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PECULIARITIES OF SEVERE LIVER GUNSHOT WOUNDS PATHOMORPHOSIS

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The purpose of the study was to determine the pathomorphological peculiarities of liver gunshot wounds. The study material was liver slices after gunshot shrapnel wounds to the colon (12 studies) from 1 hour to 6 days after the injury. Histological preparations were taken during primary surgical interventions after gunshot wounds of the liver and during repeated interventions. The most common were superficial cracks and subcapsular hemorrhages of various shapes and sizes, which had a variety of colours from light red to dark blue and were located mainly on the anterior part of the diaphragmatic surface and the anterior parts of the visceral surface of the liver. In case of liver ruptures, violations of the integrity of the liver parenchyma to different depths with the formation of a slit-like cavity were determined. The tissue crushing had different degrees of depth and volume - from superficial, with damage to small subcapsular layers of the parenchyma, to deep, with the transformation of entire liver lobes into a shapeless mass, consisting of crushed cells, partially interconnected by remnants of connective tissue. The authors concluded that liver injuries pathomorphological examination shows the following types of injuries: capsule cracks and subcapsular hemorrhages, liver parenchymal ruptures, crushing, hematomas. In traumatic necrosis of the liver parenchyma, the stromal component in the form of portal tracts remains preserved for the first few days. At the edges of hematomas, on the first day after the injury, perifocal areas of necrosis of the liver parenchyma appear, which are caused by the compressive factor of the hematoma itself. In wounds lasting more than 2 days, the zone of necrosis progresses around the hematomas due to ischemic infarctions, which can be explained by thrombus formation in the vessels and the phenomena of hypovolemic shock.

Key words: gunshot wounds, liver, pathomorphosis, pathogenetic mechanisms, surgical tactics, treatment, rehabilitation.

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ОСОБЛИВОСТІ ПАТОМОРФОЗУ ВАЖКИХ ВОГНЕПАЛЬНИХ ПОРАНЕНЬ ПЕЧІНКИ

Метою дослідження було визначення особливостей патоморфозу вогнепальних поранень печінки. Вивчали частки печінки після вогнепальних осколкових поранень товстої кишки в терміни від 1 години до 6 діб після отримання поранення. Гістологічні препарати були забрані при первинних хірургічних втручаннях після вогнепальних поранень печінки та при повторних втручаннях. Найчастіше зустрічали поверхневі тріщини та субкапсулярні крововиливи різних форм та розмірів, які мали різноманітний колір від світло-червоного до темно-синього з розташуванням переважно на передньої частині діафрагмової поверхні і передніх відділах вісцеральної поверхні печінки. При розривах печінки визначалися порушення цілості паренхіми печінки на різну глибину з утворенням щілиноподібної порожнини. Розтрощення тканини мало різний ступінь глибини та об'єму – від поверхневого, з ураженням невеликих субкапсулярних шарів паренхіми, до глибокого, з перетворенням цілих часток печінки на безформну масу, що складається з розчавлених осередків, частково пов'язаних між собою залишками сполучної тканини. Автори висловлюють, що при патоморфологічному дослідженні травм печінки спостерігаються тріщини капсули та субкапсулярні крововиливи, розриви паренхіми печінки, розтрощення, гематоми. При травматичних некрозах паренхіми печінки стромальний компонент у вигляді портальних трактів перші дні залишається збереженим. При пораненнях з терміном більше 2 діб навколо гематом прогресує зона некрозу за рахунок ішемічних інфарктів, які можна пояснити тромбоутворенням в судинах та явищами гіповолемічного шоку.

Ключові слова: вогнепальні поранення, печінка, патоморфоз, патогенетичні механізми, хірургічна тактика, лікування, реабілітація.

The study is a fragment of the research project "Development of modern methods of diagnosis and treatment of purulentseptic complications in combat surgical trauma", state registration No. 0120U101834.

The frequency of abdomen gunshot wounds during World War II ranged from 2–5 %, in modern military conflicts – 6.6–9 %, and during the AntiTerrorist Operation/Joint Forces Operation in Eastern Ukraine it equals to 7 % [3, 4, 7].

A distinctive aspect is that absolute number of wounded in the abdomen does not decrease despite the military personnel individual means of protection improvement [1, 4]. The frequency of liver damage among abdominal wounds ranges from 8.4 % to 29.3 % [11].

The American Association for the Surgery of Trauma developed a commonly accepted trauma grading scale to classify the severity of liver injuries [13]. It uses radiological, intraoperative and

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pathomorphologic criteria to determine the liver functional and morphological state [9]. Higher grades are more severe and are associated with higher possibilities of conservative treatment failure and the necessity for surgical intervention. The grade of injury does not necessarily indicate whether surgical or nonoperative treatment should be performed but it provides a standardized systemic assessment. However, higher grades of injury are associated with higher morbidity and mortality [9, 10, 13].

Liver injuries successful surgical treatment depends upon the surgical intervention adequacy to certain intraorganic structures involvement into the pathologic process. Deep and superficial wounds are distinguished, localized on the periphery or in the central part of the organ, with moderate or massive bleeding. All liver injuries are generally divided into three groups: (1) injuries that do not require surgical intervention or injuries that require surgical intervention within one segment; (2) injuries that require surgical intervention involving two or more segments and (3) any injuries combined with hepatic veins damage. The following problems such as profuse bleeding, massive hemoperitoneum, liver tissue pulpification, metabolic and hematological disorders are apparent in severe liver injuries [6].

That's why we are convinced that the degree (or volume) of liver damage with reliable morphological evidence significantly determines the tactics of surgical intervention and therefore persuades the success of these patients postoperative and further rehabilitation management.

The purpose of the study was to determine the pathomorphological peculiarities of liver gunshot wounds.

Materials and methods. Liver slices of wounded after colon gunshot shrapnel wounds (12 cases) throughout the period from 1 hr till 6 days after the injury served as the material of the study. Histological preparations were taken during primary and repeated surgical interventions after liver gunshot wounds. All wounded were male persons aged from 27 to 58 years. The average age was 42.5±3.8 years.

For histological examination, liver tissue fragments were fixed in 40 % neutral formalin and subjected to paraffin embedding according to generally accepted method [2, 5, 12]. Sections 5–6 μm thick were made after paraffin embedding which were stained with hematoxylin and eosin. The complex of pathomorphological studies was performed using "Primo Star" microscope ("Carl Zeiss", Germany) with ×40 and ×100 times magnification. A high-resolution digital camera with 8-bit digitization "AxioCam" (ERc 5s) with a pixel size of 2.2 μm and Carl Zeiss AxioCam (ERc5s) Configuration Tool software were used to document the images.

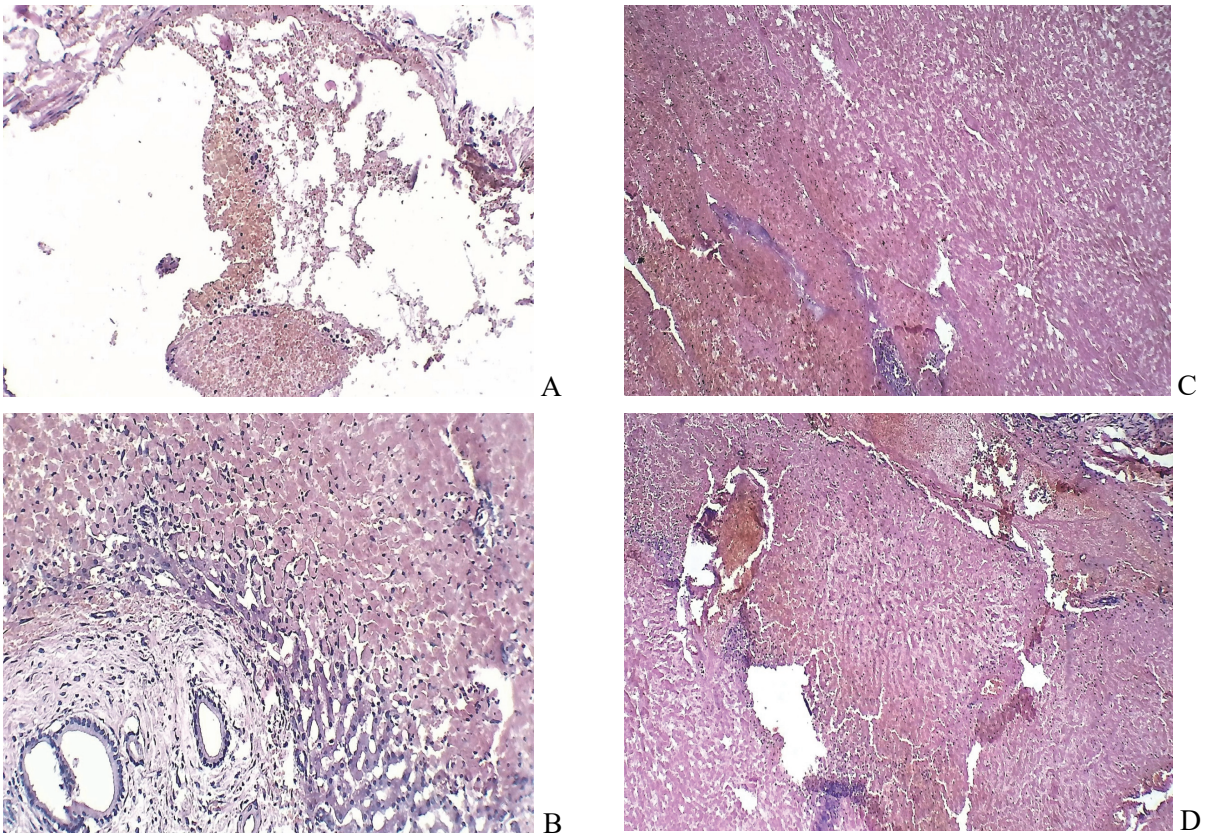


Fig. 1. Pathomorphological signs of gunshot liver injury. Hematoxylin-Eosin staining. x 40. A – Subcapsular haemorrhages with Gleason capsule detachment out of parenchyma; B – Portal tracts surrounded by a small layer of intact parenchyma with preserved bile ducts and vessels. x 100; C – Homogeneous masses of necrosis and haemorrhages in case of liver tissue crushed; D – Hematomas in the form of cavities filled with clearly visible red blood cells.

Results of the study and their discussion. We documented the 14 % frequency of gunshot wounds of abdomen with liver damage. The following types of liver damage were observed during pathomorphological examination: capsule cracks and subcapsular haemorrhages, liver parenchymal ruptures, crushing, hematomas.

The most common were superficial cracks and subcapsular haemorrhages of various shapes and sizes which varied in colour from light red to dark blue and were located mainly on liver both diaphragmatic and visceral surface frontal parts. Almost all haemorrhages were multiple in natures with the Gleason capsule detachment out of parenchyma (fig. 1A).

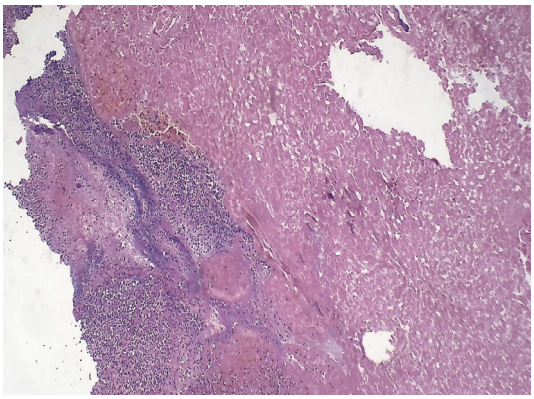
The destruction of liver parenchyma integrity to different depths with slit-like cavity formation was determined in case of liver ruptures. Liver damages according to their depth were classified on superficial, deep and through with a different nature of the shape and size. The multiple small bridges were found in the depth of the ruptures, among the foci of necrosis, which were represented by the portal tracts connective tissue surrounded by a small layer of intact parenchyma with preserved bile ducts and vessels (fig. 1 B).

The tissue destruction had different degrees of depth and volume – from superficial, with parenchyma small subcapsular layers damage, to deep, with the entire liver lobes transformation into a shapeless mass consisting of crushed cells, partially interconnected by connective tissue remnants. The organ cytoarchitecture during histological examination was completely destroyed and represented by homogeneous masses of necrosis, haemorrhages and vascular contours (fig. 1 C).

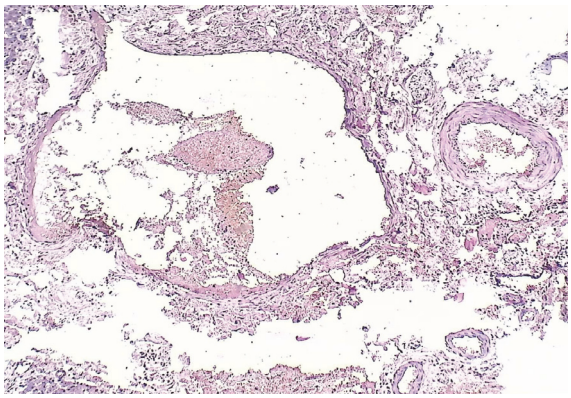
Liver tissue multiple ruptures and crushing were usually accompanied by vascular damage with subsequent formation of numerous hematomas which size directly depended on the volume and nature of organ tissue destruction, calibre and type (arterial or venous) of vascular damage.

We documented diverse histological description depending the time after the. In cases where surgical treatment was performed during the first day after injury, hematomas were determined in the form of cavities filled with clearly visible red blood cells. Perifocal areas of necrosis were detected along the edges of hematomas in the liver. In preserved hepatocytes located at a distance from the haemorrhage focus, nuclei were clearly distinguished and cytoplasm was stained (fig. 1 D).

In cases where the liver injury was more than 2 days old, fibrin and signs of erythrocyte hemolysis appeared in the hematomas, leukocyte infiltration was expressed and the zone of necrosis spread due to ischemic infarctions which surrounded the injured area in a ring-like shape, increasing the size of liver tissue irreversible changes (fig. 2 A).



A



B

Fig. 2. Pathomorphological signs of liver gunshot injury of more than 2 days old. Hematoxylin-Eosin staining. x 40. A – Liver parenchyma ischemic infarctions around the hematoma; B – Vascular paresis, anemia with erythrocyte stasis, thrombus formation inside hepatic vein and artery branches. x 100.

Vascular paresis, anemia with erythrocyte stasis and thrombus formation within the vessels lumens were detected in the preserved liver parenchyma and portal tracts in hepatic vein and artery branches (Fig. 2 B).

Thus, the performed pathomorphological studies indicate that liver gunshot wounds pathomorphosis is diverse and depends mainly from the characteristics of both the wounding metal and explosive impact, on the one hand, and from the victim's body individual properties, on the other. The volume of liver damage and the kinetic energy of the direct wounding influence on this parenchymal organ determine significantly its morpho-functional state. The peculiarities of liver pathomorphosis also depend upon the affected volume of the organ and the number of affected intraorganic structural units which determines the body's reaction in response to the injury [3, 5].

To discuss the results obtained we underline the most important thing that we methodologically use living material obtained during the surgical treatment of the wounded after gunshot wounds. In this

aspect, the data obtained are valid, since they are not experimental results approximation or specialized modelling of wounding objects influence on human tissues and organs. Unfortunately, our country, due to the destructive aggression of the enemy, has become a source of unique clinical, laboratory, pathomorphological and other types of research materials, which, firstly, is impossible on another field of combat operations, and, secondly, is used by domestic doctors and specialists in related fields exclusively for the purpose of wounded earliest possible recovery and their effective rehabilitation [4].

Having a wide experience in wounded treating after gunshot wounds, we, of course, were guided by the only leading pathomorphological work [5] but in our own clinical observations we developed this topic, moving forward from bones and skull gunshot wounds examination and approaching the clinical examination of wounded after internal organs gunshot wounds [11]. In this aspect, parenchymal organs, namely the liver, are of clinical importance [15]. We emphasize this because internal organs, differing in their density, structure, anatomical structure and histological features, react differently to a specific ballistic injury, starting from the place of penetration of the wounding projectile [8, 14].

And, thirdly, when studying the liver pathomorphological peculiarities after gunshot wounds, it is impossible to ignore the fact of especially soft tissues and internal parenchymal organs destructive traumatization by such wounds, since the traumatic projectile high kinetic energy causes high traumatization of tissues, their fragmentation into the smallest fragments with multidirectional scattering [1, 5, 10]. This is where we see the applied place of pathomorphological research, since such an examination option has an extremely important diagnostic and prognostic value from the point of view of adequate treatment tactics and subsequent rehabilitation choice.

Fourthly, our data are in some way consistent with those previously available in the literature, namely, the pathomorphological processes directions are clear due to which we are able to trace intrahepatic pathophysiological processes after gunshot wounds. Hence, one could suppose the following sequence of intrahepatic pathophysiologic processes: haemorrhage → necrosis → secondary foci of microcirculatory disorders which consequences are hepatocytes' hypoxia and ischemia, progressive blood supply disruption with subsequent liver parenchyma organization by connective tissue. With liver damage severity increasing and damage presence in two or more liver segments, areas of necrosis neighbors with areas of hypoperfusion [1, 6], and the inflammatory process presence leads to volume of damage increase which is determined by histological studies [1].

From the point of view of further surgical treatment, probable complications prevention and rehabilitation of this contingent of patients we consider it appropriate to note the inflammatory process important pathogenetic contribution in pathomorphosis of liver parenchyma gunshot lesions. The inflammatory process usually proceeds quite quickly in soft tissues gunshot lesions resulting in a rapid healing reaction of the wound surface, scar tissue formation with neoangiogenesis and blood supply restoration [1].

However, according to our research, we are talking about the negative impact of prolonged highly extended inflammation on liver morpho-functional state with its parenchyma impaired blood supply and hepatocytes necrosis initiation which significantly complicates reparative processes. Taking into account the above-mentioned liver gunshot lesions pathomorphological peculiarities also determines surgical tactics on which we attract attention with recommendatory point of view.

Therefore, we note that liver gunshot wounds pathomorphosis understanding allows us to explain the pathogenetic mechanisms, to determine the main disease diagnosis, treatment tactics and prognosis [11].

Conclusions

1. Liver injuries pathomorphological examination reveals the following types of injuries: capsule cracks and subcapsular haemorrhages, liver parenchymal ruptures, crushing, and hematomas.

2. Liver parenchyma stromal component in the form of portal tracts remains preserved during the first few days of liver traumatic necrosis.

3. Perifocal areas of liver parenchyma necrosis appear at the edges of hematomas during the first day after the injury induced by the compressive effects of hematoma itself.

4. In liver injuries lasting more than 2 days, a zone of necrosis progresses around hematomas due to ischemic infarctions which can be explained by intravascular thrombus and the phenomena of hypovolemic shock.

5. Liver gunshot wounds pathomorphosis understanding allows us to explain the pathogenetic mechanisms, to determine the main disease diagnosis, treatment tactics and prognosis.

Prospects for furthers researches include expanding the area of internal organs morphological investigations after gunshot wounds to systematize chain-directed pathomorphological processes that occur in the organism as a result of a wounding weapon with high kinetic energy. An additional perspective effect of these researches is the development and systematization of medical tactics for managing patients with internal organs gunshot wounds.

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