Morphological features of stab-cut wounds of the skin of the trunk and limbs inflicted by kitchen knives

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Examination of injuries caused by sharp objects is a complex process that requires the application of a whole range of knowledge not only in the field of forensic medicine, but also in human anatomy. Among all sharp objects, stab-cut objects are the most common, namely the kitchen knife. Researching the peculiarities of the morphology of injuries to various anatomical parts of the human body with this subject would improve the quality of forensic research. The purpose of the study is to analyze the morphological features of stab-cut wounds to the skin of the trunk and limbs caused by kitchen knives. A forensic examination of 93 stab wounds of corpses, which were inflicted by kitchen knives with one-sided sharpening and a straight butt, was carried out. Wounds in the chest ranged in size from 1.7x0.2 cm to 4.3x0.6 cm; wounds in the abdomen ranged in size from 1.8x0.4 cm to 3.3x0.7 cm; wounds in the lumbar region had sizes from 1.7x0.2 cm to 4.0x0.6 cm; wounds on the upper extremities - from 1.5x0.9 cm to 3.0x0.6 cm and wounds on the lower extremities from 1.5x0.2 cm to 3.2x0.6 cm. In all cases, the wounds had even edges and a smooth surface of the walls. Wounds located along Langer’s line have a linear shape, and those located across Langer’s lines have an oval shape. In addition, a different shape of the butt section was found, depending on the localization and the force of immersion. In this way, characteristic differences in the shape of the butt cut were revealed and the existence of differences in its morphology in different anatomical parts of the body was proved. Taking into account the location of the injury according to the location of Langer’s lines should be standard procedure in forensic investigations of injuries caused by sharp objects.

Keywords: stab-cut wound, skin, torso, limbs, kitchen knives.

Introduction

The classification of tools and the types of wounds they cause is one of the key issues of forensic medicine, because it is critical for the correct interpretation of the phenomenon and its further evaluation from a legal point of view. Classically, such types of wounds as incised, stab, slash and chop are distinguished in forensic medicine [17].

Stab wounds are one of the most common types of wounds, which are formed as a result of the action of the most common sharp object in everyday life - a knife [9]. Indeed, an analysis of homicides in Scotland between 2006 and 2011 found that a kitchen knife was used in 94 % of all homicides involving sharp objects [15]. In 29 % of cases, the use of stab items can end fatally. In most cases (79 %), this category of items is used against the background of alcohol consumption [16].

Stab wounds occupy a leading place in the structure of injuries caused by sharp objects. According to static data, in the vast majority of cases (97.8 %), when inflicting stab damage, knives with one-sided blade sharpening (knives with a butt and a blade) are used [10, 14]. Data from emergency services in the United States from 1990 to 2008 indicate that more than 8 million knife wounds were treated, which is equivalent to 119 wounds per day. The most frequent injuries were localized on the fingers (66 %) and were caused by pocket knives (47 %) or kitchen knives (36 %) [21].

M. U. H. Chowdury with co-authors [8], analyzing the data of fatal cases with the use of stab objects, indicate that 90 % of the victims are men, and the most common localization of damage is the chest with damage to the lungs or heart. Abdominal injuries with damage to the stomach or liver are less common. The third most common
type is multiple wounds on the front and back of the body. The least common type of injury is localization of the lower extremities with damage to a large blood vessel. Similar data on the localization of injuries were also obtained by Norwegian researchers [16].

For the tasks of forensic medical examination, a detailed study of the morphological and morphometric features of stab wounds of clothing, skin, cartilage, bones and internal organs continues. It is emphasized that a thorough study of the macro- and microscopic signs of the wound facilitates the diagnosis of the main properties of the stab object. There is also evidence that the nature, morphology and metric properties of stab wounds of the skin depend on their localization on the human body [2, 11].

One of the parameters that is important in the formation of wounds on the human body is Langer’s lines. Their concept was first derived in 1861 by Professor Karl Langer, who in turn performed an analysis of the data of Dupuytren and Malgaigne, who described the shape of injuries on the body of people who survived a suicide attempt, which did not match the shape of the object that caused them and in later confirmed this experimentally on human corpses. Langer, on the other hand, carried out a systematic study on the entire surface of corpses of people (of different ages - from embryos to elderly people; of different physiques, in particular, children with obesity), documenting not only macroscopic changes, but also microscopic ones, in particular, type I collagen fibers, which form a specific diamond-shaped grid, which is the cause of this phenomenon [1, 7].

Another factor that should be taken into account when working with pieces of skin with wounds removed for forensic examination is the change in the shape and size of the damage under the influence of fixing substances. Thus, in one of the studies, damage to the skin of the abdomen decreased by 11% [23].

Such prevalence of injuries caused by stab objects and the mass of factors that change the pattern of injury require comprehensive research on various anatomical parts of the human body, taking into account Langer’s lines.

The purpose of the study is to analyze the morphological features of stab wounds to the skin of the body and limbs caused by kitchen knives.

Materials and methods

The stab wounds of the skin taken from 93 corpses of persons, inflicted by common kitchen knives with one-sided sharpening and a straight butt, were studied. It was revealed that in 79 cases the wounds were multiple, in 14 - single.

The conducted research does not contradict the basic bioethical norms of the Declaration of Helsinki, the Convention of the Council of Europe on Human Rights and Biomedicine (1977), the relevant provisions of the WHO and the laws of the Republic of Uzbekistan.

The study of skin wounds was carried out in stages, using forensic research methods. The following signs of wounds were studied: the length, width of the wound, the shape of the ends (the shape of the blade and butt ends), the nature of the edges, the surface of the walls and the bottom of the wound, the length of the wound channel, the location of the wounds relative to the Langer lines.

Results

Most of the injuries were localized in the chest area (44), and more often they were oriented obliquely. In 27 cases, the wounds were located in the abdomen with a predominance of oblique orientation. 16 wounds were found in the limbs, most of them were oriented obliquely, 6 - in the lumbar region, more often oblique.

Wounds in the chest area, located along the Langer lines, had a linear shape, and those located across the Langer lines had an oval shape. The edges of the wounds are even, the surface of the walls is smooth, the blade end is sharp, and the butt end is U-shaped (Fig. 1). The size of the wounds varied from 1.7x0.2 cm to 4.3x0.6 cm. The length of the wound channels in chest injuries largely depended on the anatomical and physiological characteristics of the damaged organs. In some cases, the wound channel ended blindly in the lung, which caused a decrease in the volume of this organ due to developed hemo-, pneumo- or hemopneumothorax. In most cases, it was impossible to trace the wound channel to the end.

The wounds located in the abdomen, due to the elasticity of the skin, had a more pronounced oval shape with smooth edges, and when comparing the edges, they had a linear-

![Fig. 1. Stab wound of the chest.](image-url)
slit shape. The wounds had smooth edges, a smooth surface of the walls, the ends were acute-angled on the side of the blade, M-shaped on the side of the butt. The wound sizes ranged from 1.8x0.4 cm to 3.3x0.7 cm (Fig. 2). With abdominal injuries, the length of the wound channel may be underestimated due to the fact that the measurement of its length was carried out in a horizontal position of the body. Since the wounds were received in a vertical position of the body, there is a displacement of the abdominal organs downward. When determining the length of the wound channel on a corpse, an error may occur due to some retraction of the anterior abdominal wall.

Stab wounds of the lumbar region have a more pronounced oval shape, smooth edges, a smooth surface of the wall, the ends are acute-angled on the blade side, T-shaped on the butt side. The size of the wounds varied from 1.7x0.2 cm to 4.0x0.6 cm. Wounds of this localization may have an additional incision (Fig. 3).

Stab wounds of the limbs were more often located on the upper limb, mainly on the outer surface of the shoulders. They often had a linear, less often linear-oval shape and a gaping appearance due to the contraction of well-developed muscles. In addition, there was a dependence of the form of wounds on the degree of development of subcutaneous fat, the position and depth of immersion of the blade. The wounds had even edges and a smooth wall surface. The size of the wounds ranged from 1.5x0.9 cm to 3.0x0.6 cm. The ends of the wounds were acute-angled on the blade side, T-shaped on the butt side. The overhanging nature of the upper edge of the wound was often noted in the direction from bottom to top and somewhat from left to right. The shape of the butt end can also be L- and U-shaped.

Stab wounds of the lower extremities were located more often on the posterior-outer surface, less often on the inner-lateral surface of the thigh. They had an arcuate-linear, angular, elongated shape, a gaping appearance due to muscle contraction. The shape of the wounds was...
influenced by the position and depth of the blade. The dimensions of the wounds were from 1.5x0.2 cm to 3.2x0.6 cm, the edges were even, the surface of the walls was smooth, the ends on the blade side were sharp, on the other side of the butt side L-, U-shaped. With these types of wounds, the directions of the wound channels were easily determined. They were directed from top to bottom, from front to back, somewhat from left to right (Fig. 4).

The stab wounds of the upper and lower extremities, located along the lines of Langer, had the same semi-open shape; and the wounds located across the lines of Langer had an oval shape, their edges were open. Along with this, their relationship with the location and direction of the muscles located in this area was observed.

Discussion

Our study confirms the known data that stab wounds are most often localized on the trunk [13, 18]. In a previous study, we established that the most common location for all sharp objects is the chest area (46.6%). Wounds in the abdomen (28.2%), limbs (17.5%) and lower back (7.7%) were less common. In all cases, the oblique-longitudinal orientation of the wounds prevailed [5].

Also, the data of our previous studies confirm the data of other researchers regarding the predominant number of stab injuries in men. When injuries are caused by national Uzbek knives, the wounds usually have an angular, oval or linear shape. The blade end is classically sharp, while the obtuse end has a different morphological characteristic U-, L-, and T-shaped shapes are noted [6].

Data from literary sources indicate a rare localization of stab injuries in the head or neck region. While injuries to the left half of the chest are quite common and the most dangerous location for stab injuries. It has been noted that this predominant localization of injuries is associated with the deep conviction of the killers that the heart is completely located only in the left part of the chest and that its damage will lead to quick death [20].

In our study, chest area stab wounds amounted to 74.7%. We agree with the opinion of the authors that the dynamics of the traumatic effect of piercing-cutting objects forms certain morphological features in the wound, which make it possible to identify the traumatic object [22]. The analysis of our data on the study of stab wounds indicates that in all cases there was no complete immersion of the blade, since we did not find additional signs at the ends of the wounds formed by the heel or beard of the blade.

It is known that the trace-perceiving surface of various parts of the body is not uniform. From one knife, damages can be formed that have different metric and morphological features, imitating the actions of various trace-forming objects. It has been established that the most complete morphology of the trace-perceiving elements, which make it possible to identify the damaging object, is reflected in preparations from the back and thigh [3]. This statement does not exclude, but rather suggests further comparative study of wounds of different localizations formed by the same type of knives.

At the same time, important attention should be paid to various types of sharp objects that can cause stab wounds. Thus, in the study of Bolliger S. A. and co-authors [4], the force required to damage the entire thickness of the skin with a pocket knife and paring knife was analyzed on biological imitators of human skin. For the former, the minimum penetration force was 1900 g and for the latter 700 g, which is an unexpected result, given the seemingly identical nature of the knives from the point of view of forensic medicine.

C. Humphrey and colleagues [12] performed an experimental study by stabbing the limbs of pigs with different types of knives. The authors noted a correlation between the strength and the number (r=0.69), width (r=0.63) and depth (r=0.57) of injuries that occurred on the bones of the limbs. In addition, the authors draw attention to the difference in the appearance of wounds caused by knives with and without serrations.

Another group of researchers analyzed injuries caused by stab objects when thrown into an object. In general, the authors indicate that the nature of the injury is largely influenced by the weight of the object, the way it was thrown, and the distance to the object. So, heavy objects such as a chef's knife or a skin pick can penetrate deeply into the body even at a distance of 4 meters. Heavy objects of this type cause damage more than 6 cm deep [19].

In this way, it is possible to point to the existence of a whole array of different research methods for studying the effect of stab objects, which confirms the relevance of studying the effect of sharp objects on the human body. The features of stab wounds that we have identified can contribute to their differentiation depending on the localization on the body.

Conclusion

1. The study of stab-cut injuries caused by the most common kitchen knives showed that all the wounds we examined had smooth edges and walls with a smooth surface. However, there is a difference in the shape of the wound depending on their localization.

2. Wounds in the chest area, located along the Langer line, have a linear shape, and located across the Langer lines - an oval shape. Stab-cut injuries of the abdomen had a more pronounced oval shape, as well as wounds located in the lumbar region. The wounds of the limbs have an arcuate-linear, semi-open shape.

3. A different shape of the butt section was found. For chest wounds in the region of the butt, a U-shaped incision is characteristic, the abdomen is M-shaped, and the lower back is T-shaped. For wounds of the upper extremities, the butt incision can be T-shaped, L- and U-shaped, for the lower extremities - L-shaped and U-shaped. The blade edge of stab-cut injuries is sharp in all cases.
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References

ділянці мали розміри від 1.7х0.2 см до 4.0х0.6 см; рані на верхніх кінцях — від 1.5х0.9 см до 3.0х0.6 см і рані на нижніх кінцях — від 1.5х0.2 см до 3.2х0.6 см. В усіх випадках рані мали рівні краї та гладеньку поверхню стінок. Рани, котрі розташовані по ходу лінії Лангерса мали лінійну форму, а ті, котрі розташовані поперек лінії Лангерса — овальну. Крім того, виявлено різну форму обушкового розрізу в залежності від локалізації та сили занурення. Таким чином, виявлено характерні відмінності у формі обушкового розрізу і доведено існування відмінностей у його морфології в різних анатомічних ділянках тіла. Прийняття до уваги локалізацію ушкодження відповідно до розташування ліній Лангерса має бути стандартною процедурою при проведенні криміналістичних досліджень ушкоджень, заподіяних гострими предметами.

Ключові слова: колото-різана рана, шкіра, тулуз, кінцівки, кухонні ножі.