

# THE FIRST EXPERIENCE OF THORACOSCOPIC THYMECTOMY FROM A UNIFIED SUBXIPHOID ACCESS

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## ABSTRACT

**BACKGROUND:** Thoracoscopic thymectomy performed with using the lateral intercostal access in cases of non-invasive thymic tumors is the commonly used technique. Most frequently, the three-port and the single-port techniques are used. As the experience was accumulating, it became evident that the intercostal access has a number of disadvantages, such as unsatisfactory visualization of the nerve on the opposite side and of the cervical portion of the thymus, along with a probably of developing chronic pain syndrome. One of the possible solutions for this issue can include the use of sub-xyphoid access. **AIM:** An evaluation of direct results obtained when using the unified sub-xyphoid access during thoracoscopic thymectomy in patients with non-invasive epithelial thymic tumors. **METHODS:** An experience was analyzed that was gained after the treatment of 14 patients undergoing thoracoscopic thymectomy using the unified sub-xyphoid access for non-invasive epithelial tumors of the thymus. The age of the patients ranged from 24 to 70 years (median — 42 years); 9 of them were females (64.3%) and 5 were males (35.7%). In all the patients, at the moment of surgical treatment, stage I disease was diagnosed. The minimal dimension of the excised thymoma in this research was 15 mm with the maximal dimension being 65 mm, the median value was 38 mm. **RESULTS:** Two surgeries (14.3%) were accompanied with technical difficulties due to the presence of an adhesion process after a previous episode of pulmonary inflammation, which resulted in more significant intraoperative blood loss, which was 200 ml. The surgery duration varied from 60 to 180 minutes with the median of 82.5 minutes. In the majority of cases (97.6%), the pain syndrome level did not exceed 4 points of the visual analogue scale for pain. During the postoperative period, a single surgical complication was reported — the development of the retrosternal hematoma; no fatal outcomes were reported. **CONCLUSION:** The thoracoscopic thymectomy from the unified sub-xyphoid access is a justified option for cases of non-invasive epithelial thymic tumors. This method allows for performing the surgery in full range, not violating the oncology principles. It was proven that, for tumors measuring up to 65 mm, this method does not result in an increase in surgery duration or an increase in the rates of intraoperative complications.

**Keywords:** thymoma; epithelial tumors; thoracoscopic thymectomy; thymectomy from subxyphoid access.

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## BACKGROUND

At the present moment, the use of minimally invasive technologies is the gold standard in thymic surgery. According to various research works [1–10], thoracoscopic thymectomy is characterized by better direct and remote results comparing to classic open-access methods (sternotomy and thoracotomy). With the accumulation of the experience, it became evident that intercostal access has a number of disadvantages, the main of which are the unsatisfactory visualization of the opposite phrenic nerve and of the cervical portion of thymus, as well

as the possibility of developing the chronic pain syndrome [4, 11–14]. One of the possible solutions for this issue may include the use of sub-xyphoid access [11, 14]. For the first time this method was used in 1999 by the group of Japanese surgeons headed by T. Kido [15] for the case of thymus disease, and, at the present moment, it is one of the alternative options for gaining access to the tumors located in the anterior mediastinum.

**Research aim** — to evaluate the direct results of using the sub-xyphoid access in patients with non-invasive epithelial tumors of the thymus.

# ПЕРВЫЙ ОПЫТ ТОРАКОСКОПИЧЕСКОЙ ТИМЭКТОМИИ ИЗ ЕДИНОГО СУБКСИФОИДАЛЬНОГО ДОСТУПА

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## АННОТАЦИЯ

**Обоснование.** Торакоскопическая тимэктомия из бокового межрёберного доступа при неинвазивных опухолях тимуса является общепринятой методикой. Чаще всего используется трёхпортовая и однопортовая техника. По мере накопления опыта стало очевидно, что межрёберный доступ имеет ряд недостатков, таких как неудовлетворительная визуализация противоположного нерва и шейной порции тимуса, возможность формирования хронического болевого синдрома. Одним из возможных решений данного вопроса может быть использование субкисифоидального доступа. **Цель исследования** — оценка непосредственных результатов использования единого субкисифоидального доступа при торакоскопической тимэктомии у больных с неинвазивными эпителиальными опухолями тимуса. **Методы.** Проанализирован опыт лечения 14 пациентов, перенёвших торакоскопическую тимэктомию из единого субкисифоидального доступа при неинвазивных эпителиальных опухолях тимуса. Возраст больных составил от 24 до 70 лет (медиана 42 года); женщин было 9 (64,3%), мужчин — 5 (35,7%). У всех пациентов на момент проведения оперативного лечения выявлена I стадия заболевания. Минимальный размер удалённой тимомы в исследовании составил 15 мм, максимальный — 65 мм, медиана 38 мм. **Результаты.** Две операции (14,3%) были сопряжены с техническими сложностями ввиду наличия спаечного процесса после ранее перенесённого воспаления лёгких, что обусловило более выраженную интраоперационную кровопотерю, которая составила 200 мл. Продолжительность операций варьировала от 60 до 180 минут, медиана 82,5 минуты. В большинстве случаев (97,6%) уровень болевого синдрома не превышал 4 баллов по визуальной аналоговой шкале боли. В послеоперационном периоде наблюдали одно хирургическое осложнение — формирование ретростернальной гематомы; летальных исходов не было. **Заключение.** Торакоскопическая тимэктомия из единого субкисифоидального доступа является обоснованным вариантом при неинвазивных эпителиальных опухолях тимуса. Данный способ позволяет выполнить операцию в полном объёме, не нарушая при этом онкологических принципов. Доказано, что при опухолях размером до 65 мм данная методика не приводит к увеличению продолжительности операции и увеличению интраоперационных осложнений.

**Ключевые слова:** тимома; эпителиальные опухоли тимуса; торакоскопическая тимэктомия; тимэктомия из субкисифоидального доступа.

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## METHODS

### Research Design

The research is designed as a single-center retrospective and exploratory one.

### Conformity Criteria

**Inclusion criteria:** age from 18 to 80 years old; verified stage I and II epithelial tumor of the thymus; absence of myasthenia.

**Exclusion criteria:** stage III and IV epithelial tumor of the thymus; past episodes of operated chest cavity organs.

### Research Facilities

All the procedures were carried out within the premises of the Federal State Budgetary Institution “Federal Scientific and Clinical Center for Specialized Types of Medical Care and Medical Technologies”

of the Federal Medical-Biological Agency of Russia (FSBI FSCC of the FMBA of Russia, Moscow).

### Research Duration

The analysis was carried out using the direct results of thoracoscopic thymectomy, performed using the unified sub-xyphoid access for cases of non-invasive epithelial tumors of the thymus at the Surgery Department No. 1 of the FSBI FSCC of the FMBA of Russia during the time period from January 2021 until March 2024.

### Medical Procedure Description

The patients were operated using the unified sub-xyphoid access in cases of epithelial thymic tumors. The indications taken into account when using the unified sub-xyphoid access included the presence of the tumor in the anterior mediastinum with the

tumor stage I or II, absence of previous surgeries in the organs of the chest cavity, as well as the absence of myasthenia. All the patients underwent the standard pre-operational examination, the extent of which is stated by the national clinical recommendations. All the surgeries were conducted under general anesthesia using the single lumen pulmonary ventilation without using the carboxythrax.

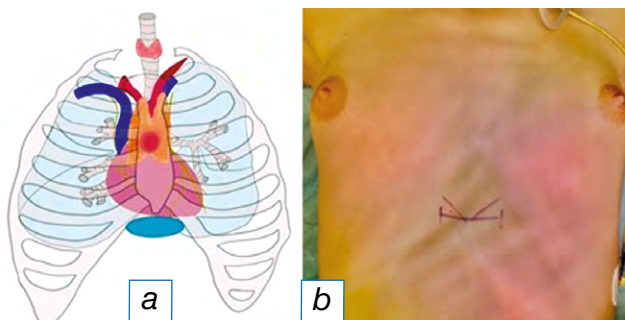
**Surgery technique.** The patient was positioned on the operating table at the supine position with the abduction of the lower limbs. The operating surgeon was positioned between the legs of the patient with the assisting surgeon standing on the right side from the patient. Each patient had a peripheral venous access provided. Further procedures included a transverse incision with a length of 4 cm, 2 cm below the xyphoid process (Fig. 1). In a number of cases, the incision could be enlarged up to 6 cm for the evacuation of the surgery sample with the tumor dimensions being more than 6 cm. Taking into consideration that, in our research, the maximal tumor size was 65 mm, no extending of the access was carried out.

For the purpose of comfortable positioning the sternal retractor and creating the exposed area to operate, it is possible to resect the xyphoid process. In our research, the xyphoid process was removed in 2 cases for the reason of an asthenic body constitution of the patients.

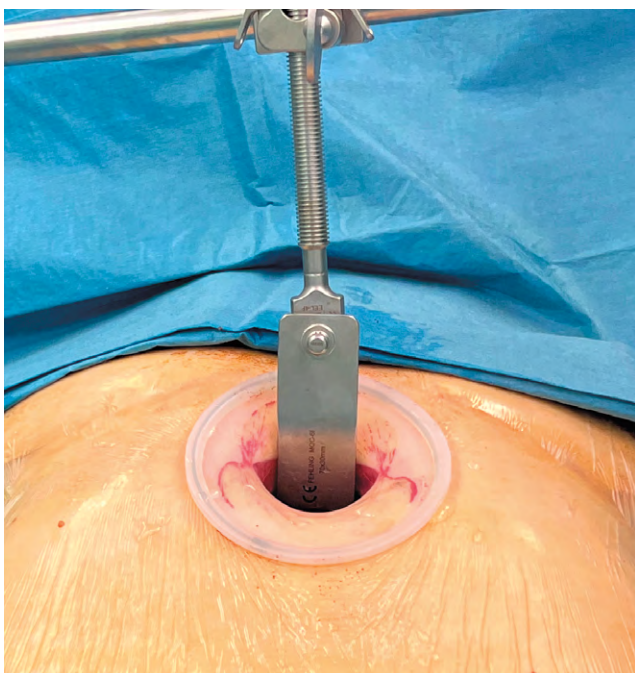
Upon the formation of the sub-xyphoid access, blunt separation was performed in terms of the tissues behind the sternum for the purpose of creating a space for wound protector and for positioning the sternal hook (Fig. 2) for providing additional retrosternal space (Useful model patent No. 225786 dd. 06.05.2024 "Sternal retractor for sub-xyphoid access" [16]. This useful model differs from the analogous devices by the presence of a videocamera slot at its working part, which provides better view in the settings of the limited spaces).

Further procedures included opening both pleural cavities with searching the main anatomic reference points — the phrenic nerves, the sup. vena cava and the brachiocephalic vein (Fig. 3). The positioning of the instruments was done in the following way: camera — middle of the port, ultrasonic scalpel — right half of the wound, forceps — left half of the wound.

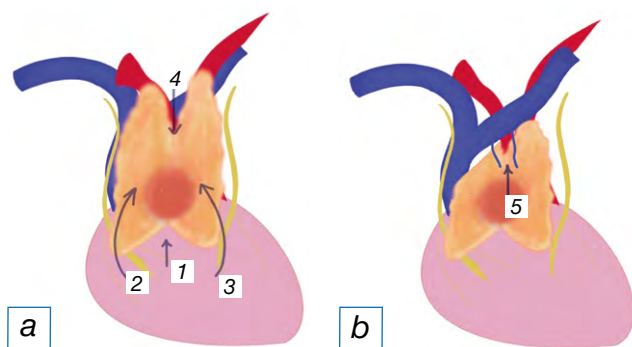
The dissection of tissues was performed along both phrenic nerves (Fig. 4), after which followed the isolation of the brachiocephalic vein with the processing of the thymic vein (Fig. 5). The vessels with a diameter more than 5 mm were preferably processed using the clips. The important step of surgery was the isolation of the



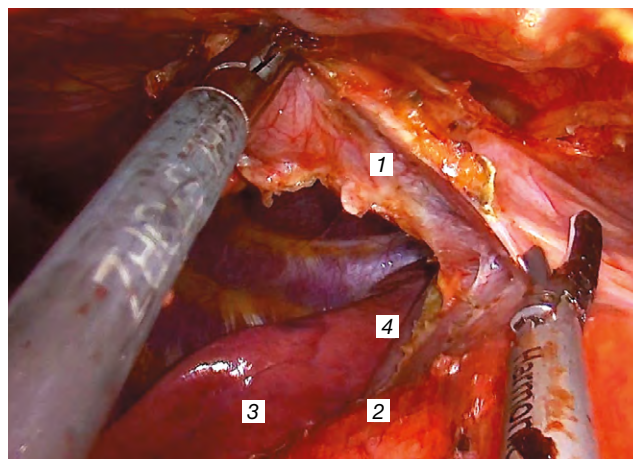
**Fig. 1.** Access diagram for thoracoscopic thymectomy from a uniportal subxyphoid approach (a); preoperative marking of a uniportal subxyphoid approach (b).



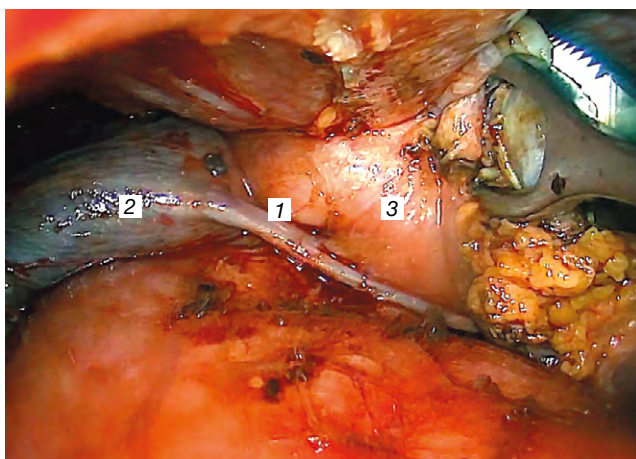
**Fig. 2.** View of an installed sternal retractor with a wound protector.



**Fig. 3.** Thoracoscopic thymectomy from a uniportal subxiphoid approach. Operation diagram (a, б). 1 — separation of thymus tissue from the pericardium; 2 — separation of thymus tissue along the right phrenic nerve; 3 — separation of thymus tissue along the left phrenic nerve; 4 — separation of the cervical portion of the thymus; 5 — ligation of thymic veins.



**Fig. 4.** Thoracoscopic thymectomy from a uniportal subxiphoid approach. Stage of pericardial separation. 1 — thymic tissue; 2 — pericardium; 3 — right lung; 4 — superior vena cava.



**Fig. 5.** Thoracoscopic thymectomy from a uniportal subxiphoid approach. Dissection of the brachiocephalic and thymic veins. 1 — thymic vein; 2 — brachiocephalic vein; 3 — cervical part of the right lobe of the thymus.



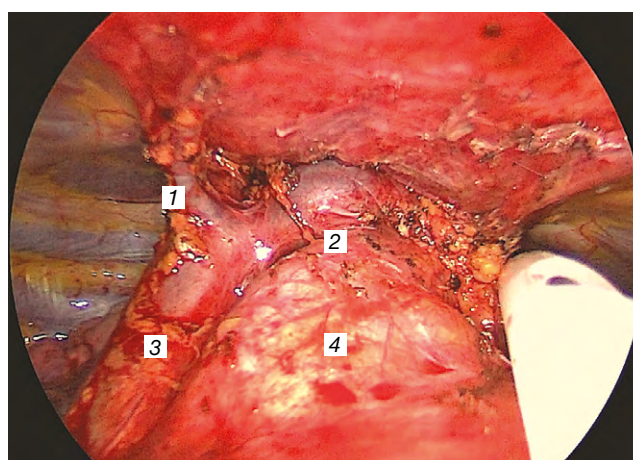
**Fig. 6.** Instrument set for minimally invasive thoracoscopy (Scanlan Int., ThoraGate Geister Medizintechnik GMBH, Germany).

cervical portion of thymus. The objective of the surgical intervention was to remove the whole thymic tissue, including the tumor.

During the surgery, an instrument was used that was specifically developed for minimally invasive thoracoscopy (Fig. 6). The dissection of tissues was done using the ultrasound scalpel (Harmonic Ethicon). The surgical intervention was completed by the installation of the single-lumen draining tube with the diameter of 20 Fr into the aperture of the left half of the chest cavity, which was passed through the surgical wound (Fig. 7, 8).

#### Ethical review

The research procedures were approved by the local ethics committee of the FSBI FSCC of the FMBA of Russia (protocol No. 5 dd. 19.12.2019).



**Fig. 7.** Thoracoscopic thymectomy from a uniportal subxiphoid approach. The final view of the operation. 1 — internal mammary vein; 2 — brachiocephalic vein; 3 — superior vena cava; 4 — pericardium.



**Fig. 8.** Thoracoscopic thymectomy from a uniportal subxiphoid approach. Appearance of the wound on the first postoperative day.

### Statistical analysis

The preliminary estimation of the sample was not performed due to the low occurrence of the studied disease and due to the research design (retrospective, descriptive).

The research data underwent statistical processing by using the methods of descriptive statistics. The accumulation, correction and systematization of the baseline information was performed using the Microsoft Office Excel 2016 tables. The statistical analysis was carried out using the STATISTICA 26 software (developed by StatSoft Inc., USA). In case of describing the quantitative parameters, the obtained data were combined into variation series, in which

the calculations of mean arithmetic values (M) and standard deviations (SD) were performed along with the median and the interquartile range Me [Q1; Q3]. The nominal variables were described with stating the absolute values and percentages (*n*, %).

## RESULTS

### Research sample (participants)

A total of 14 patients were operated using the unified sub-xyphoid access for epithelial tumors of the thymus. The age of the patients varied from 24 to 70 years with the median of 42 years old. Nine patients were females (64.3%) with 5 being males (35.7%). In all the patients, at the moment of the surgical treatment, stage I disease was diagnosed. Table 1 represents the total characteristics of the distribution of patients depending on the process stage, the tumor dimensions and the presence of concomitant diseases. The morphological types of tumors, found in the patients undergoing thymectomy from the unified sub-xyphoid access, are provided in table 2.

### Main research outcomes

The analysis was performed using the direct results of thymectomy carried out using the unified sub-xyphoid access (table 3). The minimal dimension

Table 1

**Distribution of patients depending on the stage of the disease and concomitant pathology**

Parameter	Single subxiphoidal access <i>n</i> =14
Age, years (Me [Q1; Q3])	42.0 [39.5; 51.75]
Gender, <i>n</i> (%)	Men's — 5 (35.7) Women's — 9 (64.3)
Associated diseases, <i>n</i> (%)	11 (78.6)
Hypertensive disease, <i>n</i> (%)	8 (57.1)
Chronic obstructive pulmonary disease, <i>n</i> (%)	1 (7.1)
Thyroid cancer, <i>n</i> (%)	1 (7.1)
History of pneumonia, <i>n</i> (%)	7 (50)
Disease stage (TNM classification), <i>n</i> (%)	T1aN0M0 — 14 (100)

Table 2

**Distribution of patients according to gender and morphological type of tumor, *n* (%)**

Morphological type of tumour	Men	Women	Total
AB	3 (50)	3 (50)	6 (42.9)
B1	1 (20)	4 (80)	5 (35.7)
B2	1 (33.3)	2 (66.77)	3 (21.4)
Total	5 (35.7)	9 (64.3)	14 (100)

Table 3

**Analysis of immediate results of thoracoscopic thymectomy from a uniportal subxyphoid approach**

Parameter	Single-port access n=14
Duration of surgery, minutes (Me [Q1; Q3])	75 [70; 87.5]
Volume of blood loss, ml (Me [Q1; Q3])	50.0 [7.5; 50]
Tumour size, mm (Me [Q1; Q3])	38 [35; 48.5]
Intraoperative adhesions, frequency of development, n (%)	2 (14.3)
Frequency of retrosternal haematoma development in the postoperative period, n (%)	1 (7.1)
Duration of drainage, days (Me [Q1; Q3])	1.0 [1.0; 1.0]
Postoperative bed days, days (Me [Q1; Q3])	3.0 [3.0; 3.0]

of the resected thymoma in the research was 15 mm with the maximal being 65 mm (median 38 mm). Two surgeries (14.3%) were accompanied by technical difficulties due to the presence of an adhesion process after a previous episode of pulmonary inflammation, which resulted in more significant intraoperative blood loss of 200 ml in both cases.

The surgery duration varied from 60 to 180 minutes with the median of 82.5 minutes. In 5 patients, the duration of surgical treatment was more than 100 minutes.

The time period of pleural cavity draining in 11 patients was 24 hours and in 3 patients it lasted for two days.

The research procedures also included an evaluation of the pain syndrome intensity in 2 hours after the conducted surgical treatment, during the first 24 hours after the surgery and after the drainage tube removal. In the majority of cases (97.6%), the pain syndrome intensity did not exceed 4 points of the visual analogue scale for pain (VAS). A single episode (1 patient (7.1%)) was reported of developing the pain syndrome score of 5 VAS points.

It is worth noting that, for the purpose of pain relieving, narcotic analgesics were not used. The patients after the thoracoscopic thymectomy from the unified sub-xyphoid access were staying at the In-Patient Department for the time period of 3–4 days with the median of 3 days.

## DISCUSSION

Currently, thoracoscopic thymectomy is the gold standard in the treatment of non-invasive epithelial tumors of the thymus. One of the possible accesses is the sub-xyphoid one, which is characterized by the absence of dissecting the intercostal nerves

and by the possibility of performing surgery without using separate intubation [11, 12, 17–19]. This method allows for fully performing the revision of the anterior mediastinum, of the aortic window zone and, if necessary, for performing the dissection of the mediastinal lymph nodes on both sides.

For the first time, the data on the advantages of using the sub-xyphoid access for cases of pathological neoplasms in the anterior mediastinum, as it was mentioned previously, were obtained in 1999. A group of Japanese surgeons headed by T. Kido, has presented their experience of creating the sub-xyphoid access using the sternal lifting retractors in cases of anterior mediastinum tumors [15].

In 2012, T. Suda et al. [20] have published the data on the possibility of using the unified sub-xyphoid access for diseases of thymus. Currently, a certain experience was accumulated, demonstrating the efficiency of this approach in cases of thymic neoplasms. With this being said, the meta-analysis conducted in 2024 by J. Wang et al. [21] has identified significant differences found for the unified sub-xyphoid access with thoracoscopic three-port method in terms of the pleural cavity draining time and in terms of the pain syndrome level.

As of today, various modifications were proposed for the sub-xyphoid access, which differ between each other mainly by the number of ports installed and by the method of creating the additional operative space. The followers of the multi-port sub-xyphoid thymectomy install additional 5 mm ports in the intercostal spaces or in the subcostal space. By their opinion, taking into consideration the fact that the intercostal space has an average length of 10 mm, while the installation of the 5 mm port is not resulting in the damage of the intercostal nerve, the additional ports provide a more comfortable course of the

surgical intervention [22–25]. With this modification, the sub-xyphoid access is actually used as a port for locating the camera and as the route for surgical material extraction.

As opposed to the multi-port technique, as a logical extension of the single-port thoracoscopic surgeries, there is a modification of the unified sub-xyphoid access. With this access, all the instruments and the video-camera are being introduced through a single port having the size of up to 4 cm. The followers of this modification of the surgical access consider that such an approach may provide better cosmetic effect and may minimize the risk of developing chronic pain syndrome [26–28]. The only relative disadvantage of this method is the necessity of using special instruments with parallel transfer and with the presence of anatomic fold; also, for using this modification, an experience is required in performing the single-port thoracoscopy surgeries, which may elevate the learning curve. For the purpose of increasing the operational space, two different methods are being used: the application of the carboxythrax or the use of various systems to elevate the sternum. There are no significant differences between these methods, and, mainly, their use is dictated only by the Surgeon's preferences.

Our choice of using the unified sub-xyphoid access is dictated by the commitment to lesser intraoperative trauma and, as a result, to lesser number of bed days. The results provided by us, are only preliminary and, in fact, they reflect the learning curve upon the implementation of the new method into the routine practice. We have not observed any significant complications, while the duration of the surgical intervention itself and the further stay at the In-Patient Department were similar with those described in the foreign and domestic literature. All of these indicates the safety of the sub-xyphoid access and allows for continuing further use of this method. With the accumulation of the sufficient quantity of material, it shall become possible to arrange a more comprehensive comparative evaluation of the benefits and disadvantages of the studied surgical access.

### Undesirable phenomena

An episode of post-operative complication has developed in 1 (7.1%) patient. This complication, although being only of surgical origin (retrosternal hematoma), did not require further active interventions. No therapeutic complications were observed.

No postoperative fatal outcomes were observed during the research.

## CONCLUSION

Performing the thoracoscopic thymectomy from the unified sub-xyphoid access is a justified variant for cases of non-invasive epithelial tumors of the thymus. This method allows for performing the surgery in full range, not violating the oncology principles. It was proven that using the unified sub-xyphoid access for tumors sized up to 65 mm does not result in an increase in surgery duration or an increase in the number of intraoperative complications. The benefits of this method include lesser injury of the chest cavity, absence of the necessity for separate intubation, better visualization of the opposite phrenic nerve. However, taking into consideration the necessity of using specialized instruments and the longer learning curve, the method of unified sub-xyphoid access has not gained wide spreading.

The data obtained by us allow for recommending the use of thymectomy via the unified sub-xyphoid access for cases of non-invasive thymic tumors in the settings of specialized departments.

## ADDITIONAL INFORMATION

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**Competing interests.** The authors declare that they have no competing interests.

**Authors' contribution.** *E.A. Epifantsev* — performing surgical operations on patients general concept, processing and discussion of research results, manuscript writing; *V.Yu. Gritsun* — performing surgical operations on patients, search and analytical work; *Yu.A. Khabarov* — performing surgical operations on patients, search and analytical work; *Yu.V. Ivanov* — general concept, management of patient treatment and discussion of study results, manuscript editing. The authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

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