живота ушкодження червоподібного відросту відмічається вхідний отвір правобічної локалізації. Макроскопічно при вогнепальному сліпому проникаючому пораненні живота з ушкодженням червоподібного відростку рана за розмірами більш на шкірі, ніж на червоподібному відростку. Всі сторонні металеві тіла, які були видалені з черевної порожнини після вогнепального осколкового сліпого поранення живота з ушкодженням червоподібного відростку, були великих розмірів. Контузійні ушкодження червоподібного відростка мають схильність до деструктивної трансформації, що потребує оперативного лікування – апендектомії. Збільшення частоти поранення червоподібного відростку можна пояснити масовим застосуванням осколкових боєприпасів при пораненні живота, коли засоби індивідуального захисту не забезпечують захист цієї ділянки.

Ключові слова: **вогнепальне поранення живота, ушкодження апендикулярного відростку, патоморфоз, осколкові поранення, кульові поранення**