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Mykola Pirogov's (1810-1881) illness mystery. Computed tomography and 3D reconstruction of the head of the famous surgeon's mummy

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Introduction. It is known that at the age of 70, the outstanding surgeon Mykola Pirogov suffered from pain and a wound of the palate on the right and had problems with eating. He was consulted by well-known doctors M.V. Sklifosovskiy, E. von Wahl, V.F. Grube, E.I. Bohdanovskiy and the famous surgeon T. Billroth, convincing him that the ulcer was benign.

On the fourth day after his death, on the initiative of his wife Baroness O.A. von Bistrom, Pirogov's body was embalmed by permission of the church.

Case report. In 2018, M.I. Pirogov's body was re-embalmed in Vinnytsia according to the original method by scientists of Vinnytsia National Medical University and the National University of Life and Environmental Sciences of Ukraine.

The remains were examined using a 32-slice computer tomograph Siemens "Somatom go. Up" (Germany) with 3D reconstruction of the entire body and the head of great surgeon. According to the protocol, the slices thickness was 0.8 mm, the voltage was 110–120 kV, the current strength was 30–230 mA, the thickness of reconstructions was 0.8 to 3.0 mm.

Modern technologies made it possible to see destructive changes in the bones of the skull and establish the cause of Mykola Pirogov's illness and death. The 3D reconstructions prove the fact that Pirogov's diagnosis was correct. The existing bone changes indicate widespread malignancy, most likely cancer in the mouth, nasopharynx, and pterygopalatine fossa on the right.

Discussion. Natural and anthropogenic mummies are important for history and science, as they can tell us about the health conditions and lifestyle of people in the past.

Computed tomography is a non-destructive technique, and is therefore considered the gold standard for studying mummies. This method is also used during the embalming procedure and monitor the degree of preservation of the mummified body. Currently, computed tomography is widely used in mummy research to non-invasively assess the natural or anthropogenic origin, mummification embalming technique, bone and soft tissue preservation parameters, age, constitution, health status, cause of death, post-mortem injuries, etc.

Conclusions. The use of computed tomography followed by 3D reconstruction is highly likely to not only predict the future, but also shed light on the mysteries of the past.

Keywords: Mykola Ivanovych Pirogov; re-embalming; computed tomography; 3D scanning; malignant tumor; cancerous ulcer of the oral cavity

Introduction

Mykola Ivanovych Pirogov was born on November 13, 1810, and died on November 23, 1881. He contributed a great deal to both medicine and education. Thus, he was the founder of military field surgery, treating the wounded during the Crimean War, as well as the forerunner of principles of the Red Cross movement. He made a reformist contribution to education during the time of tsarist Russia. Mykola Pirogov lived a complex, multifaceted and bright life in a constant struggle for truth and justice. The body of the outstanding surgeon and great educator rests in Vinnytsia in a museum

located in the village of Vyshnia (now it is the estate "Vyshnia" on the outskirts of the city).

Fourteen years of constant struggle with the bureaucracy, winning back the right to treat and save people from death, exhausted Mykola Pirogov. At the age of 46, a prominent practicing surgeon, who was awarded the title of brilliant surgeon during his lifetime, retires from surgery "of his own free will": "I have served my years and I am free. I will not be forced to serve longer by any grace or anything. I am a free Cossack now." Pirogov was dismissed from the Medical and Surgical Academy by the decree of July 28, 1856.

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After that, he was a trustee of educational institutions in Odessa and Kyiv provinces for another 6 years. During this time, he made revolutionary changes in the field of education.

It is known that at the age of 70, Pirogov could not see well because he had cataracts, suffered from pain and wounds on the right palate, and had problems with eating. He consumed liquid food and drinks. At first he thought the ulcer was caused by rinsing his mouth with hot water after smoking to get rid of the tobacco smell. Pirogov smoked a so-called cigar-butt – cigar. He was consulted by well-known doctors M.V. Sklifosovskyi, E. von Wahl, V.F. Grube, E.I. Bohdanovskyi and famous surgeon T. Billoth. The latter, considering his age and exhaustion, persuaded Pirogov not to be operated on, convincing him that the ulcer was benign. However, it was difficult to deceive the great doctor. In his opinion, colleagues had misdiagnosed him. Pirogov wrote that

he had *ulcus oris mem. muc. cancerosum serpiginosum* (serpiginous membranous mucous cancerous ulcer of the oral cavity) (**Fig. 1**).

On the fourth day after his death, on the initiative of his wife Baroness O.A. von Bistrom, Pirogov's body was embalmed by permission of the church.

For some time, the sarcophagus with the body was placed in the estate, and since January 24, 1882 - in the family crypt. In 1885, in honor of St Nicholas the Wonderworker, a church was built over the crypt according to the project of Kyiv architect V. Sychugov. The first re-embalming of Pirogov's body was carried out 65 years later (in 1945), and subsequently several times in Moscow (Mausoleum). However, the secret of embalming was never revealed.

At present Pirogov's body is placed in a glass sarcophagus and rests in the family crypt in Vinnytsia (**Fig. 2**).

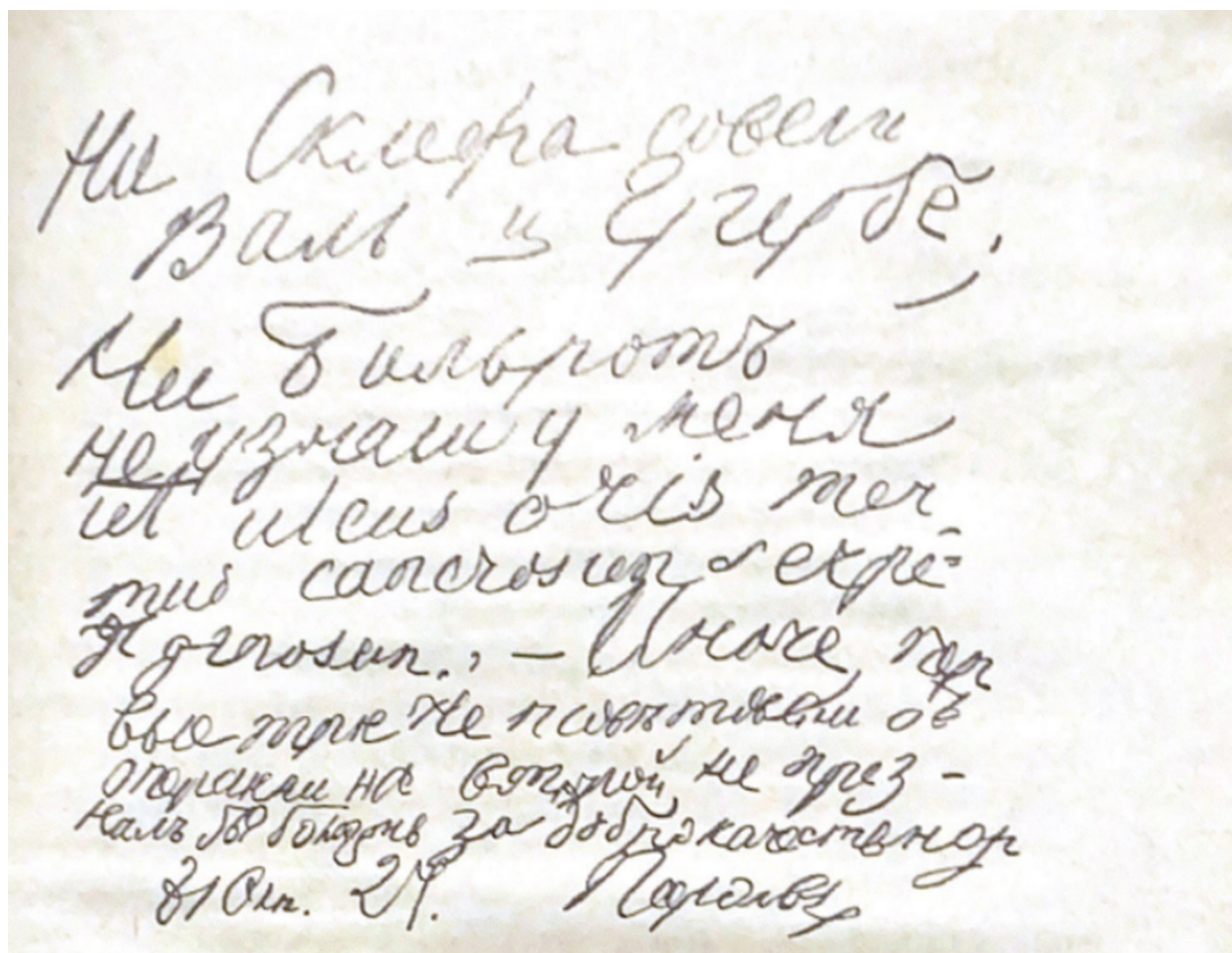


Fig. 1. Pirogov's original record of his own diagnosis (the record is kept in the exhibitions of M.I. Pirogov National Estate Museum). During the embalming in 1881, the famous anatomist-histologist V.A. Betz examined the tumour material and confirmed the malignant nature of the neoplasm

This article contains some figures that are displayed in color online but in black and white in the print edition.



Fig. 2. Head and part of the bust of the outstanding surgeon and anatomist M.I. Pirogov

Case report

In 2018, M.I. Pirogov's body was re-embalmed in Vinnytsia according to the original method by scientists of Vinnytsia National Medical University and the National University of Life and Environmental Sciences of Ukraine. Computed tomography was followed by 3D reconstruction of the entire body and the head of great surgeon.

The remains were examined using a 32-slice computer tomograph Siemens "Somatom go. Up" (Germany) with 3D reconstruction of the entire body and head of the great surgeon. According to the protocol, the slices thickness was 0.8 mm, the voltage was 110–120 kV, the current strength was 30–230 mA, the thickness of the reconstructions was 0.8 to 3.0 mm. The Hounsfield scale was used to measure density. The images were reformatted and interpreted using Vitrea 2 viewing software on Windows XP Professional × 64 Edition, Version 2003 from the developer Microsoft on an Intel(R), Xeon(R) workstation, CPU, W3520 @ 2.67GHz, 7,98 GB of RAM.

Modern technologies made it possible to see destructive changes in the bones of the skull and establish the cause of Pirogov's illness and death. The fact that Pirogov established a correct diagnosis is evidenced by the data of the 3D reconstruction. It shows the osteolytic destruction of the body of the upper jaw and hard palate on the right side. Osteolytic changes spread to the lower, lateral and medial walls of the maxillary sinus, partially to the zygomatic bone. The existing bone changes suggest a widespread malignancy, most likely cancer in the oral cavity, nasopharynx, and pterygopalatine fossa on the right (**Fig. 3-5**).

Discussion

Natural and anthropogenic mummies are important for history and science because they can tell us about the health and lifestyle of people in the past [1].

The first human mummy analyzed using X-ray imaging was an ancient Egyptian child from the Senckenberg Museum of Natural Sciences (Frankfurt am Main, Germany). The study was carried out in 1896 [2]. The first axial computed tomography study of mummified tissues (the dried brain of Nacht, a mummy of a teenager of the 21st dynasty from the collection of the Royal Ontario Museum, Toronto) was performed at the Hospital for Sick Children in Toronto in 1976 [2].

When conducting scientific research on a mummified body, it is important not only to obtain the maximum amount of information, but also to achieve complete preservation of the mummy's integrity. Computed tomography is a non-destructive method, so it is considered the gold standard in mummies research. It is also used in the embalming procedure and to monitor the degree of preservation of the mummified body. Computed tomography makes it possible not only to obtain cross-sectional images, but also, to perform post-processing and reconstruction of three-dimensional models thanks to special software [3–5].

Currently, computed tomography is widely used in mummy research to non-invasively assess the natural or anthropogenic origin, mummification embalming technique, bone and soft tissue preservation parameters, age, constitution, health status, cause of death, post-mortem injuries, etc. [6–12].

Conclusions

The use of computed tomography followed by 3D reconstruction is most likely to not only predict the future, but also to shed light on the mysteries of the past.

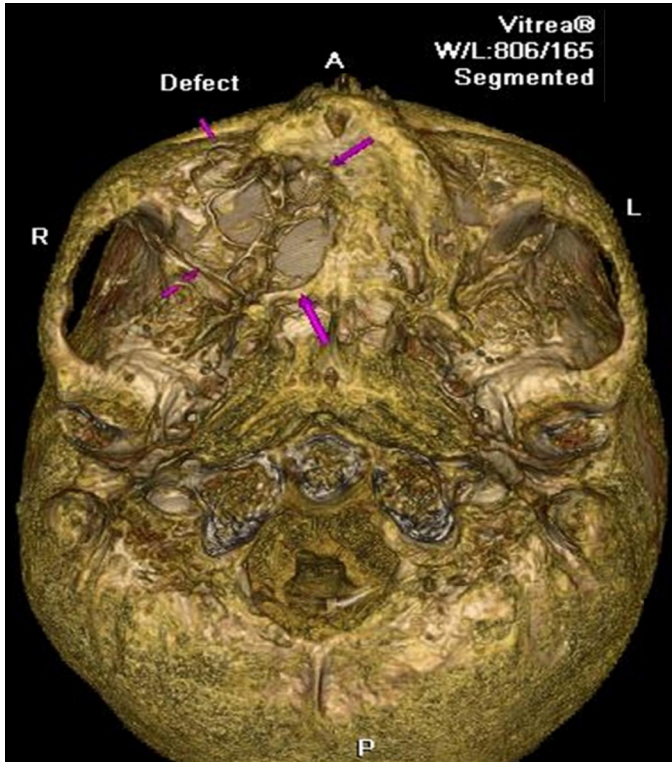


Fig. 3. Computed tomography of Pirogov's skull, bottom view. Arrows show the bone destruction by tumor

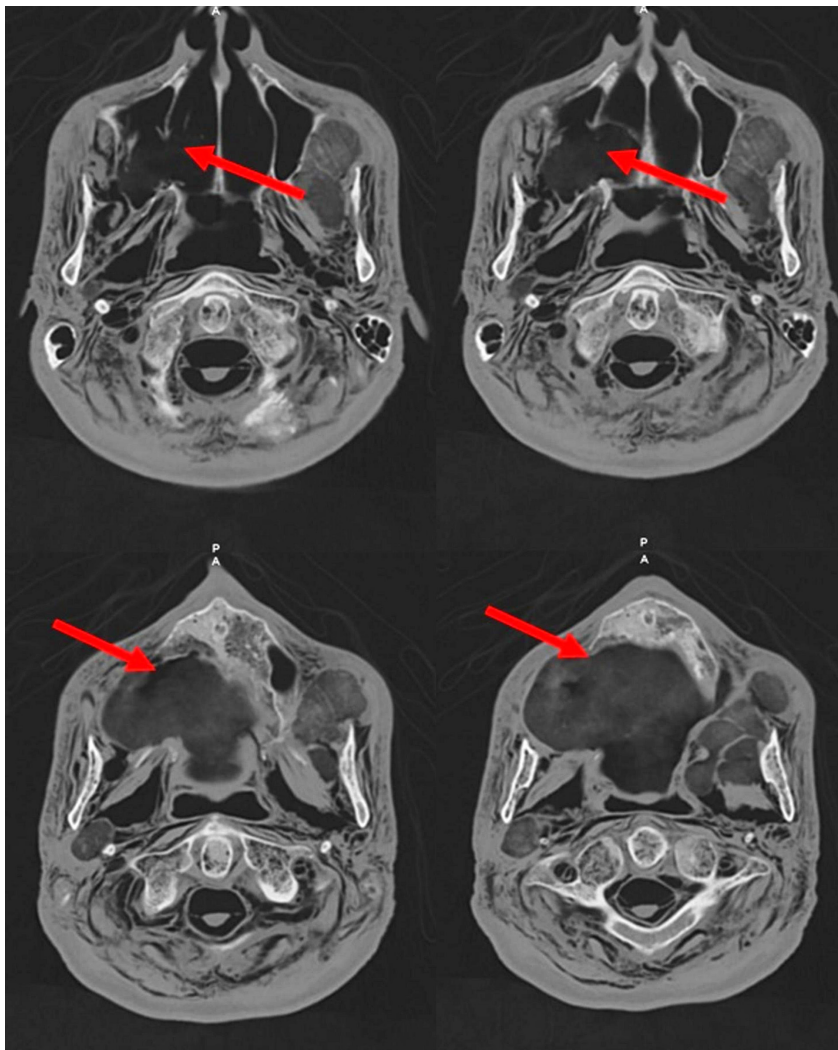


Fig. 4. Computed tomography scan of M.I. Pirogov's skull. Arrows show the bone destruction by tumor

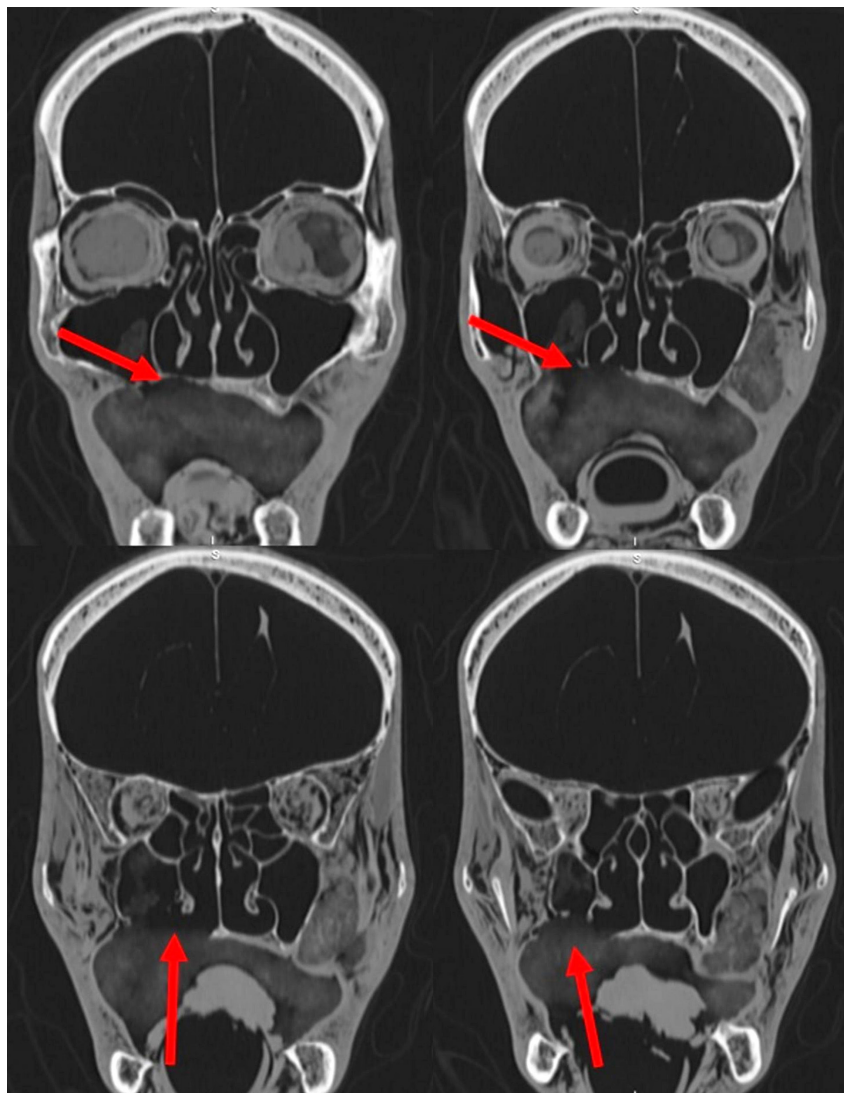


Fig. 5. Computed tomography scan of M.I. Pirogov's cranial cavities. Arrows show the bone destruction by tumor

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Information disclosure

Conflict of interest

The authors declare that the study was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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