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INCA BONE AS A MORPHOLOGICAL PARAMETER IN THE FORENSIC IDENTIFICATION OF KAZAKH NATIONALITY PERSONS

Merey M. Tolegenov[1], https://orcid.org/0000-0003-4002-232X

Murat N. Lepesbayev[1], https://0009-0006-9810-9232

Dariya M. Shabdarbayeva[1], http://orcid.org/0000-0001-9463-1935

Yernar N. Begaliev[2], http://orcid.org/0000-0001-6659-8576

Askhat B. Orakbayev[3], http://orcid.org/0000-0001-7363-3835

Saulesh A. Apbasova[1], https://orcid.org/0000-0001-6650-4971

Zhanargul K. Smailova[1], https://orcid.org/0000-0002-4513-4614

Nailya Zh. Chaizhunusova[1], https://orcid.org/0000-0002-6660-7118

Akmaral A. Zhakipova[1], https://orcid.org/0000-0003-3023-9445

[1] NCJSC "Semey Medical University", Semey, Republic of Kazakhstan;
[2] Supreme Judicial Council of the Republic of Kazakhstan, Astana, Republic of Kazakhstan;
[3] Regional Prosecutor's Office of Abay Region, Semey, Republic of Kazakhstan.

Abstract

Relevance: the article discusses the possibility of using Inca bones (os Incae) as an additional morphological parameter in the forensic identification by the skull of Kazakh nationality persons. It has been established that the frequency of occurrence of Inca bones in this population is low, however, this feature may be noticeable as an additional factor in identification algorithms.

Aim: to describe a clinical case of using a neural network model to analyze the morphometric parameters of the skull and their use in identifying the identity of a person of Kazakh nationality.

Research methods: This study is an observational one; no additional statistical data processing has been performed.

Discussion: The results of the study confirmed that the anatomical variability of the skull's occipital region is important for forensic identification. This feature reflects the features of the intertribal area's ossification, but does not have a strict racial diagnostic value. Nevertheless, the inclusion of the Inca bone as a morphological parameter in neural network identification algorithms increases the accuracy of ethnopopulation recognition. For the Kazakh population, characterized by a meso- and brachycranic type of skull with moderate occipital relief, the rare occurrence of this trait is consistent with Asian trends.

Conclusions: The Inca bone is rare in people of Kazakh nationality, which corresponds to the general trends for Asian populations. The feature can be used as an additional parameter for forensic identification by the skull. The integration of Inca bone data into neural network algorithms improves the accuracy of digital identity recognition.

Keywords: *Inca bone, forensic identification, skull, neural network model, Kazakh population, morphology.*

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Резюме

КОСТЬ ИНКОВ КАК МОРФОЛОГИЧЕСКИЙ ПАРАМЕТР ПРИ СУДЕБНО-МЕДИЦИНСКОЙ ИДЕНТИФИКАЦИИ ЛИЦ КАЗАХСКОЙ НАЦИОНАЛЬНОСТИ

Мерей М. Толегенов[1], https://orcid.org/0000-0003-4002-232X

Мурат Н. Лепесбаев[1], https:// orcid.org/0009-0006-9810-9232

Дария М. Шабдарбаева[1], http://orcid.org/0000-0001-9463-1935

Ернар Н. Бегалиев[2], http://orcid.org/0000-0001-6659-8576

Асхат Б. Оракбаев[3], http://orcid.org/0000-0001-7363-3835

Саулеш А. Апбасова[1], https://orcid.org/0000-0001-6650-4971

Жанаргуль К. Смаилова[1], https://orcid.org/0000-0002-4513-4614

Найля Ж. Чайжунусова[1], https://orcid.org/0000-0002-6660-7118

Акмарал А. Жакипова[1], https://orcid.org/0000-0003-3023-9445

[1] НАО «Медицинский университет Семей», **г. Семей, Республика Казахстан**;
[2] Высший Судебный Совет Республики Казахстан, **г. Астана, Республика Казахстан;**
[3] Областная Прокуратура области Абай, г. Семей, Республика Казахстан.

Актуальность: в статье рассматривается возможность использования кости Инков (os Incae) как дополнительного морфологического параметра при судебно-медицинской идентификации по черепу лиц казахской национальности. Установлено, что частота встречаемости кости Инков в данной популяции низкая, однако данный признак может быть полезен как дополнительный фактор в алгоритмах идентификации.

Цель: описать клинический случай применения нейросетевой модели для анализа морфометрических параметров черепа и их использования при отождествлении личности лица казахской национальности.

Методы исследования: Данное исследование является обсервационным, дополнительная статистическая обработка данных не проводилась.

Результаты исследования подтвердили, что анатомическая вариабельность затылочной области черепа имеет значение для судебно-медицинской идентификации. Данный признак отражает особенности окостенения межтеменной области, но не имеет строгого расово - диагностического значения. Тем не менее, включение кости Инков как морфологического параметра в алгоритмы нейросетевой идентификации повышает точность распознавания этнопопуляционной принадлежности. Для казахской популяции, характеризующейся мезо- и брахикранным типом черепа с умеренным затылочным рельефом, редкая встречаемость данного признака согласуется с азиатскими тенденциями.

Выводы: Кость Инков у лиц казахской национальности встречается редко, что соответствует общим тенденциям для азиатских популяций. Признак может быть использован как дополнительный параметр при судебно-медицинской идентификации по черепу. Интеграция данных о кости Инков в нейросетевые алгоритмы способствует повышению точности цифрового распознавания личности.

Ключевые слова: *кость Инков, судебно-медицинская идентификация, череп, нейросетевая модель, казахская популяция, морфология.*

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Түйіндеме

ИНКА СҮЙЕГІ ҚАЗАҚ ҰЛТЫ ТҰЛҒАЛАРЫН СОТ-МЕДИЦИНАЛЫҚ СӘЙКЕСТЕНДІРУ КЕЗІНДЕГІ МОРФОЛОГИЯЛЫҚ ПАРАМЕТР РЕТІНДЕ

Мерей М. Толегенов[1], https://orcid.org/0000-0003-4002-232X
Мурат Н. Лепесбаев[1], https:// orcid.org/0009-0006-9810-9232
Дария М. Шабдарбаева[1], http://orcid.org/0000-0001-9463-1935
Ернар Н. Бегалиев[2], http://orcid.org/0000-0001-6659-8576
Асхат Б. Оракбаев[3], http://orcid.org/0000-0001-7363-3835
Саулеш А. Апбасова[1], https://orcid.org/0000-0001-6650-4971
Жанаргуль К. Смаилова[1], https://orcid.org/0000-0002-4513-4614
Найля Ж. Чайжунусова[1], https://orcid.org/0000-0002-6660-7118
Акмарал А. Жакипова[1], https://orcid.org/0000-0003-3023-9445

[1] «Семей медицина университеті» КеАҚ, Семей қ., Қазақстан Республикасы;
[2] Қазақстан Республикасының Жоғарғы Сот Кеңесі, Астана, Қазақстан Республикасы;
[3] Қазақстан Республикасы, Семей, Абай ауданының облыстық прокуратурасы.

Өзектілігі: мақалада Инка сүйегін (os Incae) ұлты қазақ адамдардың бас сүйегі бойынша сот-медициналық сәйкестендіру кезінде қосымша морфологиялық параметр ретінде пайдалану мүмкіндігі қарастырылады. Белгілі бір популяциядағы Инка сүйектерінің пайда болу жиілігі төмен екендігі анықталды, бірақ бұл белгі сәйкестендіру алгоритмдерінде қосымша фактор ретінде пайдалы болуы мүмкін.

Зерттеудің мақсаты: бас сүйегінің морфометриялық параметрлерін талдау және оларды қазақ ұлтының тұлғасын сәйкестендіру кезінде пайдалану үшін нейрондық желі моделін қолданудың клиникалық жағдайын сипаттау.

Зерттеу әдістері: бұл зерттеу бақылау болып табылады, деректерді қосымша статистикалық өңдеу жүргізілмеген.

Зерттеу нәтижелері бас сүйегінің желке аймағының анатомиялық өзгергіштігі сот-медициналық сәйкестендіруге әсер ететінін растады. Бұл белгі периодаралық аймақтың оссификациясының ерекшеліктерін

көрсетеді, бірақ қатаң нәсілдік диагностикалық маңызы жоқ. Дегенмен, нейрондық желіні сәйкестендіру алгоритмдеріне морфологиялық параметр ретінде Инка сүйегін қосу этнопопуляцияны тану дәлдігін арттырады. Бас сүйегінің мезо - және брахикрандық түрімен сипатталатын қазақ популяциясы үшін бұл белгінің сирек кездесуі азиялық тенденцияларға сәйкес келеді.

Қорытынды: ұлты қазақ адамдарда Инка сүйегі сирек кездеседі, бұл азиялық популяциялар үшін жалпы үрдістерге сәйкес келеді. Бұл белгіні бас сүйегінің сот-медициналық сәйкестендіруінде қосымша параметр ретінде пайдалануға болады. Инка сүйек деректерін нейрондық желі алгоритмдеріне біріктіру цифрлық тұлғаны тану дәлдігін арттыруға көмектеседі.

Түйінді сөздер: *Инка сүйегі, сот-медициналық сәйкестендіру, бас сүйек, нейрожелілік модель, қазақ халқы, морфология.*

Дәйексөз үшін:

Толегенов М.М., Лепесбаев М.Н., Шабдарбаева Д.М., Бегалиев Е.Н., А.Б. Оракбаев, Апбасова С.А., Смаилова Ж.К., Чайжунусова Н.Ж., Жакипова А.А. Инка сүйегі қазақ ұлты тұлғаларын сот-медициналық сәйкестендіру кезіндегі морфологиялық параметр ретінде // Ғылым және Денсаулық сақтау. 2025. Vol.27 (6), Б. 271-277. *doi 10.34689/SH.2025.27.6.031*

Relevance

Forensic identification of an individual based on bone remains is a difficult expert task, especially in the absence of personal data [15]. In Kazakhstan, as a multinational state, craniometric features may be important for determining the ethnicity of the remains [9,5].

Traditional identification methods include: Craniometric analysis: measurement of various cranial parameters to determine gender, age, and ethnicity. This method requires high qualifications and may be subject to subjective errors [5].

Craniofacial reconstruction: restoration of a lifetime appearance based on the structure of the skull. Both manual methods and computer technologies are used, but the accuracy of reconstruction depends on the specialist's experience and the quality of the source data [6].

Comparative morphological analysis: comparison of the skull with lifetime photographs or descriptions. This method also depends on subjective factors and the quality of the available materials [2].

Studies of the anthropological characteristics of skulls of various ethnic groups are important for correct identification. However, there is insufficient data in the available sources on the specific features of Kazakh skulls. This highlights the need for additional research aimed at studying the morphological and metric parameters of the skulls of the Kazakh population, which will improve the accuracy of identification in forensic practice. The Kazakh population is characterized by a mixed anthropological type, combining features of the Caucasoid and Mongoloid races [10]. Studies show the following features:

Skull shape: predominance of brachycephaly (short head) with rounded skull shape.

Facial skeleton: broad cheekbones, moderately prominent brow ridges, moderate prognathism (jaw protrusion).

Nasal region: relatively narrow nasal bone with a slight hump.

Orbital region: medium-sized eye sockets with a rounded or oval shape [1, 3].

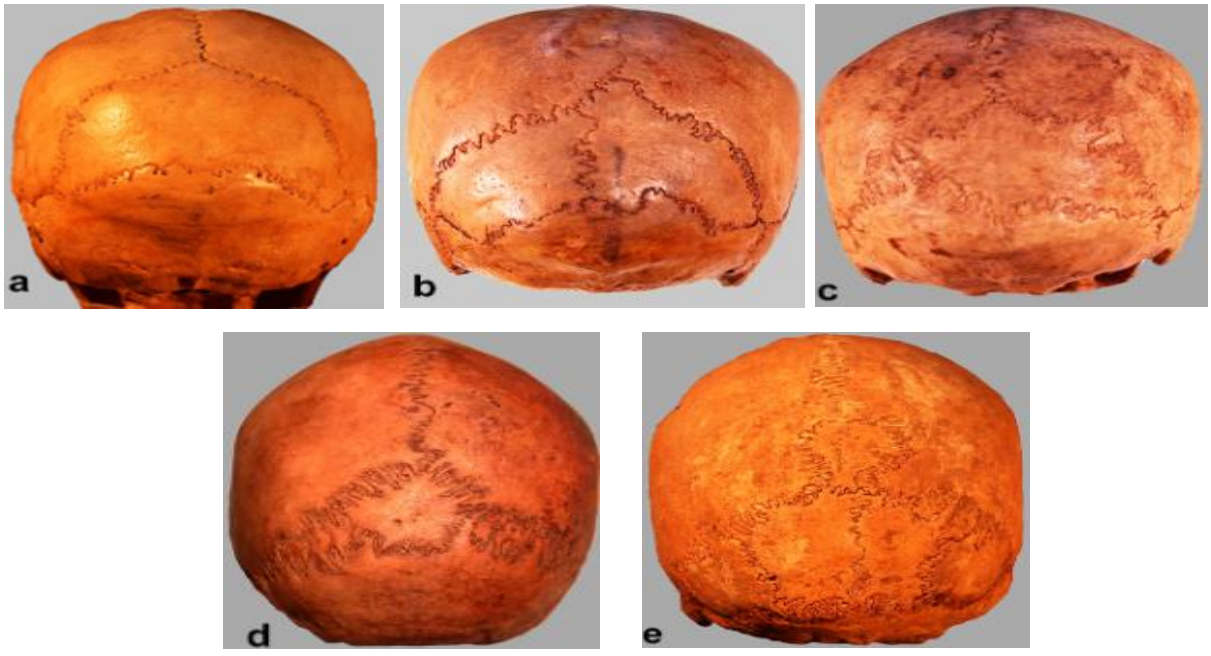

Figure 1. a) Complete Inca bone; b) bipartite Inca bone; c) Incomplete asymmetrical Inca bone; d) Incomplete symmetrical Inca bone; e) The quadripartite Inca bone and the pre-interparietal bone.

The forensic identification of a person during the examination of bone remains is based on a comprehensive assessment of the metric and non-metric features of the skull. In addition to traditional craniometric indicators, variant anatomical formations with individualizing value play an important role [14, 12]. One of these features is the Inca bone (Os incae), which is an additional bone element in the occipital region.

In modern scientific literature, the Inca bone is considered mainly in the context of physical anthropology, but its significance for forensic practice remains insufficiently studied, especially in relation to populations of Central Asia. The lack of systematic data on the frequency and morphological variants of Os incae in people of Kazakh nationality determines the relevance of this review [17].

The occipital bone is formed from several ossification centers, some of which are of membranous origin. Normally, in the process of postnatal development, their complete fusion occurs. When this process is disrupted, an inter - parietal bone is formed - the Inca bone, located between the parietal bones and the scales of the occipital bone in the area of the lambdoid suture [13,17].

From a morphological point of view, Os incae can be represented as a single bone plate, an asymmetric fragment, or a multipart formation. The variability of shape and size is due to the peculiarities of embryonic development and is probably genetically determined [14].

According to anthropological studies, the frequency of occurrence of Inca bones varies significantly in different populations. The greatest prevalence of this trait is noted among the indigenous peoples of Central and South America, where the frequency can reach 10-15% [14]. In populations of South Asia and the Middle East, the frequency of Os incae averages 1-4% [16, 11].

In European and North Asian populations, this indicator, as a rule, does not exceed 1-2% [14]. *Hanihara T. and Ishida H.* showed that the distribution of the Inca bone has a pronounced population character, which allows it to be considered as an additional ethnoanthropological marker [14].

In forensic medical practice, the Inca bone is important as a rare morphological feature that can be used to identify an individual. According to *Fujita M.Q. et al.,* the presence of Os incae can serve as an additional individualizing criterion when comparing antemortem and postmortem data, including the results of radiation research methods [12]. In addition, the Inca bone can mimic the fracture line of the occipital bone, which requires its differentiation from traumatic injuries during forensic examination [17, 7]. Taking this feature into account reduces the risk of diagnostic errors and increases the reliability of expert opinions.

Research methods: This study is an observational one, no additional statistical data processing has been performed.

Craniometric parameters were studied: the length and width of the skull, the craniality index, the shape of the occipital relief, and the variation of the intertribal region. Special attention was paid to the identification of the Inca bone (os Incae), an additional inter - parietal bone formed by incomplete fusion of the upper part of the occipital bone.

Aim: to describe a clinical case of using a neural network model to analyze the morphometric parameters of the skull and their use in identifying the identity of a person of Kazakh nationality.

A clinical case.

The circumstances of the receipt of the material

On November 09, 2022, skeletonized remains of a corpse were sent to the medical and forensic department of the branch of the RSE "Center for Forensic Examinations of the Ministry of Justice of the Republic of Kazakhstan" - the Institute of Forensic Examinations in the Abai region - for medical and forensic examination. The material was sent by a forensic medical expert. According to the direction, "On 11.08.2022, the duty station of the Zaton detention center received a message about the discovery of a human skull in the territory of the village of Karagaily."

The object of the study.

A human skull without soft tissues and articular cartilage was presented for the study. The skull is dry, brittle, yellow-brown in color, with pronounced signs of prolonged exposure to the ground. There was cracking and detachment of the outer bone plate, which indicated a significant age of burial.

Were missing:

- upper and lower jaws;
- mastoid processes;
- areas of the frontal, temporal and zygomatic bones;

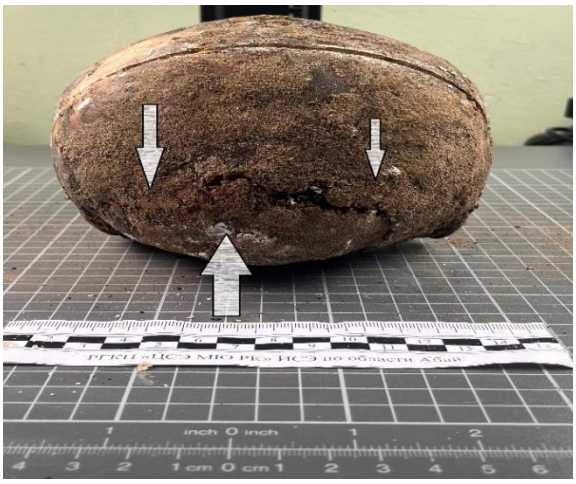

Figure 2. General view of the skull from behind before processing.

Research methods

During the examination, standard methods of medical and forensic examination were used:

- visual inspection;
- Measuring method;
- Stereomicroscopic examination;
- photographing;
- anatomical and morphological analysis.

The age was assessed according to the degree of obliteration of the skull sutures in accordance with classical forensic and anthropological methods.

Morphological features of the occipital region and the Inca bone

When examining the occipital region of the skull, pronounced features of the occipital suture formation were noted. The presence of an atypical configuration of bone structures in the area of the lambdoid suture suggests a variant development of the inter-parietal part of the occipital bone, which corresponds to the morphological features of the Inca bone (Os incae).

Figure 3. General view of the skull from above upon admission.

In conditions of partial fusion of the swept and occipital sutures, as well as the preservation of the metopic suture, the revealed feature acquires additional diagnostic significance. The Inca bone belongs to rare variant features and can be considered as a stable morphological marker, which is important for comparative analysis and identification.

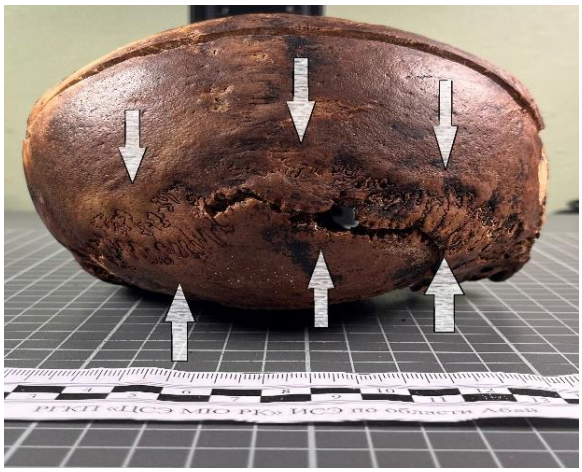

Figure 4. General view of the skull from behind after processing. The photograph shows the occipital region of the human skull with a variant configuration of bone structures in the area of the lambda suture. The arrows indicate the areas corresponding to the atypical development of the inter-parietal part of the occipital bone, which can be regarded as a manifestation of the Inca bone (Os incae)

Forensic medical assessment and the significance of the feature

In the presented clinical case:

• According to its anatomical and morphological features, the skull submitted for the study could belong to a male person of the Mongoloid race, the age of the skull was determined in the range of 30-40 years;

• the age of burial is estimated to be at least 25 years;

Figure 5. A detailed snapshot of the damaged and incomplete non-symmetrical Inca bone.

In such situations, the presence of variant anatomical formations, such as the Inca bone, can significantly increase the informative value of expert research. For the Kazakh population, characterized by a mixed anthropological type, consideration of such signs is especially relevant and requires further accumulation of clinical observations.

Discussion.

Inca bone is rarely considered in routine forensic practice, however, in conditions of limited identification data, it can serve as an additional morphological parameter. The presented clinical case demonstrates the expediency of including an analysis of the variant anatomy of the occipital region in the standard cranial examination protocol.

The formation of regional databases on the variant anatomy of the skull in persons of Kazakh nationality will in the future improve the accuracy of identification conclusions and expand the possibilities of forensic medicine.

Conclusions.

The presented clinical case confirms that the Inca bone can be considered as an additional morphological parameter in the forensic identification of a person. Given the limited amount of diagnostic features, consideration of variant cranial anatomy, including Os incae, is of practical importance and requires further systematic study in the population of Kazakhstan. Conducting targeted research among people of Kazakh nationality is a promising area for the further development of forensic medicine.

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Information about the authors:

Merey M. Tolegenov- PhD Student of the Department of Pathological Anatomy and Forensic Medicine named after Professor Yu.V. Pruglo, NJSC "Semey Medical University", Semey, Kazakhstan; E-mail: merey_87kz@mail.ru; Phone: +7 702 133 51 15; Postal address: Republic of Kazakhstan, Semey city, Abay street, 103, ORCID: https://orcid.org/0000-0003-4002-232X

Murat N. Lepesbayev - Assistant of the Department of Pathological Anatomy and Forensic Medicine named after Professor Yu.V. Pruglo, forensic physician of the highest category; Postal address: Republic of Kazakhstan, Semey city, Abay street, 103, https://orcid.org/0009-0006-9810-9232 ; E-mail: king87ml@gmail.com;

Dariya M. Shabdarbayeva– Doctor of Medical Sciences, Professor, Vice Rector for Science, NCJSC «Semey Medical University», Semey, Kazakhstan, phone 8 707 365 82 71, e-mail: dariya_kz@bk.ru, https://orcid.org/0000-0001- 9463-1935

Yernar N. Begaliyev, Doctor of Law, Professor. Membe of the Supreme Judical Council of the Republic of Kazakhstan Legal; Postal address:8 Mangilik El avenue, entrance 1B, Astana 010000, Republic of Kazakhstan 103, ORCID: 0000-0001-6659-8576; eLibrary SPIN: 1929-3392; e-mail: ernar-begaliev@mail.ru, Phone +77019539885

Aschat B. Orakbayev – Doctor of PhD. Deputy Head of the Depertament for Supervision of the Legality of Pre-Trial Investigation and Criminal Prosecution of the Abai Region Prosecutor's Office. Abai Region, Semey City, Oboronnaya Street,86; ORCID: 0000-0001-7363-3835; e-mail: askhat333orakbayev@gmail.com , Phone +77772610444

Saulesh A. Apbassova - Candidate of Medical Sciences, Associate Professor, Head of the Department of Pathological Anatomy and Forensic Medicine named after Professor Yu.V. Pruglo; Postal address: Republic of Kazakhstan, Semey city, Abay street, 103, , https://orcid.org/0000-0001-6981-5441 , E-mail: apbasova65@mail.ru ; Phone +7079196975

Smailova Zhanargyl Kaiyrgaliyevna - Candidate of Medical Sciences, Associate Professor, Vice Rector for Academic and Educational Work, NCJSC «Semey Medical University», phone 8 707 365 82 71, e-mail: zhanargul.smailova@smu.edu.kz; https://orcid.org/0000-0002-4513-4614

Nailya Chaizhunussova - Department of Public Health, Semey Medical University 103 Abay Street, Semey 071400,Kazakhstan, Tel: +77771450100, E-mail: n.nailya@mail.ru, https://orcid.org/0000-0002-6660-7118; Phone +77021222911

Akmaral A. Zhakipova - Candidate of Medical SciencesAssistant of the Department of Pathological Anatomy and Forensic Medicine named after Professor Yu.V. Pruglo, forensic physician of the highest category; Postal address: Republic of Kazakhstan, Semey city, Abay street, 103, https://orcid.org/0000-0003-3023-9445, , E-mail: zhakipova_akmaral@mail.ru ; Phone +77081681858

Contact Information

Merey M. Tolegenov- PhD Student of the Department of Pathological Anatomy and Forensic Medicine named after Professor Yu.V. Pruglo, NJSC "Semey Medical University", Semey, Kazakhstan; ORCID: https://orcid.org/0000-0003-4002-232X

Postal address: 071400, Republic of Kazakhstan, Abai Region, Semey, 103 Abai Kunanbayev Street.

E-mail: merey_87kz@mail.ru;

Phone: +7 702 133 51 15