

Modern combat injuries of the extremities. The first report: clinical and anatomical structure and structure of injury combinations

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Abstract

Objective. To determine and verify the clinical and anatomical structure and structure of combinations of combat injuries of the extremities.

Materials and methods. A retrospective analysis of 2138 observations of combat limb injuries was carried out using the laws of formal logic, parametric and non-parametric statistics.

Results. It has been established that head and neck injuries are most often combined with injuries to the upper (53.08%) and lower (46.92%) limbs. Combined injuries to the chest and upper limb occurred in 50.01 per cent of victims, and to the chest and lower limb in 49.99 per cent. The combination of injuries to the abdomen, spine, and pelvis with injuries to the lower extremities was observed in 62.40, 57.15, and 76.18 per cent of victims, respectively.

Conclusions. Limb injury as a result of modern warfare is a rather complex clinical and anatomical trauma, the main feature of which is multicomponent (damage to different segments of the limbs) and combination with damage to other organs and systems.

Keywords: combat injuries of the extremities; clinical and anatomical analysis; combination of injuries.

Modern warfare has significant health consequences for both civilians and military personnel [1–3]. The main types of human injuries include limb injuries [4–6]. Currently, this is a major problem in military and disaster medicine, as limb injuries threaten amputation and further disability of victims [7, 8]. Unfortunately, amputations as a result of combat limb injuries are quite common, although there are few modern combat limb injuries [9, 10]. The issues of determining the viability of the limb, the risk and indications for amputation remain particularly controversial [11, 12]. This suggests the need for thorough research on this issue. We have initiated a series of studies on various aspects of combat limb injuries. This report provides data on the clinical and anatomical structure and the structure of combinations of combat limb injuries.

The aim of the study is to determine and verify the clinical and anatomical structure and structure of combinations of combat injuries of the limbs.

Materials and methods

The data of 4720 people affected by the ongoing hostilities in eastern Ukraine until 24.02.2022 – before the full-scale invasion of Ukraine by the Russian Federation – were retrospectively analysed. Among them, 2,138 victims were selected by irreversible randomisation on the basis of limb damage. Thus, according to our data, limb injuries occurred in 45.30% of victims. The proportion of injuries to the upper limb was 39.94%, and the lower limb – 60.06%. This scope of the study exceeds the necessary and sufficient in accordance with the law of large numbers. The injuries of the upper and lower extremities were identified and analysed for each segment without taking into account clinical and nosological characteris-

tics and severity of injury, only purely clinical and anatomical characteristics were taken into account. Particular attention was paid to both the combination of injuries to limb segments among themselves (multiorgan trauma) and the combination of injuries to limbs and other organs and systems (multisystem trauma). The analysis was carried out using the laws of formal logic, parametric and non-parametric statistics with the help of computer technology using the Statistica system.

Results

The study of clinical and anatomical forms of injury, their relationship and structures, which, along with clinical and epidemiological characteristics, is one of the main components of a scientific study of any clinical event in accordance with the standards of evidence-based medicine.

For the study of combat injuries, clinical and anatomical characteristics and their relationship with clinical and epidemiological characteristics are important. It is especially important to characterise the injuries in relation to their combination with injuries to other organs and systems.

To determine the characteristics and values of combinations of injuries, we analysed the distribution of injuries to the upper and lower extremities on the basis of combination with injuries to other organs and systems separately for each segment (*Table 1*).

Based on the analysis of the data in *Table 1*, the following patterns were identified.

Head and neck injuries are more often combined with upper limb injuries (53.08%) than lower limb injuries (46.92%), which is 6.88% less than the absolute value of the intensive indicator or 12.79% less than the baseline indicator.

Table 1. Integral analysis of the combination of limb injuries by limb segment and anatomical substrate of the combination

Anatomical area	Anatomical haxe											
	head and neck		chest		belly		ridge		pelvis			
	%*	%**	%*	%**	%*	%**	%*	%**	%*	%**		
Upper limb												
brush	42,35	22,22	29,42	13,59	21,17	13,53	4,71	28,57	2,35	4,77		
forearm	30,95	8,02	30,95	7,06	23,81	7,53	2,38	7,14	11,91	11,90		
shoulder	31,63	22,84	46,15	29,36	18,81	16,54	0,85	7,14	2,56	7,15		
Lower limb												
hip	24,65	21,61	35,21	27,17	26,06	27,82	2,11	21,43	11,97	40,47		
shin	29,62	19,75	26,85	15,76	28,73	23,30	2,77	21,43	12,03	30,95		
foot	21,95	5,56	31,71	7,06	36,58	11,28	4,88	14,29	4,88	4,76		
In total ...	-	100	-	100	-	100	-	100	-	100		
Note:	* - from the index of injury to a segment of the limb; ** - from the index of injury to another anatomical area.											

Note. * - from the index of injury to a segment of the limb; ** - from the index of injury to another anatomical area.

Table 2. Analysis of the combination of limb segment injuries

Anatomical area	Limb segments											
	brush			forearm			shoulder			hip		
	%*	***	%**	%*	***	%**	%*	***	%**	%*	***	%**
Upper limb												
brush	-	-	22,53	21,13	12,56	18,69	11,52	15,38	9,46	12,19	8,57	10,72
forearm	10,59	14,16	-	-	8,19	12,19	7,79	10,40	5,30	6,83	3,80	4,76
shoulder	15,23	21,69	21,12	21,13	23,49	-	14,57	19,45	12,87	16,58	7,61	9,53
Lower limb												
hip	22,51	32,08	31,39	32,39	18,57	34,96	-	-	35,98	46,35	24,76	30,95
shin	16,55	23,58	19,33	19,72	4,37	27,65	32,20	42,98	-	-	35,23	44,04
foot	5,96	8,49	5,63	5,63	-	6,51	8,81	11,79	14,01	18,05	-	-
In total ...	70,84	100,0	100,0	100,0	67,18	100,0	74,89	100,0	77,62	100,0	79,97	100,0

Note. * - from the rate of injuries to the specified anatomical area; ** - from the rate of combined injuries to the specified anatomical area.

Chest injuries and upper and lower extremity injuries occurred in combination with almost equal frequency – 50.01 and 49.99% respectively.

Abdominal injuries were predominantly combined with lower limb injuries in 62.40% of victims and accounted for 24.80% of the absolute value of the intensity index, or 65.60% more than the baseline when combined with upper limb injuries.

The spine is damaged mainly with lower limb injuries in 57.15% of victims, which is 14.30% in absolute intensity or 36.81% more than the baseline when combined with upper limb injuries.

Injuries to the pelvic area were mainly combined with injuries to the lower extremities in 76.18% of victims, which is 52.36% in absolute intensity terms or almost 2 times higher than the baseline when combined with injuries to the upper extremities.

Combined injuries to individual limb segments and other anatomical areas also have certain peculiarities. Hand injuries are most often combined with head and neck injuries – in 42.35% of victims, and least often with pelvic and spinal injuries – in 2.35% and 4.71% of victims, respectively.

Forearm injuries are combined with head, neck and chest injuries with equal frequency (30.95%), and spinal injuries are the least common (2.38%).

Shoulder injuries are most often accompanied by chest injuries – in 46.15% of victims, and least often by spinal and pelvic injuries – in 0.85 and 2.56% of victims, respectively.

Hip injuries were combined with chest injuries in 35.21 per cent of victims, and spinal injuries in only 2.11 per cent of victims.

In the case of shin injuries, injuries to the head and neck, chest, and abdomen are almost equally common – 29.62, 26.85, and 28.73%, respectively, and the frequency of combination with spinal injuries is the lowest – 2.77%.

In the case of foot injuries, the abdomen is most often damaged – 36.58%, and the least common are injuries to the spine and pelvis – 4.88% each.

Also, in the case of limb injuries, the clinical and anatomical characterisation is to determine the structure of the injuries by limb segment. From the point of view of completeness and depth of the study, it is important to analyse the combination of limb injuries caused by modern combat operations (*Table 2*).

The analysis of the data presented in *Table 2* shows that multiple injuries to the forearm occur with a frequency of 100%, the shoulder – 67.18%, and the hand – 70.84%. These data indicate that the hand is used to cover the chest and head.

The structure of the combination (multiplicity) of injuries differs in different anatomical segments.

Injuries to the hand were combined with injuries to the forearm in 14.16 per cent of victims, the shoulder in 21.69 per cent, the thigh in 32.08 per cent, the lower leg in 23.58 per cent, and the foot in 8.49 per cent. In other words, 64.15 per cent of the victims had a hand injury combined with a lower limb injury, as their analysis showed, reflexively, as an attempt to protect the affected lower limb.

Forearm injuries are most often combined with hip injuries (32.39%), less often with lower leg injuries (19.72%), and rarely with foot injuries (5.63%). In other words, forearm injuries are combined with lower limb injuries in 57.74% of victims, which is related to the features described above.

The same applies to shoulder injuries, which are most often combined with hip injuries – in 34.96% of victims. In general, combined injuries to the shoulder and lower extremities occurred in 69.12% of victims, which we believe is due to the reasons mentioned above.

Combined injuries to the lower limbs also have specific features. Thus, hip injuries are most often (54.75%) combined with injuries to other segments of the lower limb, and they are combined with injuries to segments of the upper limb with the following frequency: hand – 15.38%, forearm – 10.40%, shoulder – 19.45%.

Injuries to the lower leg in 36.40% of victims were combined with injuries to other segments of the lower limb, and in 12.19% of victims they were combined with injuries to the hand, in 6.83% – with injuries to the forearm, and in 16.58% – with injuries to the shoulder.



Mine-blast trauma: traumatic amputation of the left foot, injuries to both thighs and both shins.

Injuries to the foot were most often (74.97%) combined with injuries to other segments of the lower limb (*see Figure*), and injuries to the hand, forearm and shoulder were combined with the following frequency: 10.72, 4.72 and 9.53% respectively.

This distribution of limb injuries suggests that the upper limbs are more often injured as a reflexive response, when the injured person attempts to protect the lower limb with the upper limb after being injured, and the lower limbs are injured due to the direct impact of the weapon.

Thus, it is worth noting that limb damage as a component of polytrauma as a result of modern combat operations is a rather complex clinical and anatomical trauma, the main feature of which is multicomponent (damage to different segments of the limbs) and combination with damage to other organs and systems.

The solution to this problem requires further research into the clinical characteristics of the severity and extent of the lesion, as well as an assessment of the viability of the limb.

Discussion

The results of the study indicate the existence of a probable fact of the combination of limb injuries with injuries to other anatomical areas in victims with modern combat trauma and certain patterns, which is primarily due to the location of the area of combination next to the affected limb. A thorough study of the combination of limb injury with chest injury has shown that this ratio in the volume of combination with upper and lower limb injury is associated with the protection of the chest by body armour, i.e. thoracic injuries are caused by the impact of a more intense injury factor, which leads to equivalence of injury. Our data partially coincide with those of foreign researchers [13–17]. In addition, it is worth noting that we did not find any studies of the combination of limb damage with damage to other anatomical and functional areas in the available scientific and specialised sources of information.

It has been established that the combination of lower limb injuries also has specific features, namely, hip injuries are most often (54.75%) combined with injuries to other segments of the lower limb, and they are combined with injuries to segments of the upper limb with the following frequency: hand in 15.38%, forearm 10.40%, shoulder 19.45%. Foreign authors report a lower frequency of 45.86% of combined lower limb injuries, which is primarily due to the peculiarities of modern warfare and the use of modern weapons [18–20].

This clinical and anatomical characteristic of modern combat limb injuries indicates that in most victims they are a component of multiorgan and multisystem trauma, which is of great clinical importance, especially when assessing the viability of the limb.

The results of our study confirm the expediency of continuing to study the nature of limb injuries as a result of modern warfare.

Conclusions

1. Limb injuries as a result of modern warfare in almost 90% of victims are a component of a multisystem or multiple trauma, and in 100% of victims they are polystructural.

2. Injuries to each limb segment are most commonly associated with injuries to other organs and systems. Thus, upper limb injuries are most often combined with head and neck injuries and chest injuries (22.84 and 46.15%, respectively), and lower limb injuries with abdominal and pelvic injuries (27.82 and 40.47%, respectively).

3. Limb injuries are multisegmental in 88.55% of victims, with different combinations for each limb segment, which is a consequence of the peculiarities of modern weapons.

4. Addressing the problem of limb injuries as a component of multisystem and multiorgan trauma as a result of modern warfare requires in-depth research to minimise the risk of limb loss.

Funding. No external sources of funding or support were used. No fees or other compensation was paid.

Authors' contributions. All authors contributed equally to this paper.

Conflict of interest. The authors who contributed to this study have declared that they have no conflicts of interest in relation to this manuscript.

Consent to publication. All authors have read and approved the final version of the manuscript and agreed to its publication.

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Received: 10.06.2023