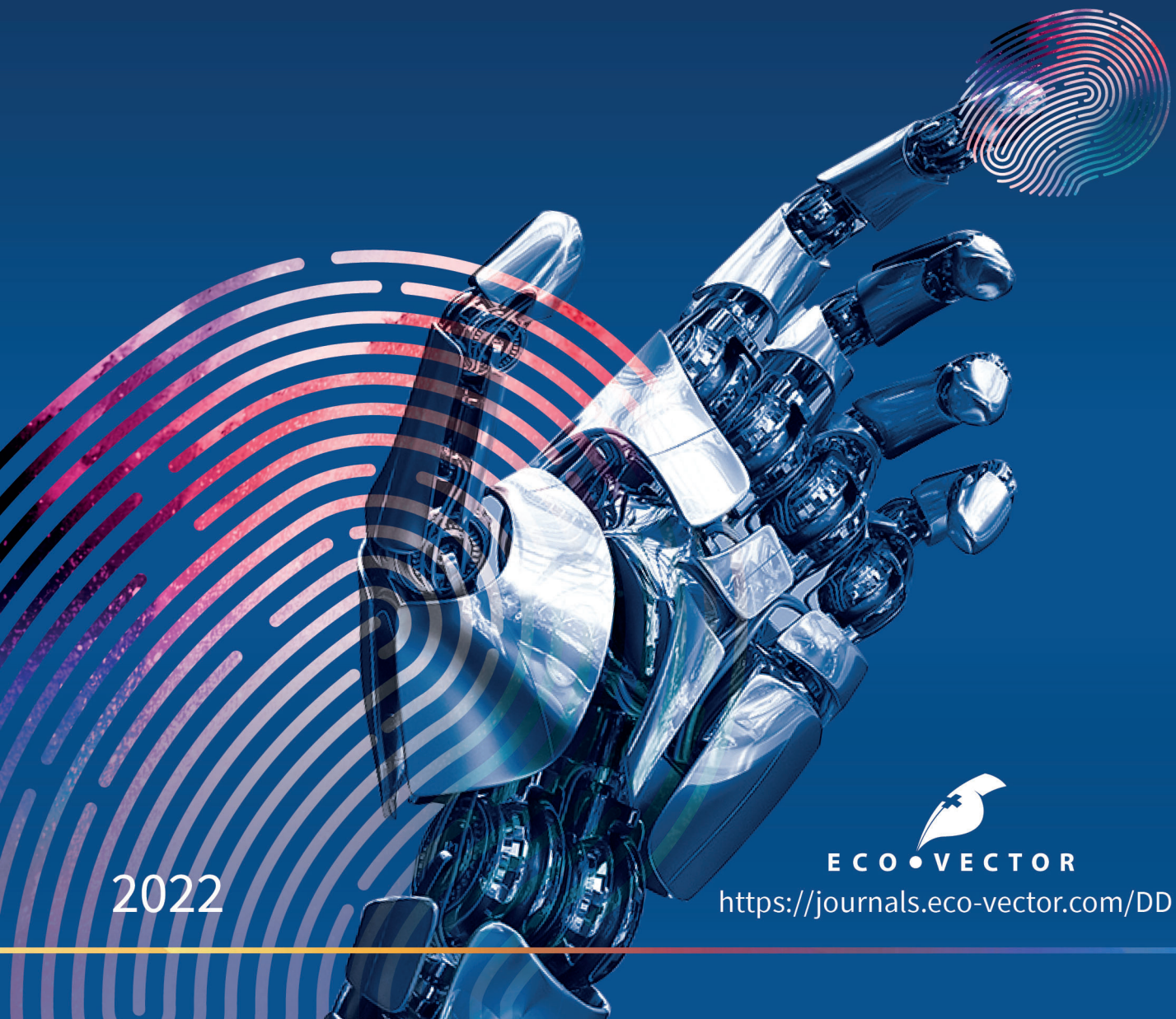
MOSCOW CENTER
FOR DIAGNOSTICS & TELEMEDICINE

ISSN 2712-8490 (Print)
ISSN 2712-8962 (Online)

DIGITAL DIAGNOSTICS

A peer-reviewed scientific medical journal

3 Volume 1 Issue



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Оригинал-макет
подготовлен в издательстве «Эко-Вектор».
Литературный редактор: *М.Н. Шошина*
Корректор: *М.Н. Шошина*
Вёрстка: *Ф.А. Игнащенко*
Обложка: *Е.Д. Бугаенко*

Отпечатано в ООО «Типография Фурсова».
196105, Санкт-Петербург, ул. Благодатная, 69.
Тел.: +7 (812) 646-33-77

ISSN 2712-8490 (Print)
ISSN 2712-8962 (Online)

Digital Diagnostics

Том 3 | Выпуск 1 | 2022

ЕЖЕКВАРТАЛЬНЫЙ РЕЦЕНЗИРУЕМЫЙ НАУЧНЫЙ МЕДИЦИНСКИЙ ЖУРНАЛ

ЭКО • ВЕКТОР

FOUNDERS
- Moscow Center for Diagnostics and Telemedicine
- Eco-Vector

PUBLISHER
Eco-Vector
Address: 3 liter A, 1H, Aptekarsky pereulok, 191186, Saint Petersburg Russian Federation
E-mail: info@eco-vector.com
WEB: https://eco-vector.com

ADVERTISE
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EDITORIAL
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Elena A. Philippova
E-mail: ddjournal@eco-vector.com
Phone: +7 (965) 012 70 72

SUBSCRIPTION
For print version:
www.journals.eco-vector.com/

PUBLICATION ETHICS
Journal's ethic policies are based on:
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INDEXATION
- Russian Science Citation Index
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Copyeditor: *M.N. Shoshina*
Proofreader: *M.N. Shoshina*
Layout editor: *Ph. Ignashchenko*
Cover: *E. Bugaenko*

ISSN 2712-8490 (Print)
ISSN 2712-8962 (Online)

Digital Diagnostics

Volume 3 | Issue 1 | 2022

QUARTERLY PEER-REVIEW MEDICAL JOURNAL

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DOI: https://doi.org/10.17816/DD87628

Влияние COVID-19 на динамику изменений дозовой нагрузки на пациентов при проведении компьютерной томографии в медицинских организациях Москвы

Ю.В. Дружинина[1, 2], С.А. Рыжов[1, 3], А.В. Водоватов[4], И.В. Солдатов[1], З.А. Лантух[1], А.Н. Мухортова[1], Ю.Н. Лубенцова[1]

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АННОТАЦИЯ

Обоснование. Распространение новой коронавирусной инфекции (COVID-19) в Москве привело к значительному увеличению числа компьютерных томографий органов грудной клетки, выполняемых пациентам в рамках диагностики и оценки эффективности проводимой терапии. Связанное с COVID-19 изменение структуры лучевой диагностики в Москве ведёт к изменениям в величине и структуре коллективной дозы облучения населения столицы, при этом сам процесс выглядит разнонаправленным. Отсутствие на текущий момент достоверной информации по изменению структуры лучевой диагностики и уровней облучения населения Москвы в связи с эпидемией COVID-19 и обусловило проведение данной работы.

Цель — оценить влияние эпидемиологической обстановки на динамику изменений уровня дозовых нагрузок на пациентов при проведении компьютерно-томографических исследований в медицинских организациях Москвы за период 2017–2020 гг.

Материалы и методы. Собраны и проанализированы заполненные формы № 3-ДОЗ за 2017–2020 гг., полученные от медицинских организаций города Москвы различных форм собственности; данные формы № 30 за 2017–2020 гг. и данные единого радиологического информационного сервиса (ЕРИС) за 2020 г. Проведён анализ годовых коллективных и средних индивидуальных доз облучения пациентов по анатомическим областям тела.

Результаты. Анализ данных учётных форм продемонстрировал существенный рост компьютерно-томографических исследований в Москве: реальное количество исследований оказалось на 31% больше ожидаемых. Количество исследований органов грудной клетки в 2020 г. увеличилось почти в 2 раза по сравнению с другими временными периодами. В совокупности всё это повиляло на рост значений средней эффективной дозы, которая в 2020 г. также выросла более чем в 2 раза.

Заключение. Эпидемиологическая обстановка в 2020 г. оказала существенное влияния как на динамику изменений дозовой нагрузки на пациентов при проведении компьютерной томографии, так и на вклад определённых видов компьютерно-томографических исследований в зависимости от анатомической области. Анализ помог выявить ряд преимуществ и недостатков различных форм сбора данных.

Ключевые слова: радиационная безопасность; дозовая нагрузка; пациент; компьютерная томография; лучевая диагностика; 3-ДОЗ; форма № 30; ЕРИС; аналитика.

Как цитировать

Дружинина Ю.В., Рыжов С.А., Водоватов А.В., Солдатов И.В., Лантух З.А., Мухортова А.Н., Лубенцова Ю.Н. Влияние COVID-19 на динамику изменений дозовой нагрузки на пациентов при проведении компьютерной томографии в медицинских организациях Москвы // *Digital Diagnostics*. 2022. Т. 3, № 1. С. 5–15. DOI: https://doi.org/10.17816/DD87628

Рукопись получена: 12.11.2021 **Рукопись одобрена:** 26.01.2022 **Опубликована:** 14.02.2022

ЭКО•ВЕКТОР

DOI: https://doi.org/10.17816/DD87628

Coronavirus disease-2019: Changes in computed tomography radiation burden across Moscow medical facilities

Yuliya V. Druzhinina[1, 2], Sergey A. Ryzhov[1, 3], Aleksandr V. Vodovatov[4], Ilya V. Soldatov[1], Zoya A. Lantukh[1], Anna N. Mukhortova[1], Iuliia N. Lubentsova[1]

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ABSTRACT

BACKGROUND: The spread of coronavirus disease-2019 (COVID-19) in Moscow has significantly increased the number of chest computed tomography examinations to establish a diagnosis and assess the treatment efficacy. In Moscow, the new approach to diagnostic imaging associated with COVID-19 caused divergent shifts in the volume and structure of the population radiation burden. This study aimed to bridge the gap in data, as no reliable information about the changes in the structure of diagnostic imaging and the current radiation burden due to COVID-19 in the Moscow population has been reported.

AIMS: To evaluate the impact of the pandemic on the computed tomography radiation doses in Moscow medical facilities between 2017 and 2020.

MATERIALS AND METHODS: We collected and analyzed the following data: forms No. 3-DOZ completed by the public and private Moscow medical facilities in 2017–2020; forms No. 30 completed in 2017–2020; data from the Unified Radiological Information Service for 2020. The study provides details about the annual population radiation exposure and the average individual radiation doses, with a breakdown by anatomic region.

RESULTS: The statistical form evaluation elucidated the boost of computed tomography imaging in Moscow, accounting for 31% higher than anticipated. In 2020, the number of chest imaging studies increased almost two-fold compared to the previous periods. Thereby, causing a corresponding increase in the mean effective dose by over two times.

CONCLUSION: The results show that the epidemiological situation of 2020 had a profound effect on the changes in the computed tomography-related radiation exposure, which helped us get insight into the diagnostic effect of certain types of computed tomography studies applied to various anatomic regions. The analysis contributed to a better understanding of the strengths and weaknesses of various statistical forms.

Keywords: radiation safety; radiation dose; patient; computed tomography; diagnostic imaging; 3-DOZ; form 30; ERIS; analytics.

To cite this article

Druzhinina YV, Ryzhov SA, Vodovatov AV, Soldatov IV, Lantukh ZA, Mukhortova AN, Lubentsova YN. Coronavirus disease-2019: Changes in computed tomography radiation burden across Moscow medical facilities. *Digital Diagnostics.* 2022;3(1):5–15. DOI: https://doi.org/10.17816/DD87628

Received: 12.11.2021 **Accepted:** 26.01.2022 **Published:** 14.02.2022

DOI: https://doi.org/10.17816/DD87628

COVID-19对莫斯科医疗机构计算机断层扫描期间患者剂量负荷变化动态的影响

Yuliya V. Druzhinina[1, 2], Sergey A. Ryzhov[1, 3], Aleksandr V. Vodovatov[4], Ilya V. Soldatov[1], Zoya A. Lantukh[1], Anna N. Mukhortova[1], Iuliia N. Lubentsova[1]

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简评

论证。新型冠状病毒感染（COVID-19）在莫斯科的传播导致对患者进行的胸部计算机断层扫描数量大幅增加，这是诊断和评估治疗效果的一部分。莫斯科与COVID-19相关的放射诊断结构的变化导致首都人口集体辐射剂量的范围和结构发生变化，而该过程本身似乎是多向的。由于COVID-19流行病，目前缺乏关于莫斯科人口放射诊断结构和暴露水平变化的可靠信息，促使这项工作开展。

目标是评估疫情对2017-2020年期间莫斯科医疗机构计算机断层扫描研究期间患者剂量负担水平变化动态的影响。

材料与方法。收集并分析了从莫斯科市各种所有权形式的医疗机构得到的2017-2020年填好的第3-DOZ号表格； 2017-2020年第30表格数据和统一放射信息服务(ERIS)的2020年数据.对患者的年度集体和平均个人暴露剂量按身体解剖区域进行了分析。

结果。对这些登记表的分析表明，莫斯科的计算机断层扫描检查显着增加：实际检查数量比预期高31%。与其他时间段相比，2020年的胸部检查次数几乎翻了一番。总起来看，所有这些都影响了平均有效剂量的增长，在2020年也增加了一倍多。

结论。2020年疫情对计算机断层扫描期间患者剂量负担变化的动态以及某些类型的计算机断层扫描研究的贡献（取决于解剖区域）产生了重要影响。该分析有助于确定不同形式的数据收集的一些优势和劣势。

关键词：辐射安全； 剂量负担； 患者； CT扫描； 放射诊断； 3-DOZ； 第30号表格； 统一放射信息服务(ERIS)，分析。

To cite this article
Druzhinina YV, Ryzhov SA, Vodovatov AV, Soldatov IV, Lantukh ZA, Mukhortova AN, Lubentsova YN. COVID-19对莫斯科医疗机构计算机断层扫描期间患者剂量负荷变化动态的影响. *Digital Diagnostics.* 2022;3(1):5–15. DOI: https://doi.org/10.17816/DD87628

收到：12.11.2021 **接受：**26.01.2022 **发布日期：**14.02.2022

BACKGROUND

The use of computed tomography (CT) in diagnosing coronavirus disease-2019 (COVID-19) has been widely discussed among physicians. Initially, multiple perspectives on the applicability of diagnostic radiology existed worldwide, ranging from the use of CT as disease screening [1] to CT scans only in confirmed COVID-19 cases [2]. The reliability of polymerase chain reaction diagnostics did not exceed 70%; thus many countries, including Russia, particularly Moscow, decided to introduce the term "clinically confirmed COVID-19 case" that combines symptoms, respiratory disorders, and CT or X-ray findings (regardless of results from a single laboratory test for SARS-CoV-2 ribonucleic acid by a polymerase chain reaction and epidemiological history) [3]. Additionally, diagnostic radiology detects COVID-19 pneumonia, complications, and differential diagnosis with other lung diseases, as well as determines the status and change dynamics and assesses the therapy effectiveness [4]. The common manifestation of COVID-19 includes viral lung damage (viral pneumonia), thus radiological methods are one of the main tools to assess disease severity and decide the hospitalization needs for patients [5, 6].

Chest CT is not a classical method for diagnosing acute respiratory viral infection but is highly sensitive to pulmonary thickening, a typical COVID-19 symptom [7]. The spread of COVID-19 in Moscow significantly increased the number of chest CT scans performed on patients as part of COVID-19 diagnosis and therapy effectiveness assessment. The increased number of chest CT scans is probably related both to the increased demand for this type of examination and the increased availability of medical care for patients with COVID-19 signs due to the organization of outpatient CT centers within the city; however, this issue was not included in the goals and objectives of the study.

The rapid growth in the number of CT scans was associated with an increased radiation dose of medical exposure in the Moscow population, hence additional cases of radiation-induced cancers and hereditary effects [8, 9]. Additionally, the scope of radiological techniques to detect pathological conditions had rapidly increased, along with the increased radiological burden on patients, accompanying persons, and medical facility staff [10]. COVID-19-related changes in the structure of diagnostic radiology in Moscow changed the value and structure of the radiation dose to the city's population, with the multidirectional process. On the one hand, the number of chest CT scans dramatically increased; on the other hand, the transfer of some exclusive medical organizations for COVID-19 treatment and the closure of medical facilities or individual departments for quarantine due to COVID-19 decreased the number of performed CT scans on elective patients, primarily multiphase procedures with X-ray contrast agents associated with high (up to 50–80 mSv) individual radiation doses [11, 12]. The structure of radiological examinations was affected by the suspension of the All-Russian Medical Examination of the Adult Population of the Russian Federation, stipulated by a decree of the Government of the Russian Federation[1] and other regulatory documents of the executive authorities. Unfortunately, reliable information on the changes in the diagnostic radiology structure and exposure levels of the Moscow population is currently unavailable due to the COVID-19 epidemic.

The study aimed to assess the radiation dose changes in the Moscow population from CT scans in 2020 compared to 2017–2019 as affected by the epidemiological situation associated with COVID-19.

MATERIALS AND METHODS

Data from Forms No. 3-DOZ and No. 30 for 2017–2020 and the Unified Radiological Information Service (ERIS) for 2020 was analyzed.

Research and Practical Clinical Center for Diagnostics and Telemedicine Technologies of the Moscow Health Care Department systematically collect and records data according to Form No. 3-DOZ "Information on Patient Radiation Doses during Medical X-Ray Radiological Examinations,"[2] approved by the order of the Federal State Statistics Service[3].

In Moscow, as elsewhere in the country, data are collected using Form No. 30,[4] approved by the order of the Federal State Statistics Service. The study only analyzed the sections related to diagnostic radiology.

Additionally, ERIS[5]data were analyzed.

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[1] Decree of the Government of the Russian Federation dated March 21, 2020, No. 710-r "On the Temporary Suspension of the All-Russian Medical Examination of the Adult Population of the Russian Federation." Available at https://www.garant.ru/products/ipo/prime/doc/73681079/. Accessed on 01/15/2022.

[2] Information on Patient Radiation Doses during Medical X-Ray Radiological Examinations (form No. 3-DOZ). Available at http://www.consultant.ru/document/cons_doc_LAW_52009/c262c55885294afd998489c7f7ef8fe17e14da38/. Accessed on 01/15/2022.

[3] Federal State Statistics Service Order No. 411 dated October 16, 2013, (revised on December 22, 2021) "On Approval of Statistical Tools for Federal Statistical Monitoring of Sanitary Status of Territories, Occupational Diseases (Poisonings), and Radiation Doses by Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing." Available at http://www.consultant.ru/document/cons_doc_LAW_153534/2ff7a8c72de3994f30496a0ccbb1ddafdaddf518/. Accessed on 01/15/2022.

[4] Federal State Statistics Service Order No. 863 dated December 30, 2020, (revised on December 20, 2021) "On Approval of Federal Statistical Monitoring Forms with Instructions for their Completion for the Organization of Federal Statistical Health Protection Monitoring by the Ministry of Health of the Russian Federation." Available at http://www.consultant.ru/document/cons_doc_LAW_373430/. Accessed on 01/15/2022.

[5] Research and Practical Clinical Center for Diagnostics and Telemedicine Technologies of Moscow Health Care Department: Unified Radiological Information Service (ERIS). Available at https://zdrav.expert/index.php/Продукт:НПКЦ_ДиТ_ДЗМ:_Единый_радиологический_информационный_сервис_(ЕРИС). Accessed on 01/15/2022.

This retrospective study did not contain personalized information about the patients. The data presented in Forms No. 3-DOZ and No. 30 was anonymized and contained information only about the number of examinations by modality and anatomical regions. Data from the ERIS were also anonymized and extracted only by the number of performed CT scans.

Both annual population and average individual radiation patient doses depending on anatomical body regions during CT scans were analyzed. Moreover, the specific contribution of CT concerning other types of examinations, particularly fluorography, radiography, fluoroscopy, and special (angiographic and interventional) and radionuclide (functional tests and scintigraphy) instrumental methods was estimated.

Data from Forms No. 3-DOH and No. 30 were analyzed for 2017–2020, whereas ERIS data were considered only for 2020, which is due to the completion of connecting all CT scanners operated in Moscow public medical facilities to the Unified Radiological Information Service only by 2020.

Each of the three options for data collection (ERIS and Forms No. 30 and No. 3-DOZ) has both advantages and disadvantages. For example, ERIS, which is the most complete and user-friendly database, has a significant limitation on the operating time and modalities of the currently connected equipment used in diagnostic radiology. Form No. 30 has excellent data details but a significant limitation on the organizations that fill it out. Additionally, most of this is manual work, in which the quality and completeness of the provided information are significantly affected by the human factor. Significant disadvantages of Form No. 3-DOZ, which provides the most complete information on the number of examinations, the population and effective dose per examination, and the distribution of the demand for examinations depending on the anatomical region, includes the limited range of organizations that fill it out and the human factor resulting from incorrect information due to the manual data entry.

Statistical analysis

The statistical analysis used the specialized options of Microsoft Excel software, where data on the number of examinations presented in Forms No. 3-DOH and No. 30 for 2017–2019 were entered. The estimated number of examinations in 2020 was calculated based on the “Forecast” function of the same software.

RESULTS

Annually, an increased number is observed in medical organizations that submit data according to the federal state statistical monitoring form, which is used by the Federal Service for the Oversight of Consumer Protection and Welfare to collect information on patient radiation doses during medical X-ray radiological examinations to protect the well-being of citizens of the Russian Federation (Form No. 3-DOZ),. Hence, the number of X-ray radiological examinations and, therefore, the population radiation dose (manSv) consistently increased (Table 1).

The specific share of the use of different types of examinations (Table 2) and the specific population dose contribution from different types of examinations (Table 3) in 2017–2020 was estimated to assess the current

Table 1. Summary data on radiological examinations and dose burdens in Moscow medical facilities according to Form No. 3-DOZ

Parameters	2017 г.	2018 г.	2019 г.	2020 г.
Number of medical facilities	1233	1330	1394	1453
Number of examinations, units	27 128 339	28 882 702	29 705 881	23 626 477
Population dose, manSv	10 946	11 593	12 582	16 662
Average effective dose, mSv	0,404	0,401	0,424	0,705

Table 2. Specific share of the use of different types of examinations according to Form No. 3-DOZ

Year	FG, %	RG, %	FS, %	CT, %	Other procedures, %	RN, %
2017	28.4	63.9	1.1	5.5	0.7	0.4
2018	27.8	63.7	0.8	6.4	0.9	0.4
2019	26.1	62.9	0.8	6.8	3.0	0.4
2020	22.7	62.0	0.6	13.1	1.0	0.5

Note. Here and in Table 3: FG, fluorography; RG, radiography; FS, fluoroscopy; CT, computed tomography; RN, radionuclide examinations.

Table 3. Specific population dose contribution from different types of examinations according to Form No. 3-DOZ

Year	FG, %	RG, %	FS, %	CT, %	Other procedures, %	RN, %
2017	2.8	13.2	6.8	60.7	11.3	5.2
2018	3.3	11.0	5.5	64.2	9.1	6.9
2019	2.8	9.4	5.2	65.0	10.1	7.5
2020	1.5	5.2	2.4	75.9	7.2	7.8

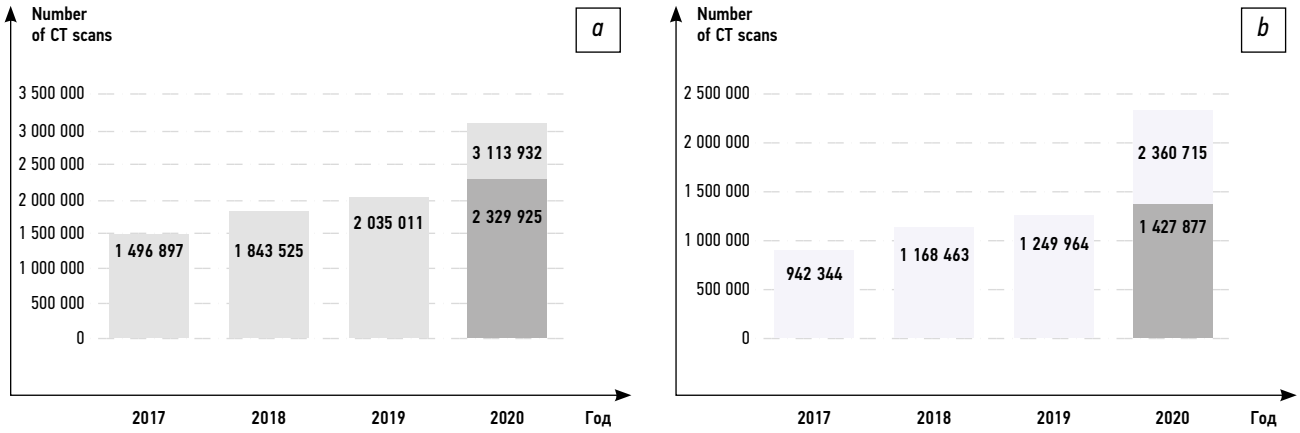

Fig. 1. Number of CT scans according to Forms No. 3-DOZ (*a*) and No. 30 (*b*). The yellow color marks the predicted number of examinations.

situation with the average effective dose per procedure in 2020.

The results presented in Tables 2 and 3 show a significantly increased number of CT scans performed in 2020 (almost twofold) and a uniformly increased population radiation dose contribution (manSv). Additionally, CT scans in all analyzed years (2017–2020) contribute to the maximum radiation patient doses (manSv).

The predicted number of 2,329,925 examinations for 2020 was calculated using the Microsoft Excel "Forecast" function, based on the number of given CT scans in the reporting Form No. 3-DOZ for 2017–2019. A linear one with an approximation coefficient of 0.989 was used when making a forecast of five different types of trend lines. According to Form No. 3-DOZ, the actual number of examinations was 3,113,932, which is 31% higher compared with the expected number of CT scans. A similar analysis was conducted according to Form No. 30 (Fig. 1): the expected number of examinations in 2020 was 1,427,877, whereas 2,360,715 examinations were conducted in reality, which is 65% higher than that of the predicted number (see Fig. 1). The linear type of trend lines with the approximation coefficient of 0.9714 was also used when making the forecast.

Based on three sources (Forms No. 30, ERIS, and No. 3-DOZ), Table 4 was generated, which presents data on the number of CT scanners and CT scans depending on the data source.

Table 5 shows the effective radiation doses per CT scan depending on the anatomical region.

The dynamics of the demand share for CT scans were analyzed according to Form No. 3-DOZ based on the anatomical region (Table 6). Based on Tables 5 and 6, the specific contribution to the total effective dose was estimated depending on the number of CT scans of certain anatomical regions (Table 7).

DISCUSSION

Data analysis results demonstrated a significant impact on the distribution structure of the use of different types of X-ray radiological examinations and the dynamics of changes in the effective radiation doses of patients. The analysis results of Form No. 3-DOZ, presented in Table 1, shows that the average effective dose per X-ray radiological examination in 2017–2019 differed by 5%, whereas the average effective dose (mSv) per examination increased by 66% and 74% in 2020 compared with 2019 and 2017–2018, respectively.

The number of examinations, such as fluorography, radiography, and fluoroscopy, evenly decreased from 2017 to 2020 (Table 2). Relatedly, the population dose contribution from these examinations also decreased (Table 3). However, a sharp increase in CT scans (more than twofold in 2020 compared with 2017) was observed (Table 2). The population dose contribution from CT scans grew more evenly, with a maximum increase in all years, reaching approximately 76% in 2020 (Table 3). The number of radionuclide examinations was approximately the same from 2017 to 2019, with a slight increase in 2020 (Table 2). Additionally, the population dose contribution from radionuclide examinations, due to their variety conducted using an increasingly broad spectrum of radiopharmaceuticals and the expansion of examination protocols, grew slowly, which resulted in an increased effective dose of patient exposure per examination (Table 3). The number of other examinations, which include

Table 4. Data on the number of CT scanners and CT scans for 2020 from three sources

Data source	Scanners	Scans	Number of scans per scanner
ERIS	183	1 931 908	10 557
Form No. 30	305	2 360 715	7740
Form No. 3-DOZ	595	3 113 932	5233

Table 5. Average effective dose per CT scan depending on the anatomical region for 2017–2019 compared to data for 2020 according to Form No. 3-DOZ

Anatomical region	Average effective radiation doses, mSv			
	2017 г.	2018 г.	2019 г.	2020 г.
Thoracic organs	5.609	4.933	4.818	4.545
Extremities	0.718	0.781	0.702	0.674
Cervical vertebrae	3.142	2.288	2.134	1.710
Thoracic vertebrae	5.228	5.708	4.331	4.563
Lumbar vertebrae	6.139	6.795	6.438	5.884
Pelvis and femur	6.368	6.468	6.573	6.858
Ribs and sternum	3.712	3.953	2.566	3.811
Abdominal organs	8.886	8.246	8.005	7.413
Upper gastrointestinal tract	5.348	3.721	4.118	6.894
Lower gastrointestinal tract	5.810	5.832	5.951	12.304
Skull, maxillofacial area	1.681	1.448	1.476	1.225
Teeth	0.080	0.100	0.104	0.042
Kidneys, urinary system	7.269	7.210	6.651	6.103
Other	4.396	4.556	4.104	3.023
The average radiation dose for CT scan, mSv	4.442	4.040	4.019	4.061

Table 6. Dynamics of the demand share for CT scan based on the anatomical region

Anatomical localization (according to Form No. 3-DOZ)	The share of one examination of the anatomical region relative to the total number of examinations per year, %			
	2017 г.	2018 г.	2019 г.	2020 г.
Thoracic organs	24.36	24.09	25.55	55.6
Extremities	2.88	2.37	2.98	1.98
Cervical vertebrae	1.71	1.99	2.39	1.4
Thoracic vertebrae	0.97	1.09	1.05	0.62
Lumbar vertebrae	2.56	2.28	2.37	1.27
Pelvis and femur	3.04	3.64	3.3	2.11
Ribs and sternum	0.03	0.02	0.22	0.03
Abdominal organs	16.31	15.2	15.44	9.11
Upper gastrointestinal tract	0.48	0.29	0.25	0.02
Lower gastrointestinal tract	0.65	0.48	0.12	0.43
Skull, maxillofacial area	38.52	40.41	38.28	22.41
Teeth	1.54	0.69	0.25	0.72
Kidneys, urinary system	4.58	4.39	6.14	3.67
Other	2.37	3.06	1.66	0.63

Table 7. Specific contribution to the total effective dose based on the number of CT scans of certain anatomical regions

Specific contribution (%) to the total effective dose depending on the number of CT scans of certain anatomical regions, mSV		2017 г.	2018 г.	2019 г.	2020 г.
Thoracic organs	%	24.36	24.09	25.55	55.6
	mSv	1.37	1.19	1.23	2.53
High-dose examinations (lumbar vertebrae, pelvis and femur, upper and lower gastrointestinal tract, kidneys, and urinary system)	%	27.62	26.28	27.62	16.61
	mSv	2.2	2.0	2.03	1.17
Other CT scans (extremities, cervical vertebrae, ribs and sternum, skull, and teeth)	%	48.02	49.63	46.83	27.79
	mSv	0.87	0.85	0.76	0.36
Average effective radiation doses	mSv	4.442	4.040	4.019	4.061

DOI: https://doi.org/10.17816/DD87628

procedures, such as radiosurgery and angiography, slightly and irregularly varied from year to year, along with the population dose contribution, which was most probably due to incorrect recording of examinations in different columns for one or another year (Tables 2, 3).

According to Forms No. 30 and No. 3-DOZ, the actual number of CT scans performed in 2020 was significantly higher than that predicted from the 2017–2019 data. Thus, according to Forms No. 3-DOH and No. 30, the increased number of examinations conducted in 2020 compared with those expected was 31% and 65%, respectively. According to ERIS, which records only examinations conducted in medical facilities belonging to the Moscow City Health Department, 1,931,908 CT scans were performed, which was 81% and 62% of the total number of examinations recorded in Forms No. 30 and No. 3-DOZ, respectively. This means that most of the registered CT scans were performed in medical facilities of the Moscow City Health Department. The results indicate a significant impact on the dynamics of the population dose to the organizational and methodological measures taken due to the epidemiological situation and the transfer of the outpatient departments to the operation mode of the outpatient CT centers.

Further analysis of the impact of the epidemiological situation on the dynamics of changes in the patient dose burden during CT was conducted according to the data presented in Form No. 3-DOZ for 2017–2020.

The study showed that average effective radiation patient doses during CT scan in all anatomical regions, except for doses from lower gastrointestinal tract examinations, uniformly decreased from year to year, which is directly associated with equipment renewal and examination protocol quality improvement (Table 5). The reasons for such a significant (over twofold) increase in the average effective dose for lower gastrointestinal tract examinations (Table 5) have not yet been found an explanation, which requires detailed analysis, consideration, and possible correction of the examination protocols to reduce the effective dose while maintaining the quality of the obtained diagnostic information.

The analysis found that skull and maxillofacial examinations contributed the most in 2017–2019, presumably, because this line also included dental CT scanners examinations. In 2020, the largest number of examinations was conducted on thoracic organs (over twice as many as in 2017), while the number of the skull and maxillofacial area examinations sharply decreased (approximately twofold), and insignificantly on almost all anatomical regions except for ribs and sternum, whose specific contribution to the number of examinations increased and gradually decreased (Table 6).

Based on Tables 5 and 6, the specific contribution to the total effective dose from chest CT scans and high-dose examinations (lumbar vertebrae, pelvis and femur, upper and lower gastrointestinal tract, kidneys, and urinary system) and other CT scans (extremities, cervical vertebrae, ribs and sternum, skull, and teeth) was estimated and presented in Table 7. The results suggest that the main population radiation dose contribution was from chest CT scans.

Study limitations

This study was limited to 1 year of data on CT radiation burden in the ERIS, inadequate information on patient doses recorded in Form No. 30, and the restricted range of organizations that fill out Forms No. 3-DOZ and No. 30.

CONCLUSIONS

The epidemiological situation in 2020 had a significant impact both on the dynamics of changes in CT dose burden on patients and on the number of certain types of CT scans depending on the anatomical region. The largest share (55.6%) of all CT scans in 2020 was that of thoracic organs, with an overall almost twofold increased share of CT in the total number of all X-ray radiological procedures. The analysis of the dynamics of changes in the number and population dose in X-ray radiological examinations confirms that the population dose in medical exposure was formed mainly due to CT scans. Therefore, special attention should be paid to the control of existing CT examination protocols and to the development and implementation of new protocols that would reduce the radiation burden while maintaining the quality of diagnostic information. Moreover, particular attention should be paid to the possibility of conducting a low-dose CT instead of the traditional one for COVID-19 analysis, which would significantly reduce the radiation burden on patients.

The analysis revealed several advantages and disadvantages of different forms of data collection. Generally, the existing reporting forms are representative enough; however, the specifics of their completion may significantly reduce their value and the available data quality. Thus, the use of specialized dose-monitoring software is recommended to avoid errors and simplify the work of medical professionals who are responsible for collecting data on X-ray radiological examinations.

ADDITIONAL INFORMATION

Funding source. The authors declare that there is no external funding for the exploration and analysis work.

Competing interests. The authors declare no obvious and potential conflicts of interest related to the publication of this article.

Authors' contribution. Y.V. Druzhinina — search for relevant publications, literature analysis, research design development, data processing, writing; S.A. Ryzhov — determination of the main focus of the review, expert evaluation of literature review, research design development; A.V. Vodovatov — determination of the main focus of the review, expert evaluation of literature review, research design development, editing of the review; I.V. Soldatov — determination of the main focus of the review, expert evaluation of literature review;

Z.A. Lantukh — expert evaluation of literature review, systematization and final editing of the review; A.N. Mukhortova — determination of research methods determination of research methods and materials; Y.N. Lubentsova — literature analysis, determination of research materials. All 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.

Acknowledgments. The authors express our gratitude for the help in preparing the article for publication to the data researcher of the department for the coordination of scientific research, Irina A. Vinogradova, and to the translator of the scientific research work group, Andrey A. Romanov.

REFERENCES

1. Zhao W, Zhong Z, Xie X, et al. Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: a multicenter study. *AJR*. 2020;214(5):1072–1077. doi: 10.2214/AJR.20.22976

2. Erturk SM. CT is not a screening tool for corona-virus disease (COVID-19) pneumonia. (letter). *AJR*. 2020;215(1):W12–W12. doi: 10.2214/AJR.20.23288

3. Morozov SP, Protsenko DN, Smetanina SV, et al. Radiation diagnosis of coronavirus disease (COVID-19): organization, methodology, interpretation of results. Issue 65. Version 2 dated 17.04.2020. Moscow; 2020. 78 p. (Series: Best practices of radiation and instrumental diagnostics). (In Russ).

4. Ministry of Health of the Russian Federation. Temporary methodological recommendations. Prevention, diagnosis and treatment of new coronavirus infection (COVID-19). Version 11 (07.05.2021). Moscow; 2021. 225 p. (In Russ).

5. Morozov SP, Reshetnikov RV, Gombolevskiy VA, et al. Diagnostic accuracy of computed tomography for identifying hospitalizations for patients with COVID-19. *Digital Diagnostics*. 2021;2(1):5–16. (In Russ). doi: 10.17816/DD46818

6. Siordia JA. Epidemiology and clinical features of COVID-19. A review of current literature. *J Clin Virol*. 2020;127:104357. doi: 10.1016/j.jcv.2020.104357

7. Morozov SP, Kuzmina ES, Ledikhova NV, et al. Mobilizing the academic and practicalpotential ofdiagnostic radiology duringthe COVID-19 pandemic in Moscow. *Digital Diagnostics*. 2020;1(1):5–12. (In Russ). doi: 10.17816/DD51043

8. Vodovatov AV, Romanovich IK, Historian OA, et al. Preliminary assessment of changes in the structure of the collective dose from CT examinations for the period March-June 2020 in connection with the diagnosis of COVID-19 in the Russian Federation. Preprint [Internet]. (In Russ). Available from: https://covid19-preprints.microbe.ru/article/28. Accessed: 15.01.2022.

9. Okhrimenko SE, Ilin LA, Korenkov IP, et al. Optimization of radiation doses to patients in x-ray diagnostics // Hygiene and Sanitation. 2019;98(12):1331–1337. (In Russ). doi: 10.47470/0016-9900-2019-98-12-1331-1337

10. Morozov SP, Soldatov IV, Lantukh ZA, et al. Characteristics of the dose load on patients in medical institutions in Moscow [Internet]. (In Russ). Available from: https://tele-med.ai/documents/482/harakteristika_dozovoj_nagruzki_na_pacientov_v_medicinskih_organizaciyah_g_moskvy_1.pdf. Accessed: 15.01.2022.

11. Balonov MI, Golikov VYu, Vodovatov AV, et al. Scientific foundations of radiation protection in modern medicine. Ed. by M.I. Ballonov. Vol. 1. Radiation diagnostics. Saint Petersburg: Ramzaev Research Institute; 2019. 320 p. (In Russ).

12. Chipiga LA, Bernhardsson C. Patient doses in computed tomography examinations in two regions of the Russian Federation. *Radiat Prot Dosimetry*. 2016;169(1-4):240–244. doi: 10.1093/rpd/ncv516

СПИСОК ЛИТЕРАТУРЫ

1. Zhao W., Zhong Z., Xie X., et al. Relation between chest CT findings and clinical conditions of coronavirus disease (COVID-19) pneumonia: a multicenter study // American Journal of Roentgenology. 2020. **Vol. 214,** N **5**. P. 1072–1077. doi: 10.2214/AJR.20.22976

2. Erturk S.M. CT is not a screening tool for corona-virus disease (COVID-19) pneumonia. (letter) // American Journal of Roentgenology. 2020. Vol. 215, N 1. P. W12–W12. doi: 10.2214/AJR.20.23288

3. Морозов С.П., Проценко Д.Н., Сметанина С.В., и др. Лучевая диагностика коронавирусной болезни (COVID-19): организация, методология, интерпретация результатов. Вып. 65. Версия 2 от 17.04.2020. Москва, 2020. 78 с. (Серия: Лучшие практики лучевой и инструментальной диагностики).

4. Министерство здравоохранения Российской Федерации. Временные методические рекомендации. Профилактика, диагностика и лечение новой коронавирусной инфекции (COVID-19). Версия 11 (07.05.2021). Москва, 2021. 225 с.

5. Морозов С.П., Решетников Р.В., Гомболевский В.А., и др. Диагностическая точность компьютерной томографии для определения необходимости госпитализации пациентов с COVID-19 // Digital Diagnostics. 2021. Vol. 2, N 1. P. 5–16. doi: 10.17816/DD46818

6. Siordia J.A. Epidemiology and clinical features of COVID-19. A review of current literature // J Clin Virol. 2020. Vol. 127. P. 104357. doi: 10.1016/j.jcv.2020.104357

7. Морозов С.П., Кузьмина Е.С., Ледихова Н.В., и др. Мобилизация научно-практического потенциала службы лучевой диагностики г. Москвы в пандемию COVID-19 // Digital Diagnostics. 2020. Vol. 1, N 1. P. 5–12. doi: 10.17816/DD51043

8. Водоватов А.В., Романович И.К., Историк О.А., и др. Предварительная оценка изменения структуры коллективной дозы от КТ-исследований за период март-июнь 2020 г. в связи с диагностикой COVID-19 в Российской Федерации. Препринт [интернет]. Режим доступа: https://covid19-preprints.microbe.ru/article/28. Дата обращения: 15.01.2022.

9. Охрименко С.Е., Ильин Л.А., Коренков И.П., и др. Оптимизация доз облучения пациентов в лучевой диагностике // Гигиена и санитария. 2019. Т. 98, № 12. С. 1331–1337. doi: 10.18821/0016-9900-2019-98-12-1331-1337

10. Морозов С.П., Солдатов И.В., Лантух З.А., и др. Характеристика дозовой нагрузки на пациентов в медицинских организациях Москвы [интернет]. Режим доступа: https://tele-med.ai/documents/482/harakteristika_dozovoj_nagruzki_na_pacientov_v_medicinskih_organizaciyah_g_moskvy_1.pdf. Дата обращения: 15.01.2022.

11. Балонов М.И., Голиков В.Ю., Водоватов А.В., и др. Научные основы радиационной защиты в современной медицине / под ред. М.И. Балонов. Т. 1. Лучевая диагностика. Санкт-Петербург: НИИРГ имени проф. П.В. Рамзаева, 2019. 320 с.

12. Chipiga L.A., Bernhardsson C. Patient doses in computed tomography examinations in two regions of the Russian Federation // Radiat Prot Dosimetry. 2016. Vol. 169, N 1-4. P. 240–244. doi: 10.1093/rpd/ncv516

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DOI: https://doi.org/10.17816/DD95661

Всероссийский рейтинг отделений лучевой диагностики: результаты конкурса 2020 года

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АННОТАЦИЯ

Вопросы менеджмента качества медицинской помощи и организации работы отделений лучевой диагностики всегда актуальны и требуют постоянного контроля и аналитической экспертизы. Московское региональное отделение Российского общества рентгенологов и радиологов (МРО РОРР) с 2018 года проводит независимую оценку отделений лучевой диагностики во всех регионах России. Цель рейтинга — выявить лидеров отрасли, а также распространить лучшие практики по всей стране. По результатам анкетирования выявлены положительные тенденции развития службы диагностической помощи по всей стране и критические точки, влияющие на качество работы медицинских организаций.

Представлен анализ функционирования 123 отделений лучевой диагностики в 2020 году. По окончании приёма заявок на участие в рейтинге был сформирован перечень из 163 медицинских организаций, расположенных в 15 городах 7 федеральных округов. Процедура оценки была разбита на три этапа. На первом этапе состоялось онлайн-анкетирование: каждой из организаций-участников было предложено ответить на вопросы по устройству работы отделения, оснащённости, перечню и особенностям выполнения диагностических исследований, а также работе с пациентами. Во время второго этапа проводился клинический и технический аудит набора анонимизированных исследований с заключениями. Следует отметить, что техническому аудиту уделялось особое внимание, поскольку ряд медицинских организаций нарушал методику проведения исследований. Третий этап включал проверку информации о медицинских организациях в открытых источниках. Во время первого и второго этапов начислялись баллы, на основании которых были выбраны финалисты, лидеры и победители рейтинга.

По итогам оценки всех этапов 31 организация вышла в финал, 6 попали в группу лидеров и 5 стали победителями, при этом 45% финалистов относились к Центральному федеральному округу. Прослеживается наибольшая заинтересованность аудита работы в муниципальных и частных медицинских учреждениях, нежели ведомственных и федеральных. Помимо перечня победителей собрана некоторая база данных, которая может представлять собой срез состояния службы лучевой диагностики в Российской Федерации.

Проведение подобных конкурсов направлено в первую очередь на повышение качества и безопасности проведения рентгенологических исследований. Методика проведения конкурса совершенствуется каждый год.

Ключевые слова: лучевая диагностика; организация здравоохранения; стационар.

Как цитировать

Семенов Д.С., Панина О.Ю., Хоружая А.Н., Кудрявцев Н.Д., Васильев Ю.А., Ледихова Н.В., Шулькин И.М., Морозов С.П. Всероссийский рейтинг отделений лучевой диагностики: результаты конкурса 2020 года // *Digital Diagnostics*. 2022. Т. 3, № 1. С. 43–54. DOI: https://doi.org/10.17816/DD95661

Рукопись получена: 18.01.2022 **Рукопись одобрена:** 11.03.2022 **Опубликована:** 08.04.2022

ЭКО•ВЕКТОР

DOI: https://doi.org/10.17816/DD95661

All-Russian rating of radiology departments: 2020 competition results

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ABSTRACT

The issues of quality medical care management and organization of the work of the department of radiation diagnostics are always relevant and require constant monitoring and analytical expertise. Since 2018, the Moscow regional branch of the Russian Society of Radiologists and Radiologists (MRO PORR) has been conducting an independent assessment of the departments of radiation diagnostics in all the regions of Russia. The rating aimed to identify industry leaders and spread the best practices throughout the country. The survey results identified the positive trends in the development of diagnostic care services throughout the country and critical points that affect the quality of work of medical organizations.

This study presents an analysis of the functioning of 123 departments of radiation diagnostics in 2020. After meeting the inclusion criteria, a list of 163 medical organizations in 15 cities of 7 federal districts was formed. The evaluation procedure was divided into three stages. The first stage consisted of an online survey, wherein each of the participating organizations was asked to answer questions about the department's work arrangement, equipment, list, and features of performing diagnostic tests, as well as working with patients. The second stage consisted of a clinical and technical audit of a set of anonymized studies with conclusions. Special attention was paid to technical audits since several medical organizations violated the methodology of conducting research. The third stage included checking the information about medical organizations in open sources. During the first and second stages, points were awarded, based on which the finalists, leaders, and rating winners were selected.

According to the evaluation results of all stages, 31 organizations reached the final stage, 6 were in the group of leaders, and 5 were winners, whereas 45% of the finalists belonged to the Central Federal District. Greater interest was found in the auditing work in municipal and private medical institutions than in departmental and federal ones. Some database has been collected, in addition to the list of winners, which may represent a cross-section of the state of the radiation diagnostics service in the Russian Federation.

Conducting such competitions is primarily aimed at improving the quality and safety of X-ray examinations. The methodology of the competition is improved every year.

Keywords: health facility administration; radiology department; hospital.

To cite this article

Semenov DS, Panina OU, Khoruzhaya AN, Kudryavtsev ND, Vasilyev YuA, Ledikhova NV, Shulkin IM, Morozov SP. All-Russian rating of radiology departments: 2020 competition results. *Digital Diagnostics.* 2022;3(1):43–54. DOI: https://doi.org/10.17816/DD95661

Received: 18.01.2022 **Accepted:** 11.03.2022 **Published:** 08.04.2022

DOI: https://doi.org/10.17816/DD95661

全俄放射诊断科评级：2020年竞赛结果

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简评

医疗质量管理和放射诊断科工作组织的问题总是迫切的，需要不断的监控和分析鉴定。自2018年以来，俄罗斯X射线学家和放射学家学会莫斯科地区分会对俄罗斯各个地区进行放射诊断的独立评估。该评级的目的是发现行业领导者，并在全国内传播最佳实践。根据调查结果，确定了全国诊断救护服务发展的积极趋势以及影响医疗机构工作质量的关键点。

对2020年123个放射诊断科的运行情况提供了分析。在参与评级申请受理结束时，已形成7个联邦区15个城市163家医疗机构的名单。评估程序分为三个阶段。在第一阶段，进行了在线问卷调查：要求每个参与组织回答有关部门组织、装备程度、执行诊断测试的列表和特点以及与患者合作的问题。在第二阶段，对一组匿名研究进行了临床和技术审核，并得出结论。值得注意的是，由于一些医疗组织违反了研究方法，因此技术审计受到特别关注。第三阶段包括验证公开来源中的有关医疗组织的信息。在第一阶段和第二阶段加算评分，并在此基础上选出评级的入围者、领导者和获胜者。

根据各阶段的评估结果，31个组织进入决赛，6个进入领导组，5个成为获胜者，而45%的入围者属于中央联邦区。对市政和私营医疗机构的审计兴趣大于对部门和联邦机构的审计兴趣。除了获奖者名单之外，还编制了一些数据库，这可以代表俄罗斯联邦放射诊断服务状况的断面。

此类竞赛主要旨在提高X射线检验的质量和安全。竞赛的方式每年都在改进。

关键词：放射诊断； 医疗机构； 住院部。

To cite this article

Semenov DS, Panina OU, Khoruzhaya AN, Kudryavtsev ND, Vasilyev YuA, Ledikhova NV, Shulkin IM, Morozov SP. 全俄放射诊断科评级：2020年竞赛结果. *Digital Diagnostics.* 2022;3(1):43–54. DOI: https://doi.org/10.17816/DD95661

收到： 18.01.2022 **接受：** 11.03.2022 **发布日期：** 08.04.2022

INTRODUCTION

Issues of medical care quality management and organization in radiology departments (RDs) are always relevant and require continuous monitoring and analytical expertise [1, 2]. Qualitative improvement of the diagnostic process becomes particularly important to continuously increase the number of examinations conducted [3, 4].

The Moscow Regional Branch of the Russian Society of Roentgenographers and Radiologists (MRB RSRR) has been independently evaluating RDs in all regions of Russia since 2018. These ratings aim to identify industry leaders and disseminate best practices within the country. The expert group gradually collects and analyzes information from colleagues through questionnaires and open-source data analysis, and the results of anonymized examinations—radiological, radioisotopic, and ultrasound—were audited. Data analysis on medical facilities forms a picture of the radiology service in Russian healthcare.

Therefore, this study aimed to analyze the functioning of 123 RDs in 2020. The positive trends in the development of diagnostic services across the country and critical points affecting the performance of medical facilities were also identified.

MATERIALS AND METHODS

At the end of the application process, 163 medical facilities were included in the list. The procedure was divided into three stages to comprehensively assess the performance of RDs.

During the first stage, an online survey was conducted. Each participating organization was invited to answer questions on the functioning of the department, equipment, list and features of diagnostic tests, and patient care. Questions were categorized into modality groups, such as computed tomography (CT), magnetic resonance imaging (MRI), radiography (RG), mammography (MMG), positron emission tomography (PET), radionuclide diagnosis (RND), and ultrasound (US) scanning. The total number of questions was 150: 25 for CT, 19 for MRI, 23 for RG, 17 for MMG, 17 for PET, 14 for RND, 16 for US, and 19 general questions. In addition to questions on modalities, specific items regarding the relevance of data provided were included in the survey (e.g., the compliance with current regulatory documentation and completeness of the implementation of Russian and international recommendations).

Each survey question was assessed using a numerical scale: additional points were awarded for each "correct" answer, corresponding to the standards and recommendations, whereas points were deducted for each violation of the department rules and regulations or the use of ineffective solutions. A maximum of 40 points could be scored for the survey, and the threshold score for passing the first stage was 15.

At the second stage, the examinations were audited clinically and technically. Medical facilities provided a set of anonymized examinations with conclusions to the expert group of the NPKTs DiT DZM (Research and Practical Clinical Center for Diagnostics and Telemedicine Technologies of Moscow Healthcare Department): each facility provided two pelvic (male) MRI scans, abdominal MRI, contrast-enhanced abdominal CT, low-dose chest CT (LD-CT) if available, chest RG, MMG, PET/CT, and three breast and thyroid US scans. The maximum possible score for the audit stage was 60 points.

At the third stage, information on the medical facility was checked in open sources, that is, official websites and data from reporting forms (such as Form No. 30). No points were assigned for this stage.

At the end of these stages, the total points were calculated, and the winners were selected based on these results. For a participant to be included in the group of prize-winners, threshold points were required: >15, 50, and 70 points for the finalists (a passing score according to the survey results), leaders, and winners, respectively. Each group—leaders and winners—could include any institutions that reached the required points.

RESULTS

Of the 163 participants, 123 RDs completed the first stage of the survey, with 50% taking up to 140 patients per day and 33.33% taking 140–420 patients.

The rating covered 15 cities (Moscow, St. Petersburg, Khanty-Mansiysk, Kazan, Yakutsk, Nizhny Novgorod, Krasnoyarsk, Stavropol, Omsk, Chita, Voronezh, Cheboksary, Irkutsk, Samara, and Tyumen) from seven federal districts. Due to the limited number of cities, these ratings may not be directly scalable to the entire country; however, the presented methodology and results may become the basis for a more extensive study of the radiology services in Russia.

In the first stage, 31 medical facilities reached the final stage, and medical institutions from four regions, that is, Moscow (2 participants), Central, Volga, and Ural Federal Districts were the top five, with scores of 24.04–34.34 points.

The second stage of the independent assessment of the RDs is an audit of the examination packages provided by participants to the NPKTs DiT DZM experts and a review of open sources. From September 18, 2020 to October 11, 2020, 11 organizations out of all finalists submitted examinations. The NPKTs DiT DZM experts checked a total of 182 examinations (22 CT, 44 MRI, 20 RG, 20 MMG, 20 NDCT, 8 PET, and 48 US scans).

The technical audit received special attention, since several medical facilities violated the methodology of conducting examinations. For example, a standard abdominal CT scan should start from the lower lobes of the lungs and cover the area up to the upper third of the femur. Some departments raised the lower boundary of the scanning area to the iliac crests, excluding the pelvic organs, which is a

mistake. Individual cases with non-standard targets were not included in the analysis.

Based on the total score at the second stage, the top three were institutions from the Ural, Volga, and Central Federal Districts (24.57, 23.04, and 21.75 points respectively).

After calculating the results of all stages, 31 organizations, 6 leaders, and 5 winners reached the final stage, with 45% of the finalists belonging to the Central Federal District. Medical facilities were represented by municipal (14), private (10), departmental (2), and federal (5) institutions. Based on the type of medical care, the institutions were outpatient (7), inpatient (3), and specialized (21). Thus, the auditing work was highest at municipal and private medical institutions, rather than at departmental and federal ones.

In addition to the list of winners, some databases were created to represent a cross-section of the state of the radiology service in the Russian Federation. These materials are discussed in more detail below (with no reference to specific departments, since this information is excluded from analysis).

GENERAL ASPECTS OF THE RADIOLOGY SERVICE

Making an appointment

For the patient, the interaction with RDs begins with an appointment for the examination. This process is sufficiently elaborated in all participants of the survey based on both the number of recording methods and informing the changes. Regarding the first, the most common form was recording at the attending physician (after an initial or repeated consultation with a specialist), followed by the frequency of recording at the reception desk and by phone. Appointments through an application on the website of a medical institution, in the patient's personal account, via messenger or a mobile application could be made in rare cases.

The majority of the departments (78%) remind the patient of the examination; of these, only 34% send information on the preparation for the examination in advance. A survey and a conversation between the patient and the physician before the examination is conducted in 56% of cases, an oral interview is held in 38%, and no interaction with the patient is provided in 6% of cases.

Issuing examination findings

The findings are mostly provided on a digital medium (CD or DVD) or on film (23 cases) through a personal account or cloud data storage (16 cases). In the current clinical practice, findings on film are only appropriate for some radiographic offices and when using the operation of the analog equipment. When choosing a new technology, digital media would be a good option. Some private clinics do not give up the "film" to be client-oriented. This is practiced only when a physician does not have an automated workstation and asks for the examination findings on film [5].

Availability of examinations

Aside from the convenience of the appointment, an important factor is the opening hours of the department and the possibility to arrange same-day appointments (in case the patient is ready for the examination). This issue is particularly important to increase the coverage of screening programs [6, 7]. The availability of examinations for emergency patients is best in Moscow and worst in the Volga Federal District (12 points vs. 2 points, respectively).

The ability to perform radiological services on the day of application (Fig. 1) was provided for X-ray examinations and CT and US scans (104, 95, and 78 cases, respectively). For these modalities, both the readiness of the department to

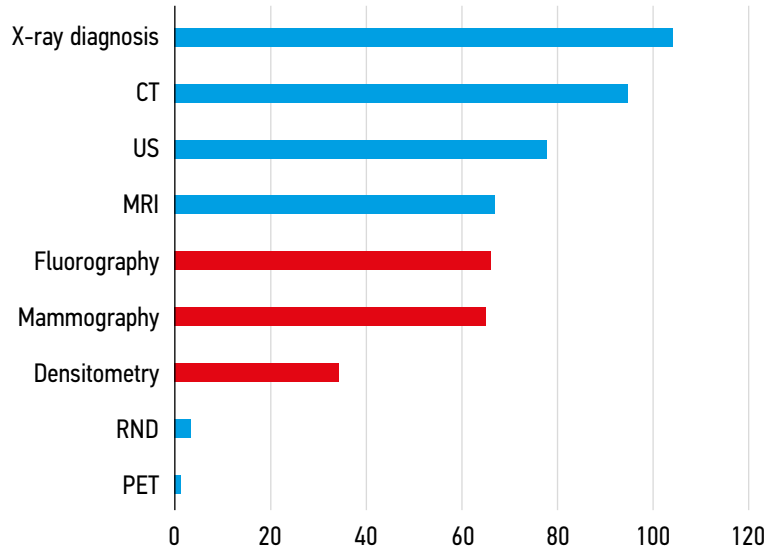

Fig. 1. Availability of same-day X-ray examinations.

Note. CT, computed tomography; *US*, ultrasound; *MRI*, magnetic resonance imaging; *RND*, radionuclide diagnosis; *PET*, positron emission tomography.

DOI: https://doi.org/10.17816/DD95661

receive the patient on the day of application and the patient's preparation for the examination (for abdominal examinations, MMG, and US of pelvic organs in women of childbearing age) are important. However, in the survey, the researchers were interested in the readiness of the department to receive a patient.

PET/CT and RND (1 and 3 cases, respectively) were the least available procedures in terms of same-day appointments because of the complicated logistics of delivering radiopharmaceuticals for these types of examinations and the need for careful planning of the required volume, depending on the number of records per day. Moreover, patients require preparation before PET/CT and RND to exclude pseudopositive accumulation of radiopharmaceuticals; however, this is beyond the scope of the survey.

Appointments on weekends were available at 94 (67%) RDs, only Saturday appointments could be performed at 26 (19%) RDs, and 20 (14%) RDs did not work on weekends. Based on modality, X-ray examinations, CT, and MRI were available on weekends (Fig. 2), whereas PET and RND were the least available.

Based on the survey results, the availability of screening tests, such as fluorography, MMG, and densitometry, on the day of application is lower than that of MRI or CT scans. The former types of examination are logically explained by the trend toward screening withdrawal, whereas the latter two obviously require more attention in terms of throughput and office efficiency. Another reason for the decreased availability of these examinations may be the peculiarities of medical service pricing.

Patient safety

Patient safety in diagnostic examinations is one of the priority tasks [8]. While radiation safety in Russia is strictly regulated at the legislative level [9], several other aspects are specifically included in the survey. Thus, 92% of radiologists, 54% of radiographers, 40% of nurses, and 25% of US physicians were certified cardiopulmonary resuscitators. However, with the system modernization of primary specialized accreditation for specialists and continuous medical education, the vast majority of the employees will be competent in first aid.

Follow-up after intravenous contrast enhancement in RDs: Patients were released immediately after the examination in 5 cases (4%) or <15 min in 16 (12%) cases; the follow-up lasted for 15–30 min in 68 (50%) cases or >30 min in 47 (35%) cases. Notably, some program participants omitted this item from the survey.

Unfortunately, regardless of the measures taken to prevent accidents and medical errors, they are inevitable in practice. Global experience shows the feasibility and effectiveness of recording, such incidents for subsequent analysis; however, domestic medicine lags behind in this direction [2]. Nevertheless, the survey demonstrated that 70% of departments take measures to prevent accidents in one form or another. Joint reviews of complex cases are conducted as needed in 86 (62%), weekly in 49 (36%), and not conducted in 3 (2%) cases. The complaint registry is available in 64 of 136 RDs.

One medical institution did not have internal quality control, whereas only 29 of 135 respondents engage external experts for auditing. The auditing practice implemented by the NPKTs DiT DZM showed the high efficiency of this approach with low labor costs [9].

To the question "Do you actively use second opinion?," the answer "Yes, via email" was given by 67 (48%) respondents; "Yes, via PACS/RIS" by 51 (37%) respondents; and 21 (15%) respondents do not use the option (data by modalities are detailed in Fig. 3).

Remote description of examinations may be regarded as a "privilege" for a physician; however, during the coronavirus disease 2019 pandemic, this turned out to be a necessity [4]. In addition, this approach greatly increases the availability of expert opinions from experienced specialists [5, 10]. Our data

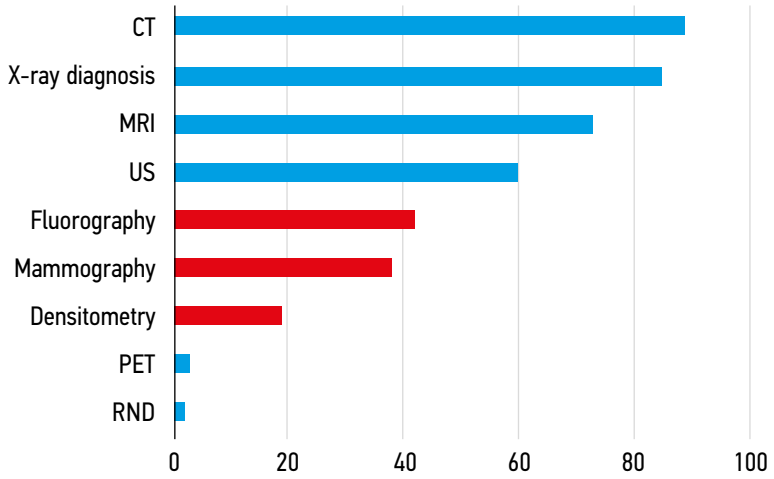

Fig. 2. Appointments in radiology departments (RDs) on weekends.

Note. CT, computed tomography; *MRI*, magnetic resonance imaging; *US*, ultrasound; *PET*, positron emission tomography; *RND*, radionuclide diagnosis.

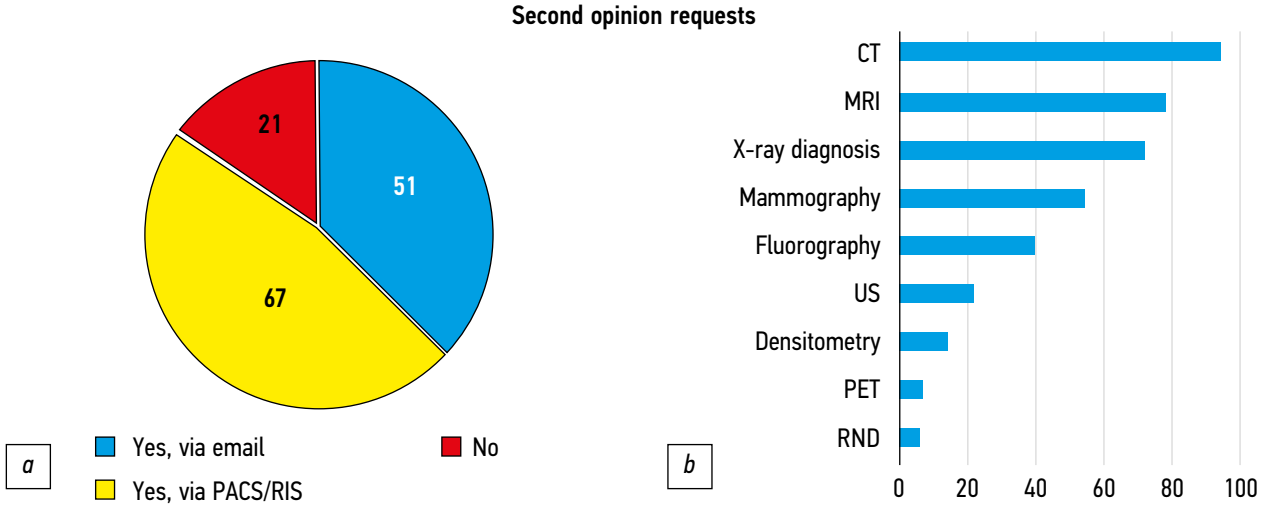

Fig. 3. Characteristics of second opinion requests in RDs: *a*, general information on its availability; *b*, data on modalities for which specialists most commonly request a "second opinion." Most frequently (94%), further CT scan examination is required.

Note. CT, computed tomography; *MRI*, magnetic resonance imaging; *US*, ultrasound; *PET*, positron emission tomography; *RND*, radionuclide diagnosis.

showed that 30% of radiologists describe patients' scans directly in the office where examinations are performed; 30% of cases reported that the physician's office is remote, but is located in the same building; and 40% of respondents practice remote description, in particular, by experts from other medical facilities. While some complex examinations require the direct presence of a radiologist, a separate office is still necessary for proper and effective work.

DIAGNOSTIC EQUIPMENT AND EXAMINATION METHODOLOGY

CT scanners are installed in 100 RDs, which are all equipped with automatic injectors for administering contrast agents. Remarkably, 22 machines have ⩾128 slices, and 18 have dual-energy CT (DECT) function.

The list of examinations performed varies from department to department and obviously depends on the equipment and peculiarities of the patient flow. The prevalence of different types of CT scans is shown in Fig. 4. Apparently, LD-CT, which is performed in 65 out of 100 departments, and whole-body CT are the most common (54). Furthermore, 28 RDs perform CT-guided surgeries, including minimally invasive interventions.

Among the departments that participated in the survey, 68 were equipped with US diagnostic machines, and most were equipped with convex, linear, and transvaginal transducers (Fig. 5).

The rating of the most common examinations is headed by breast and male pelvic US scans (60 and 57 medical facilities, respectively). In 46 departments, minimally invasive US-guided interventions are performed, namely, therapeutic punctures and drainage, fine-needle aspiration biopsy of the thyroid gland, and prostate and internal organ biopsies (liver, kidneys, pancreas, and others). Less frequently, hepatic elastometry, peripheral nerve US scanning, and compression elastography (28, 24, and 23 medical institutions, respectively) are performed.

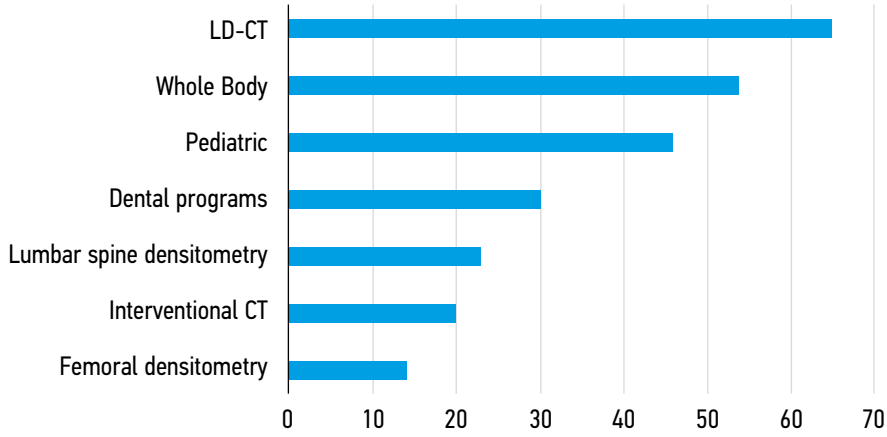

Fig. 4. Prevalence of CT scans performed in the RDs of the rating participants.

Note. CT, computed tomography; *LD-CT*, low-dose computed tomography.

The analysis showed that at least among the rating participants, the availability of X-ray machines is lower than that of CT scanners. A total of 91 devices (including 60 mobile and 44 dental) are installed in these medical institutions; and 76 of these are digital.

Most medical facilities (77) perform fluoroscopy; however, special examinations are not available in all institutions (Fig. 6).

A total of 63 departments are equipped with mammographs, and the proportion of digital devices is comparable to X-ray machines (86% vs. 84%). The most common examinations are ductography and targeted MMG (61 and 59 departments, respectively). The availability of mammographic examinations is shown in Fig. 7.

A total of 22 machines are equipped with tomosynthesis, and 28 have a biopsy attachment: 21 and 17 departments with vertical access and horizontal table, respectively. Vacuum aspiration biopsy is less available, that is, only in 11 out of 63 departments.

In terms of work organization, all rating participants perform MMG in two views, and <3% of examinations are repeated due to technical problems. Moreover, the Bi-RADS scale is used in 59 departments; however, physicians in only 44 departments are additionally certified in MMG.

The departments of the rating participants have 84 MRI scanners with 1.5, 3, and <1.5 Tesla induction (58, 21, and 5 departments, respectively). Most manufacturers include a

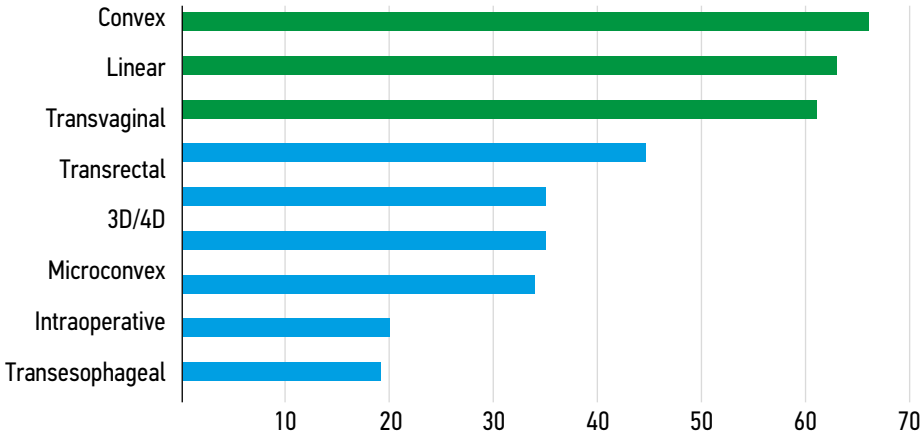

Fig. 5. Transducers of ultrasound diagnostic devices.

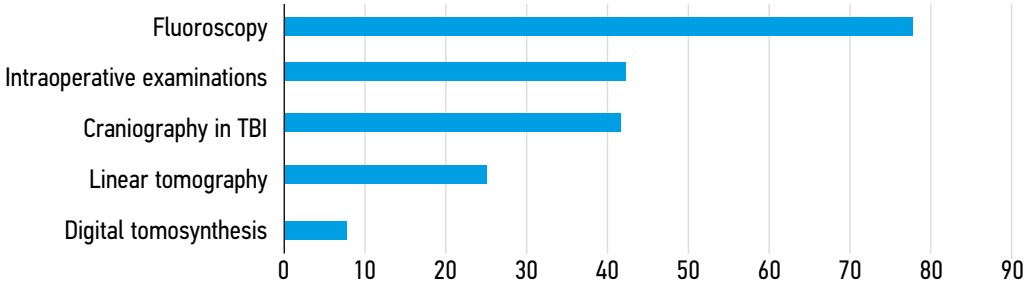

Fig. 6. Availability of specialized X-ray examinations.
Note. TBI, traumatic brain injury.

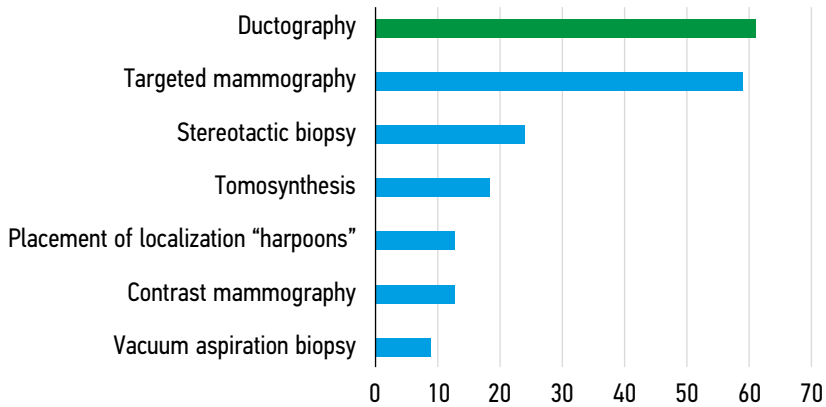

Fig. 7. Availability of mammographic examinations.

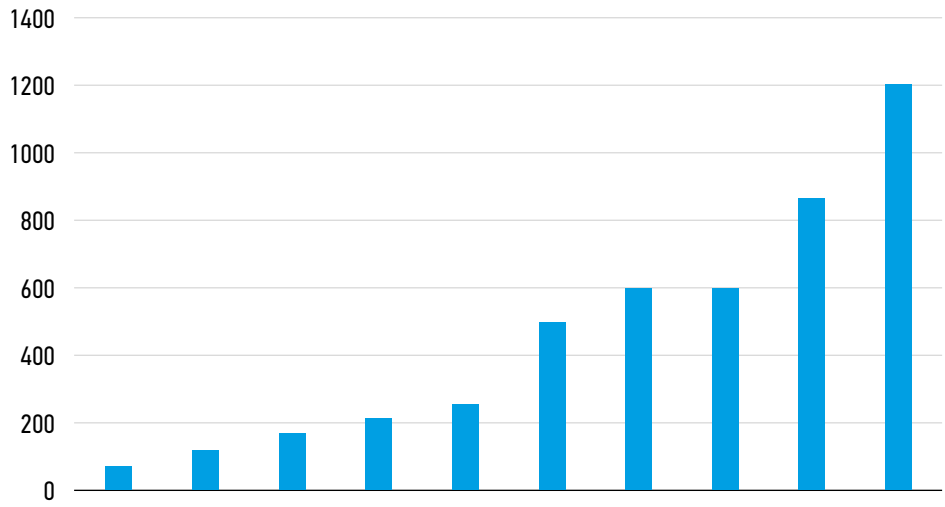

Fig. 8. Number of visitors per day in the top ten RDs based on the rating.

minimum set of radiofrequency coils for the most common examinations (head and neck, abdomen, and small pelvis) as the standard equipment. However, a peculiarity of this modality is the frequent "profiling" of the MRI office on a small group of examinations, depending on the particular medical facility. Thus, cardiac MRI, tractography, and surgical interventions (MRI-guided biopsy) are performed in 27, 36, and 6 surveyed departments, respectively.

One of the most common non-standard examinations is MR angiography, which is performed in 76 departments. However, this applies primarily to angiography of the brachiocephalic arteries. Concurrently, only 32 and 23 departments perform aortic examinations and angiography of the lower extremities, respectively.

PET (including CT) is not as widespread as the other diagnostic methods; however, only five departments are equipped with this type of machines. The PET part of the equipment in most cases (three of five) has four detector rings, and CT has ⩾64 slices. All departments have their own production of radiopharmaceuticals, whereas four of five have only fluorodeoxyglucose. In practice, examinations are performed using 11C-methionine, 18F-choline, 18F-tyrosine, 18F-DOPA, 18Ga-PSMA, and 18F-PSMA.

Regarding the examination features, all departments (with few exceptions) use means to ensure patient and staff safety; however, the automatic administration of radiopharmaceuticals is used only in one medical institution. Furthermore, two of five PET departments only examine cancer patients.

Based on scoring results, the top ten RDs were determined. This list included a wide variety of medical facilities with capacity ranging from 70 to 1,200 people per day and an average of 459 (Fig. 8).

Certainly, all of these organizations are well equipped and have at their disposal a wide range of equipment, including additional options. Each of the 10 RDs has a data storage and transmission system and remote description capabilities, follows the standardized protocols and international guidelines (such as PI-RADS and BI-RADS), audits examinations, and carefully implements measures to ensure safety of both patients and staff.

CONCLUSIONS

The results of the competition provided an insight into the level of organization among RDs in different regions of the Russian Federation. The main advantage of the participation of medical institutions in this competition is the opportunity to have an independent assessment of the department's work by the expert council of MRB RSRR, identify strengths and weaknesses, and receive personal recommendations. Such competitions are primarily aimed at improving the quality and safety of X-ray examinations.

The methodology of the competition is improved every year. Hopefully, the number of rating participants will increase in the future, and a single RD standard will be created across the country.

ADDITIONAL INFORMATION

Funding source. This article was prepared as part of research (No. in the Unified State Information System for Accounting of Research, Development, and Technological Works, EGISU: AAAA-A21-121012290079-2) under the Program of the Moscow Healthcare Department «Scientific Support of the Capital's Healthcare» for 2020–2022.

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

Authors' contribution. All 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. The largest contribution is distributed as follows: D.S. Semenov — drawing up a questionnaire, collecting information, collection and analysis of literature, writing text;

O.U. Panina — collection and analysis of literature, working with data, writing text; A.N. Khoruzhaya — counting and analysis of data, writing text, finalizing the article; N.D. Kudryavtsev — counting and analyzing data, writing text; Yu.A. Vasilyev — data analysis and statistics; N.V. Ledikhova — drawing up a questionnaire, expert support; I.M. Shulkin — creation of a research plan, preparation of a questionnaire; S.P. Morozov — concept and formation of the research question.

REFERENCES

1. The ESR Audit Tool (Esperanto): genesis, contents and pilot. *Insights Imaging*. 2018;9(6):899–903. doi: 10.1007/s13244-018-0651-0
2. Morozov SP, Gabai PG, Vladzimirsky AV, et al. Fundamentals of medical imaging management: a tutorial. Moscow: GEOTAR-Media; 2020. 432 p. (In Russ).
3. Tyurin IE. Radiation diagnostics in the Russian Federation in 2016. *Bulletin Roentgenol Radiol*. 2017;98(4):219–226. (In Russ).
4. Morozov SP, Kuzmina ES, Ledikhova NV, et al. Mobilizing the academic and practical potential of diagnostic radiology during the COVID-19 pandemic in Moscow. *Digital Diagnostics*. 2020;1(1):5–12. (In Russ). doi: 10.17816/DD51043
5. Smyshlyaev AV, Melnikov YY, Shakhabov IV. Telemedicine technologies as a tool for increasing the availability of medical care for the population at the present stage: key problems and development prospects. *Chief Physician*. 2020;5:44–54. (In Russ). doi: 10.33920/med-03-2005-05
6. Rasskazova EA, Rozhkova NI. Screening for early diagnosis of breast cancer. *Res Practice Med*. 2014;1(1):45–51. (In Russ).
7. Wood DE, Eapen GA, Ettinger DS, et al. Lung cancer screening: clinical practice guidelines in oncology. *J Natl Compr Canc Netw*. 2012;10(2):240–265. doi: 10.6004/jnccn.2012.0022
8. Patient Safety in Medical Imaging: a joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS). *Insights Imaging*. 2019;10(1):1–17. doi: 10.1186/s13244-019-0721-y
9. Vodovatov AV, Golikov VY, Kalnitsky SA, et al. Evaluation of levels of exposure of adult patients from common radiographic examinations in the Russian Federation in 2009–2014. *Radiation Hygiene*. 2017;10(3):66–75. (In Russ). doi: 10.21514/1998-42602017-10-3-66-75
10. Morozov SP, Vladzimirsky AV, Ledikhova NV, Kuzmina ES. Expert telemedicine consulting in the service of radiological diagnostics of the city of Moscow. *Vrach Information Technology*. 2018;(S1):48–57. (In Russ).

СПИСОК ЛИТЕРАТУРЫ

1. The ESR Audit Tool (Esperanto): genesis, contents and pilot // Insights Imaging. 2018. Vol. 9, N 6. P. 899–903. doi: 10.1007/s13244-018-0651-0
2. Морозов С.П., Габай П.Г., Владзимирский А.В., и др. Основы менеджмента медицинской визуализации: учебное пособие. Москва: ГЭОТАР-Медиа, 2020. 432 р.
3. Тюрин И.Е. Лучевая диагностика в Российской Федерации в 2016 г. // Вестник рентгенологии и радиологии. 2017. Т. 98, № 4. С. 219–226.
4. Морозов С.П., Кузьмина Е.С., Ледихова Н.В., и др. Мобилизация научно-практического потенциала службы лучевой диагностики г. Москвы в пандемию COVID-19 // Digit Diagnostics. 2020. Т. 1, № 1. С. 5–12. doi: 10.17816/DD51043
5. Смышляев А.В., Мельников Ю.Ю., Шахабов И.В. Телемедицинские технологии как инструмент повышения доступности медицинской помощи для населения на современном этапе: ключевые проблемы и перспективы развития // Главврач. 2020. № 5. С. 44–54. doi: 10.33920/med-03-2005-05
6. Рассказова Е.А., Рожкова Н.И. Скрининг для ранней диагностики рака молочной железы // Исследования и практика в медицине. 2014. Т. 1, № 1. С. 45–51.
7. Wood D.E., Eapen G.A., Ettinger D.S., et al. Lung cancer screening: clinical practice guidelines in oncology // J Natl Compr Canc Netw. 2012. Vol. 10, N 2. P. 240–265. doi: 10.6004/jnccn.2012.0022
8. Patient Safety in Medical Imaging: a joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS) // Insights Imaging. 2019. Vol. 10, N 1. P. 1–17. doi: 10.1186/s13244-019-0721-y
9. Водоватов А.В., Голиков В.Ю., Кальницкий С.А., и др. Анализ уровней облучения взрослых пациентов при проведении наиболее распространенных рентгенографических исследований в Российской Федерации в 2009–2014 гг. // Радиационная гигиена. 2017. Т. 10, № 3. С. 66–75. doi: 10.21514/1998-42602017-10-3-66-75
10. Морозов С.П., Владзимирский А.В., Ледихова Н.В., Кузьмина Е.С. Экспертное телемедицинское консультирование в службе лучевой диагностики города Москвы // Врач и информационные технологии. 2018. № S1. С. 48–57.

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DOI: https://doi.org/10.17816/DD88605

Полиоссальная фиброзная дисплазия: результаты визуализации спорного случая

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АННОТАЦИЯ

Фиброзная дисплазия — редкое опухолеподобное доброкачественное врождённое заболевание костей, которое, по всей вероятности, связано с мутациями гена *GNAS* и характеризуется широким спектром клинических проявлений, начиная от изолированных моноссальных и полиоссальных форм и заканчивая другими внескелетными проявлениями (синдром МакКьюна–Олбрайта). В результате этих изменений отмечается увеличение хрупкости костей, повышается риск возникновения переломов.

В данной статье описана пациентка в возрасте 65 лет, поступившая в наше рентгенологическое отделение с жалобами на боли в шее и спине. Ранее у больной были диагностированы поражения костей шейного и грудного отделов с подозрением на метастазы. В нашем отделении у пациентки предварительно диагностировали фиброзную дисплазию, что впоследствии было подтверждено данными ренгенографии, компьютерной и магнито-резонансной томографии. Окончательный диагноз поставлен по результатам биопсии костей.

Таким образом, фиброзная дисплазия в основном поражает кости, при этом нормальная костная ткань замещается диспластической фиброзной тканью. В зависимости от количества поражённых костей и сопутствующих эндокринных изменений выделяют три формы заболевания: моноссальную, полиоссальную и синдром Олбрайта. Дифференциальный диагноз среди прочего включал множественную миелому. Выбрана оптимальная тактика лечения.

Ключевые слова: полиоссальная фиброзная дисплазия; фиброзная ткань; литическое поражение костей.

Как цитировать

De Michele F., Carpagnano F.A., Paparella M.T., Guglielmi G. Полиоссальная фиброзная дисплазия: результаты визуализации спорного случая // *Digital Diagnostics*. 2022. Т. 3, № 1. С. 55–63. DOI: https://doi.org/10.17816/DD88605

Рукопись получена: 17.11.2021 **Рукопись одобрена:** 17.01.2022 **Опубликована:** 09.03.2022

DOI: https://doi.org/10.17816/DD88605

Polyostotic fibrous dysplasia: imaging findings of a controversial case

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ABSTRACT

Fibrous dysplasia is a rare non-neoplastic tumor-like congenital bone disease that is most likely associated with GNAS gene mutations, with a broad spectrum of clinical presentations, ranging from isolated monostotic and polyostotic forms to other extra-skeletal associated manifestations as in McCune–Albright syndrome. It is responsible for bone's weakening and increased fragility, making it prone to fractures.

A 65-year-old female patient was referred to our radiology department for cervical and dorsal pain, with a previous diagnosis of incidental cervical and dorsal bone lesions that are suspected for metastases. X-ray, computed tomography, and magnetic resonance imaging were performed with a precise diagnostic suspicion of fibrous dysplasia that is confirmed by bone biopsy.

Fibrous dysplasia principally affects the bone and is characterized by bone replacement itself by dysplastic fibrous tissue. According to the number of affected bones and their association to endocrine alterations, it is classified into three categories: monostotic, polyostotic, and Albright's disease. Differential diagnosis with multiple myeloma among others and the best treatment decision was made.

Keywords: polyostotic fibrous dysplasia; fibrous tissue; bone lytic lesions.

To cite this article

De Michele F, Carpagnano FA, Paparella MT, Guglielmi G. Polyostotic fibrous dysplasia: imaging findings of a controversial case. *Digital Diagnostics*. 2022;3(1):55–63. DOI: https://doi.org/10.17816/DD88605

Received: 17.11.2021 **Accepted:** 17.01.2022 **Published:** 09.03.2022

DOI: https://doi.org/10.17816/DD88605

多骨性纤维结构发育不良：一个有争议的病例的影像学结果

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简评

纤维异样增殖症是一种罕见的肿瘤样良性先天性骨病，最可能与GNAS基因突变有关，临床表现范围广泛，从孤立的单骨和多骨形式至其他骨骼外表现（McCune-Albright综合征）。由于这些变化，骨脆性增加，骨折的风险更高。

本文描述了一名65岁的患者，她因主诉颈部和背部疼痛而入住我们的放射科。此前，该患者被诊断为颈部和胸部骨骼病变，疑似转移。在我科，该患者先前被诊断为纤维异样增殖症，随后通过X射线、计算机断层扫描和磁共振成像确认。最终诊断是基于骨活检的结果。

因此，纤维异样增殖症主要损坏骨骼，正常骨骼被发育不良的纤维组织取代。根据受影响骨骼的数量和相关的内分泌变化，可以区分三种形式的疾病：单骨、多骨和奥尔布赖特综合征。除其他外，鉴别诊断包括多发性骨髓瘤。选择了最佳治疗方法。

关键词：多骨性纤维结构发育不良； 纤维状组织； 溶骨病。

To cite this article
De Michele F, Carpagnano FA, Paparella MT, Guglielmi G. 多骨性纤维结构发育不良：一个有争议的病例的影像学结果. *Digital Diagnostics*. 2022;3(1):55–63. DOI: https://doi.org/10.17816/DD88605

收到： 17.11.2021 **接受：** 17.01.2022 **发布日期：** 09.03.2022

BACKGROUND

Fibrous dysplasia (FD) is a benign progressive condition that is characterized by abnormal fibroblast proliferation and bone and marrow replacement with fibrous connective tissue [1]. Described for the first time by von Recklinghausen in 1891 [2], FD is a rare congenital disease caused by a sporadic postzygotic missense mutation that leads to abnormal fibroblast proliferation, defective osteoblast differentiation, and increased bone resorption [3-4]. It may affect one or several bones, according to the monostotic or polyostotic type, and may be associated with hyperfunction endocrinopathies and hyperpigmentation of the skin (café-au-lait spots) in the so-called "McCune–Albright syndrome" (MAS) [5-6]. FD has a predilection for certain bones including the femur, tibia, ribs, pelvis, and craniofacial. The estimated prevalence of FD is 1/30,000, with the monostotic type 5–6 times as prevalent as the polyostotic one. Generally, FD is a silent disease and some patients are asymptomatic. With the presence of symptoms, they often include bone pain, headache, bone deformities, facial asymmetry, proptosis, diplopia, pathological fractures, and during childhood. More serious symptoms include optic neuropathy, blindness, deafness, vestibular dysfunction, and occasionally, facial nerve palsy. Scintigraphy/isotopic bone scans are normally used to assess the extent of FD and the number of FD lesions, whereas computed tomography (CT) and, even less, magnetic resonance imaging (MRI) are useful to characterize the typical morpho-structural characteristics of each bone lesion, which usually have a lytic appearance and are characterized by thinning of the cortex with a "ground-glass" matrix [7]. Biochemical markers of bone turnover are in some cases elevated and final diagnosis can be confirmed by biopsy. Moreover, hypophosphatemia may be present together with increased secretion of fibroblast growth factor (FGF-23) from the dysplastic tissue [8]. Hypophosphatemia may contribute to mineralization defects, which can lead to osteomalacia, rickets, and bone pain with deformities [9]. Cure or spontaneous resolution of FD are unavailable, but not all patients require treatment. Surgery may be indicated for larger lesions, which cause adjacent tissue compression with nerve constriction and pain. Bisphosphonates are often used as a medical treatment as they have been suggested to reduce the increased bone resorption at the affected sites.

DESCRIPTION OF THE CASE

Clinical data

Herein, presented a case of a 65-year-old female patient, without a specific clinical history, who was referred to our radiology department for cervical pain and discomfort for some years, as the only symptom. There was no history of preceding trauma, but the physical examination revealed dark-colored spots on the skin (café-au-lait spots), facial asymmetry, and obesity. In the previous years, she underwent several diagnostic exams to exclude attributable pathologies to her symptoms, resulting in the presence of lytic lesions of the cervical and dorsal metamers. Therefore, she was investigated for the suspicion of bone heteroplasia or neoplastic secondarysm, without an exhaustive final diagnosis. When she was referred to our radiology department, we decided to investigate her multiple known bone lesions from a multi-diagnostic perspective. Therefore, we performed an X-ray, CT, and MRI scan of the skeleton, with particular attention on segments that are affected by the above-mentioned signs and symptoms. Then we required positron emission tomography (PET) - and Single-photon emission computed tomography (SPECT) scans, as well as a bone biopsy, to confirm our diagnostic suspicion.

Radiological findings

X-ray imaging showed the presence of well-circumscribed lytic lesions at the level of C5, C7, and D1 vertebrae and at the posterior arch of the fifth left rib, together with a larger localization of the disease at the first left rib's posterior arch, which presented a bubbly cystic bone lesion with a cortical "blown appearance", cortical thinning, and none periosteal reaction (Fig. 1).

The multiplanar reconstruction CT scan showed a "ground-glass" appearance of the bone matrix, together with homogeneously sclerotic and lytic areas of involved cervical vertebrae, underlying the involvement of C7 and D1 metamers and confirming the C5's one (Fig. 2a, 2b, and 2c).

The first posterior left rib, already described with a plain radiograph, was better investigated, resulting in the presence of a huge expansile bone lesion with a thin overlying cortical bone and "ground-glass" bone matrix appearance together with cystic lytic areas, which confirm the complete substitution of the trabecular bone with fibrous tissue (Fig. 2d).

Moreover, the total-body CT scan showed the involvement of the fifth dorsal vertebra along the posterior corresponding left rib, which shows the same bony changes as others (Fig. 2e).

The MRI, even if not straight and not particularly useful for the differential diagnosis, was performed, thus confirming the polyostotic skeletal involvement.

It showed T1 hypointense lytic lesions at the level of C5, C7, D1, D4, and D5 vertebrae, with involvement of posterior elements of C5–C6 (Fig. 3a) and a corresponding heterogeneous contrast enhancement in T1w sequences after Gadolinium administration (Fig. 3b). The bone tissue showed extensive remodeled areas, without confirmed periosteal reaction.

Nuclear medicine

The whole body Fluorine-18 Fluorodeoxyglucose PET-CT scan confirmed the involvement of each of the

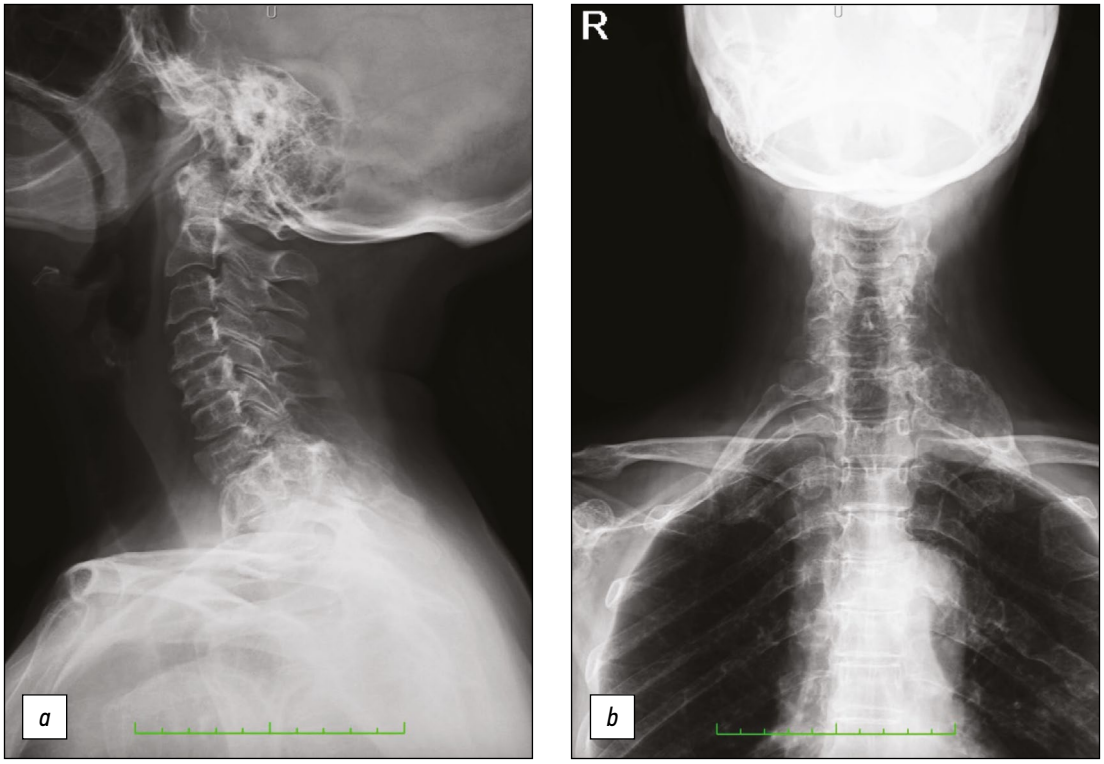

Fig. 1. The cervical tract X-ray, in the context of a diffused uncovertebral arthrosis, shows the presence of some ill-defined lithic bony lesions at C5, C7, and D1 vertebrae (*a*) and the posterior arch of the fifth left rib (*b*); moreover, a 5.5 × 2.5 cm expansile lesion of the posterior first left rib is visible, with a swollen and blown cortical appearance (b).

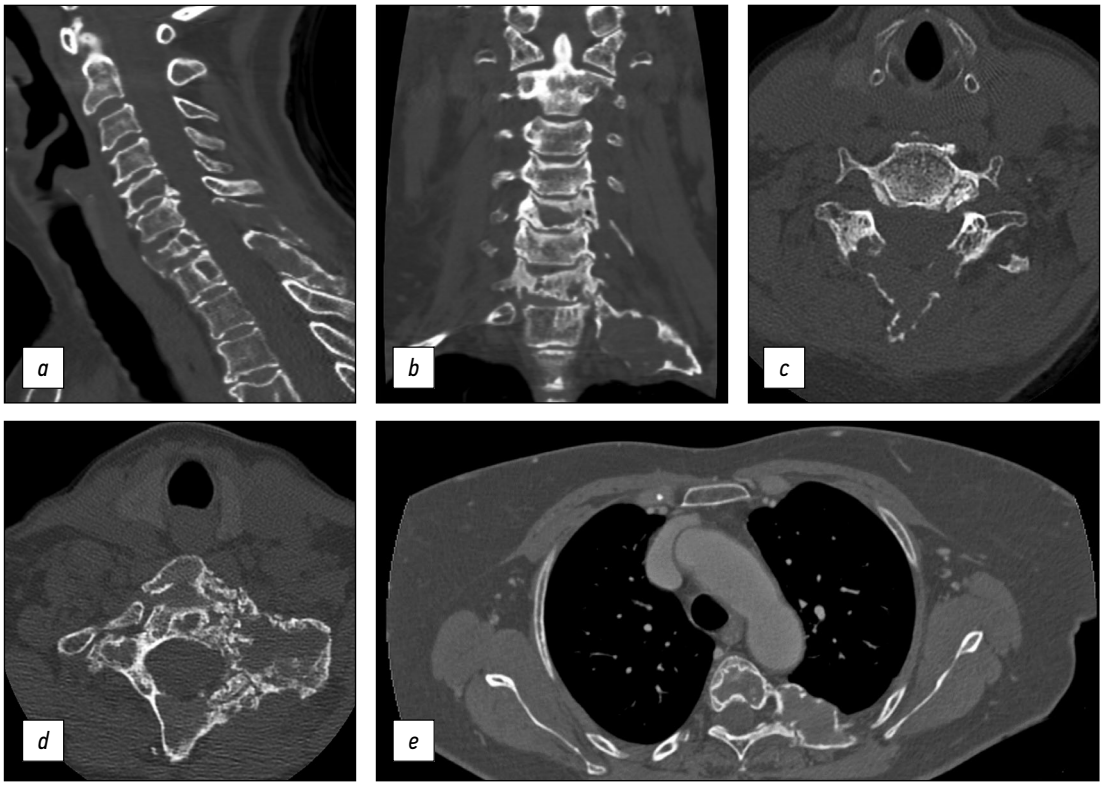

Fig. 2. Sagittal (*a*) and coronal (*b*) cervical CT showing extensive lytic bone lesions at C5, C7, and D1 vertebrae, involving the seventh cervical posterior laminae and spinous process (*c*). The posterior arch of the first left rib shows an expansile bone lesion, surrounded by a thin and blown cortical layer, with a ground-glass bone matrix appearance and no soft tissue component (better seen on the axial plane in the figure 2*d*). Axial plane of the thoracic CT scan showing the involvement of the fifth dorsal vertebra, together with the corresponding left rib (*e*).

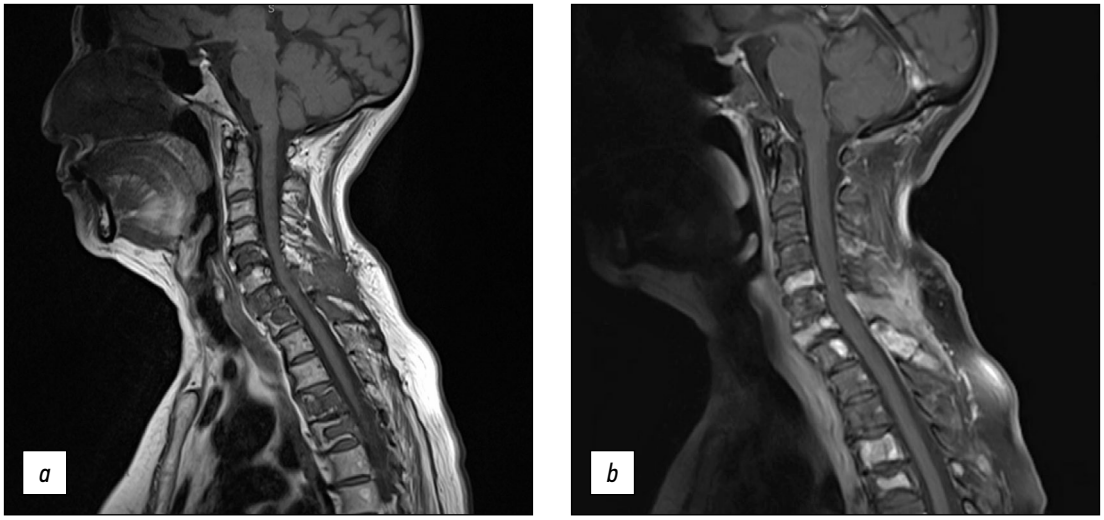

Fig. 3. Sagittal T1w sequence of the cervical tract shows heterogeneously low-signal bone lytic lesions involving C5, C7, D1, D4, and D5 vertebrae and the spinous processes of C5 and C6 metamers (3*a*); all these findings were also confirmed by the administration of Gadolinium contrast enhancement (3*b*).

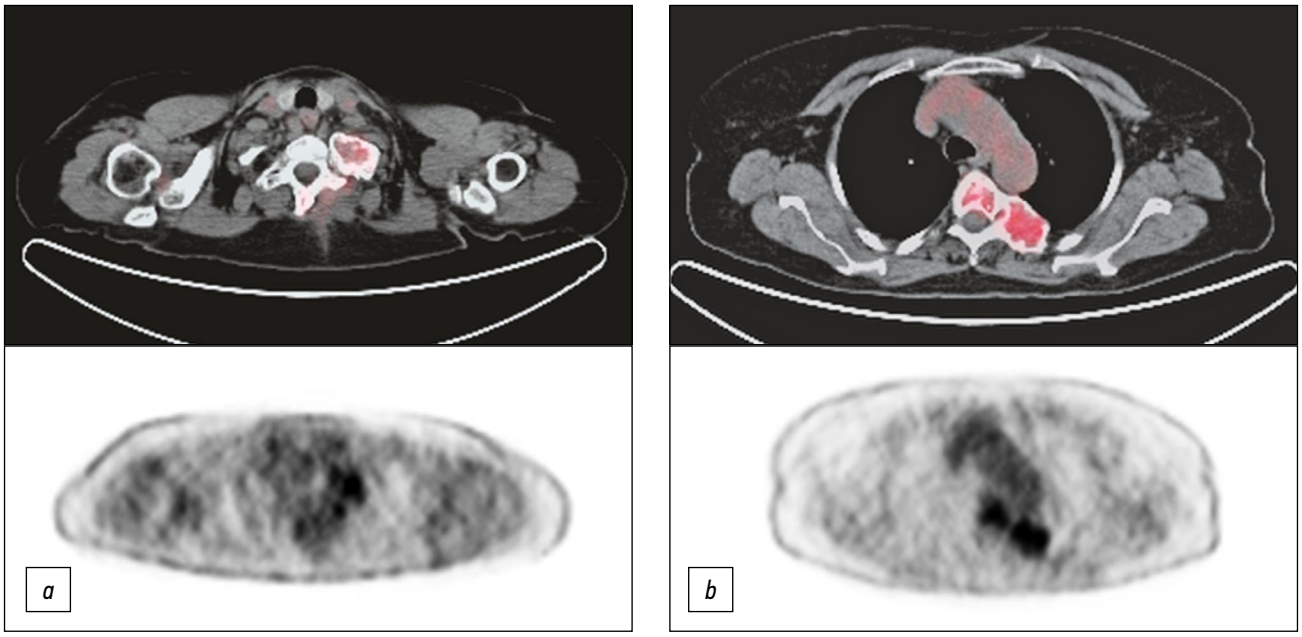

Fig. 4. 18F-FDG PET-CT scan showing an increased tracer uptake at the posterior arch of the first left rib (4*a*), the fifth dorsal vertebra, and the posterior arch of the corresponding left rib (4*b*).

above-mentioned skeletal segments and identified with other imaging methods but, paying special attention to some of them that showed more intense uptake of the radiotracer, specifically the posterior arch of the first left rib, the fifth vertebral body, and the left posterior arch of the corresponding rib (Fig. 4).

Additionally, the presence of a marked metabolic activity at these levels was confirmed by the SPECT-CT scan, which showed two areas of intense and pathological focal accumulation of the osteotropic tracer (99mTc-HDP) in the left paravertebral side. The upper one, corresponds to the first dorsal vertebra, with an SUV max of 39.91, and the other at D5-fifth left rib with an SUV max of 47.06 (Fig. 5).

Biopsy

Bone biopsy was performed, which revealed the presence of osteoporotic and necrotic bone spicules with cartilagineous and fibromuscular fragments in extensive myxoid areas. Thus, the diagnosis of polyostotic FD was made, which was a very important step in the diagnostic process because the neoplastic nature of the lesions was excluded, unlike assumed by the reports of previous years.

CONCLUSION

FD primary affects the bones, causing the replacement of the osseous matrix by dysplastic fibrous tissue, with a sporadic extra-skeletal involvement. It is classified based

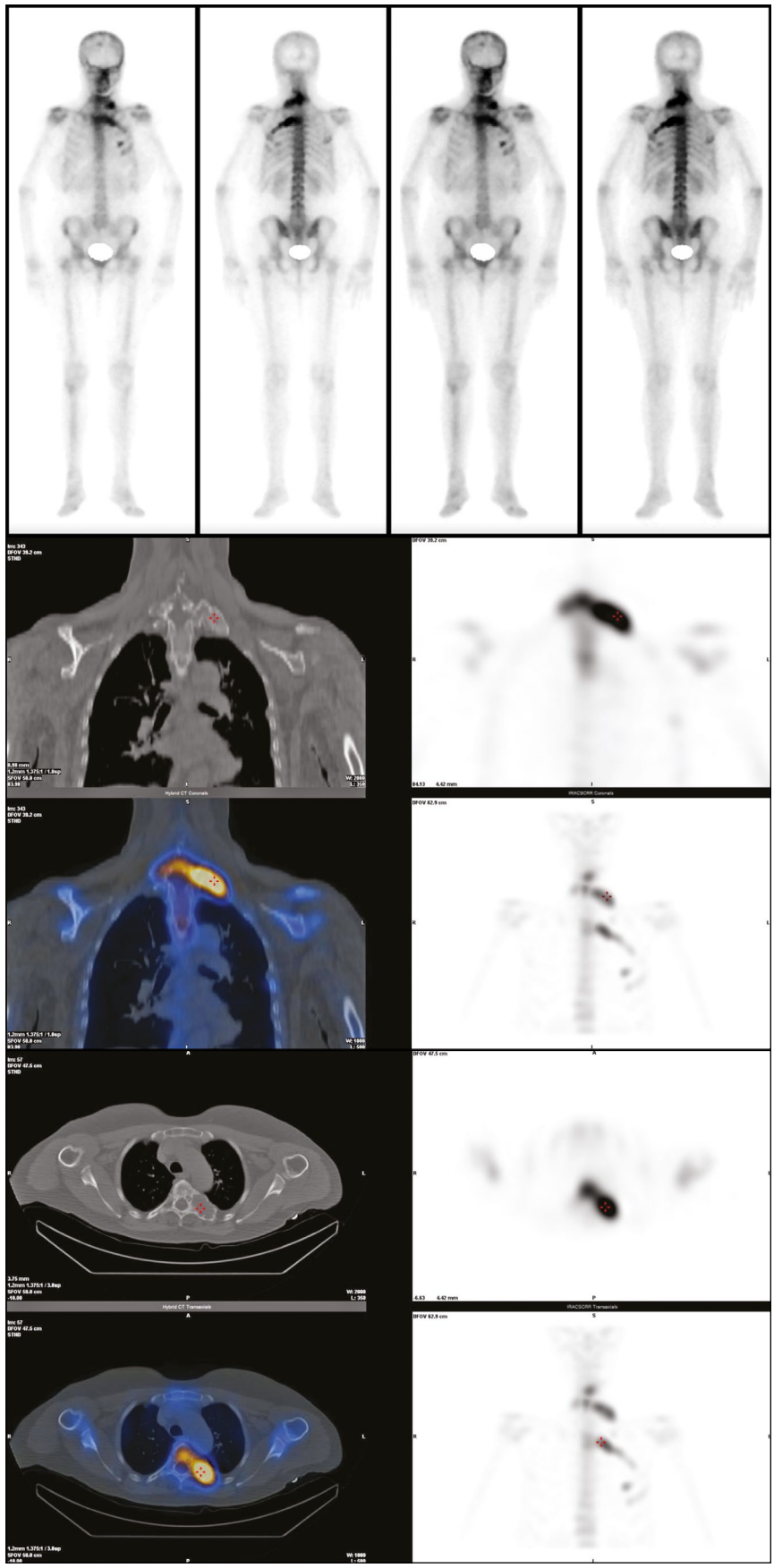

Fig. 5. The whole body SPECT-CT confirmed the involvement of the above-mentioned bone segments and no other particularly shows two areas of high pathological focal accumulation of the osteotropic tracer (99mTc-HDP) in the left paravertebral side (D1 and D5-fifth left rib).

DOI: https://doi.org/10.17816/DD88605

on the number of affected bones and its association to endocrine alterations in monostotic, polyostotic, and Albright's disease. A congenital etiology is suggested and pathologic fractures are the most frequently associated complications.

Herein, presented a case of an adult female patient with a long story of unexplained cervical and dorsal pain.

Thanks to a multidisciplinary approach and integrated imaging, which allowed us to exclude the neoplastic nature of bone injuries, orienting our intuition toward the diagnostic suspicion of polyostotic FD was possible, which was confirmed by histological examination.

ADDITIONAL INFORMATION

Funding source. This article was not supported by any external sources of funding.

Competing interests. The authors declare no explicit and potential conflicts of interest associated with the publication of this article.

Authors' contribution. All 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.

Consent for publication. Informed written consent was taken from the subject of discussion before submission.

REFERENCES

1. Neville BW, Damm DD, Allen CM, Bouquot JE. Bone pathology. In: Neville BW, Damm DD, Allen CM, Bouquot JE, editors. Oral and maxillofacial pathology. Philadelphia, PA: WB Saunders Company; 2002. P. 553–557.

2. Iseri PK, Efendi H, Demirci A, Komsuoglu S. Fibrous dysplasia of the cranial bones: a case report and review of the literature. *Yale J Biol Med.* 2005;78(3):141–145.

3. Lustig LR, Holliday MJ, McCarthy FF, Nager GT. Fibrous dysplasia involving the skull base and temporal bone. *Arch Otolaryngol Head Neck Surg.* 2001;127(10):1239–1247. doi: 10.1001/archotol.127.10.1239

4. Chapurlat RD, Orcel P. Fibrous dysplasia of bone and McCune-Albright syndrome. *Best Pract Res Clin Rheumatol*. 2008;22(1):55–69. doi: 10.1016/j.berh.2007.11.004

5. Feller L, Wood N, Khammissa R, et al. The nature of fibrous dysplasia. *Head Face Med*. 2009;5:22. doi: 10.1186/1746-160X-5-22

6. Riminucci M, Kuznetsov SA, Cherman N, et al. Osteoclastogenesis in fibrous dysplasia of bone: in situ and in vitro analysis of IL-6 expression. *Bone*. 2003;33(3):434–442. doi: 10.1016/s8756-3282(03)00064-4

7. Kransdorf MJ, Moser RP, Gilkey FW. Fibrous dysplasia. *Radiographics*. 1990;10(3):519–537. doi: 10.1148/radiographics.10.3.2188311

8. Bhattacharyya N, Wiench M, Dumitrescu C, et al. Mechanism of FGF23 processing in fibrous dysplasia. *J Bone Miner Res*. 2012;27(5):1132–1141. doi: 10.1002/jbmr.1546

9. Yamamoto T, Imanishi Y, Kinoshita E, et al. The role of fibroblast growth factor 23 for hypophosphatemia and abnormal regulation of vitamin D metabolism in patients with McCune-Albright syndrome. *J Bone MinerMetab*. 2005;23(3):231–237. doi: 10.1007/s00774-004-0589-9

СПИСОК ЛИТЕРАТУРЫ

1. Neville B.W., Damm D.D., Allen C.M., Bouquot J.E. Bone pathology. In: Neville BW, Damm DD, Allen CM, Bouquot JE, editors. Oral and maxillofacial pathology. Philadelphia, PA: WB Saunders Company, 2002. P. 553–557.

2. Iseri P.K., Efendi H., Demirci A., Komsuoglu S. Fibrous dysplasia of the cranial bones: a case report and review of the literature // Yale J Biol Med. 2005. Vol. 78, N 3. P. 141–145.

3. Lustig L.R., Holliday M.J., McCarthy F.F., Nager G.T. Fibrous dysplasia involving the skull base and temporal bone // Arch Otolaryngol Head Neck Surg. 2001. Vol. 127, N 10. P. 1239–1247. doi: 10.1001/archotol.127.10.1239

4. Chapurlat R.D., Orcel P. Fibrous dysplasia of bone and McCune-Albright syndrome // Best Pract Res Clin Rheumatol. 2008. Vol. 22, N 1. P. 55–69. doi: 10.1016/j.berh.2007.11.004

5. Feller L., Wood N., Khammissa R., et al. The nature of fibrous dysplasia // Head Face Med. 2009. Vol. 5. P. 22. doi: 10.1186/1746-160X-5-22

6. Riminucci M., Kuznetsov S.A., Cherman N., et al. Osteoclastogenesis in fibrous dysplasia of bone: in situ and in vitro analysis of IL-6 expression // Bone. 2003. Vol. 33, N 3. P. 434–442. doi: 10.1016/s8756-3282(03)00064-4

7. Kransdorf M.J., Moser R.P., Gilkey F.W. Fibrous dysplasia // Radiographics. 1990. Vol. 10, N 3. P. 519–537. doi: 10.1148/radiographics.10.3.2188311

8. Bhattacharyya N., Wiench M., Dumitrescu C., et al. Mechanism of FGF23 processing in fibrous dysplasia // J Bone Miner Res. 201. Vol. 227, N 5. P. 1132–1141. doi: 10.1002/jbmr.1546

9. Yamamoto T., Imanishi Y., Kinoshita E., et al. The role of fibroblast growth factor 23 for hypophosphatemia and abnormal regulation of vitamin D metabolism in patients with McCune–Albright syndrome // J Bone MinerMetab. 2005. Vol. 23, N 3. P. 231–237. doi: 10.1007/s00774-004-0589-9

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DOI: https://doi.org/10.17816/DD100281

Миксома створки митрального клапана

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АННОТАЦИЯ

Первичные опухоли сердца являются крайне редким заболеванием, распространённость их в популяции, по разным данным, составляет 0,0017–0,03%.

В большинстве случаев опухоли сердца имеют доброкачественный характер, более половины подобных образований представлены миксомами сердца. Миксома, поражающая створки клапанов сердца, является редчайшей патологией. Впервые подобный вариант изменений был описан в 1934 году. Наиболее часто миксомы сердца локализуются на уровне межпредсердной перегородки в непосредственной близости от овальной ямки. Одним из типичных признаков миксом является узкая ножка и неровная поверхность, что обусловливает риск эмболии. Эхокардиографическое исследование и магнитно-резонансная томография на настоящий момент являются методами выбора при подозрении на объёмное образование сердца. При подобной нетипичной локализации опухоли обязательна дифференциальная диагностика с вегетациями на клапанах сердца и папиллярной фиброэластомой.

Представлен случай пожилой пациентки с жалобами на одышку, колющие боли в левой половине грудной клетки, аритмии, в анамнезе которой имелась аспирационная пневмония, экстирпация пищевода с эзофагогастропластикой желудка. При обследовании у пациентки выявлены пароксизмальная форма фибрилляции предсердий (вне пароксизма), хроническая сердечная недостаточность, артериальная гипертензия. Клинические данные больной были нехарактерны для инфекционного эндокардита с вегетациями на клапанах. Благодаря эхокардиографическому исследованию и мультиспиральной компьютерной томографии с болюсным контрастным усилением на атриальной поверхности задней створки митрального клапана обнаружено дополнительное объёмное образование размерами 5–9 мм, округлой формы, с чёткими неровными контурами, смещаемое вместе со створкой клапана в полость левого желудочка в систолу предсердий. Оптимальная визуализация образования получена в режиме Fiesta-CINE в модифицированных двух- и четырёхкамерных проекциях. Пациентке выполнено удаление образования с шовной пластикой митрального клапана в условиях искусственного кровообращения. При гистологическом исследовании образования получена характерная морфологическая картина миксомы. Послеоперационный период протекал без осложнений.

Ключевые слова: миксома; митральный клапан; компьютерная томография; магнитно-резонансная томография.

Как цитировать

Вишнякова М.В. (мл)., Абраменко А.С., Вишнякова М.В., Шумаков Д.В. Миксома створки митрального клапана // *Digital Diagnostics*. 2022. Т. 3, № 1. С. 64–70. DOI: https://doi.org/10.17816/DD100281

Рукопись получена: 07.02.2022 **Рукопись одобрена:** 07.04.2022 **Опубликована:** 13.04.2022

DOI: https://doi.org/10.17816/DD100281

Cardiac myxoma originating from mitral valve leaflet

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ABSTRACT

Primary heart tumors are an extremely rare disease, with a prevalence of 0.0017%–0.03% in the population according to various data.

Heart tumors are benign in most cases, and more than half of such formations are represented by cardiac myxomas. Myxoma is the most common primary cardiac tumor; however, its number is extremely small among the general population. Myxoma that affects the cardiac valves is a rare pathology. For the first time, such variance of changes was described in 1934. Most often, cardiac myxomas are localized at the atrial septum level near the oval fossa. One of the typical signs of myxoma is a narrow leg and an uneven surface, which causes the risk of embolism. Echocardiographic examination and magnetic resonance imaging are currently the methods of choice when suspecting the presence of volumetric heart formation. With such atypical tumor localization, conducting a mandatory differential diagnosis with heart valve vegetations and papillary fibroelastoma is necessary.

Herein, presented an elderly patient with complaints of shortness of breath, stabbing pains in the left half of the chest, and arrhythmias with a history of aspiration pneumonia and esophageal extirpation with stomach esophagogastroplasty. During the examination, the patient revealed a paroxysmal form of atrial fibrillation (outside of paroxysm), chronic heart failure, and arterial hypertension. The clinical data of the patient were not characteristic enough for the possibility of infectious endocarditis with valvular vegetations. The echocardiographic examination and multispiral computed tomography with bolus contrast enhancement on the atrial surface of the posterior flap of the mitral valve revealed an additional volume formation of 5–9 mm in size, rounded shape, with clear uneven contours, together with the valve flap into the left ventricular cavity into the atrial systole. The formation was optimally visualized using the Fiesta-CINE mode in modified two- and four-chamber projections. The formation was removed with suture plasty of the mitral valve in artificial blood circulation conditions. The histological examination of the formation revealed a morphological characteristic of myxoma. The postoperative period proceeded without complications.

Keywords: case report; myxoma; mitral valve; computed tomography; magnetic resonance imaging.

To cite this article

Vishniakova MV (Jr), Abramenko AS, Vishnyakova MV, Shumakov DV. Cardiac myxoma originating from mitral valve leaflet. *Digital Diagnostics.* 2022;3(1):64–70. DOI: https://doi.org/10.17816/DD100281

Received: 07.02.2022 **Accepted:** 07.04.2022 **Published:** 13.04.2022

DOI: https://doi.org/10.17816/DD100281

二尖瓣粘液瘤

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简评

原发性心脏肿瘤是一种极为罕见的疾病，根据各种来源，其在人群中的患病率为0.0017 - 0.03%。

在大多数情况下，心脏肿瘤为良性，其中一半以上为心脏粘液瘤。影响瓣叶的粘液瘤是一种非常罕见的病理现象。1934年首次描述了这种类型的变化。大多数情况下，心脏粘液瘤位于卵圆窝附近的房间隔水平。粘液瘤的典型症状之一是狭窄的腿和不平整的表面，这会导致栓塞的风险。超声心动图和磁共振成像目前是疑似心脏肿块的选择法。在此类非典型的肿瘤定位的情况下，必须与心脏瓣膜上的赘生物和乳头状弹力纤维瘤进行鉴别诊断。

介绍了一名老年患者的病例，主诉喘息，左胸刺痛，心律失常，此患的病史包括吸引性肺炎，食管胃吻合术，食道摘除术。患者检查发现阵发性心房颤动（阵发外）、慢性心力衰竭、动脉高血压。患者的临床资料不具感染性心内膜炎特征，瓣膜上有赘生物。超声心动图和多螺旋计算机断层扫描在二尖瓣后叶的心房表面进行快速对比增强，显示额外的体积形成 5-9 mm，圆形，轮廓明显不均匀，与瓣叶一起移位进入心房收缩期左心室腔。在Fiesta-CINE模式下，在修改后的两室和四室投影中获得了肿块的最佳可视化。患者在体外循环下接受了肿块的切除，并进行了二尖瓣成形术。肿块的组织学检查揭示了粘液瘤的特征性形态情况。术后期间一切顺利。

关键词：粘液瘤； 二尖瓣； CT扫描；磁共振成像。

To cite this article
Vishniakova MV (Jr), Abramenko AS, Vishnyakova MV, Shumakov DV. 二尖瓣粘液瘤. *Digital Diagnostics.* 2022;3(1):64–70.
DOI: https://doi.org/10.17816/DD100281

收到： 07.02.2022 **接受：** 07.04.2022 **发布日期：** 13.04.2022

INTRODUCTION

Primary cardiac tumor is an extremely rare disease. According to different data, their prevalence in the population is 0.0017%–0.03% [1, 2]. Cardiac tumors are benign in most cases, of which more than half are represented by cardiac myxomas [3–7].

Myxomas are believed to originate from residual fragments of multipotent mesenchymal cells in the endocardium. Cardiac myxomas are most commonly located at the interatrial septum level near the oval fossa. One of the typical features of myxomas is a narrow pedicle and an irregular surface, which leads to the risk of embolism in this type of tumor.

CLINICAL CASE

Patient T, a 64-year-old female patient, was admitted with complaints of dyspnea, stabbing pain in the left side of the chest, and arrhythmia. Her medical history included aspiration pneumonia and esophageal extirpation with gastric esophagogastroplasty.

Physical, laboratory, and instrumental findings

The examination revealed a paroxysmal form of atrial fibrillation (in a paroxysm-free period), chronic IIA heart failure (functional class II), and grade 3 arterial hypertension.

The echocardiographic picture demonstrated mild mitral valve insufficiency and additional posterior mitral valve leaflet mass up to 9 mm in size located on the pedicle.

Multispiral computed tomography with bolus contrast enhancement on a Philips iCT 256-slice ECG-synchronized device and magnetic resonance imaging (MRI) of the heart on a General Electric Optima MR450w GEM 1.5 T machine were performed for a detailed mass, thoracic organs, and coronary artery assessments.

Computed tomography revealed no additional volumetric masses or areas of inflammatory infiltration in the pulmonary tissue. The stomach was visualized in the bed of the removed esophagus without pathological volumetric masses at this level. The examination revealed no pronounced coronary artery narrowings. An additional volumetric mass measuring 5–9 mm, round in shape, with clear irregular contours, and displaced together with the valve leaflet into the left ventricular cavity during atrial systole was visualized on the atrial surface of the posterior mitral valve leaflet (Fig. 1).

A series of Fiesta-CINE functional examinations in standard axes (two- and four-chamber long axis with 8 mm slice thickness and 0 mm inter-slice interval) was performed after a series of panoramic and axial chest scans in cardiac MRI. Tumor visualization in standard cardiac MRI views was difficult because of the small size of the mass. Optimal mass visualization was obtained in the modified Fiesta-CINE two- and four-chamber views (Fig. 2).

A small round-shaped mass (5 × 8 mm in size) on the posterior mitral valve leaflet on the left atrial side was confirmed. The examination was performed before and after early and delayed contrast enhancement using T2 SS, FSE, and FS pulse sequences—T2 WI with signal suppression from blood and adipose tissue—and PS MDE (PSIR), TI 250 ms

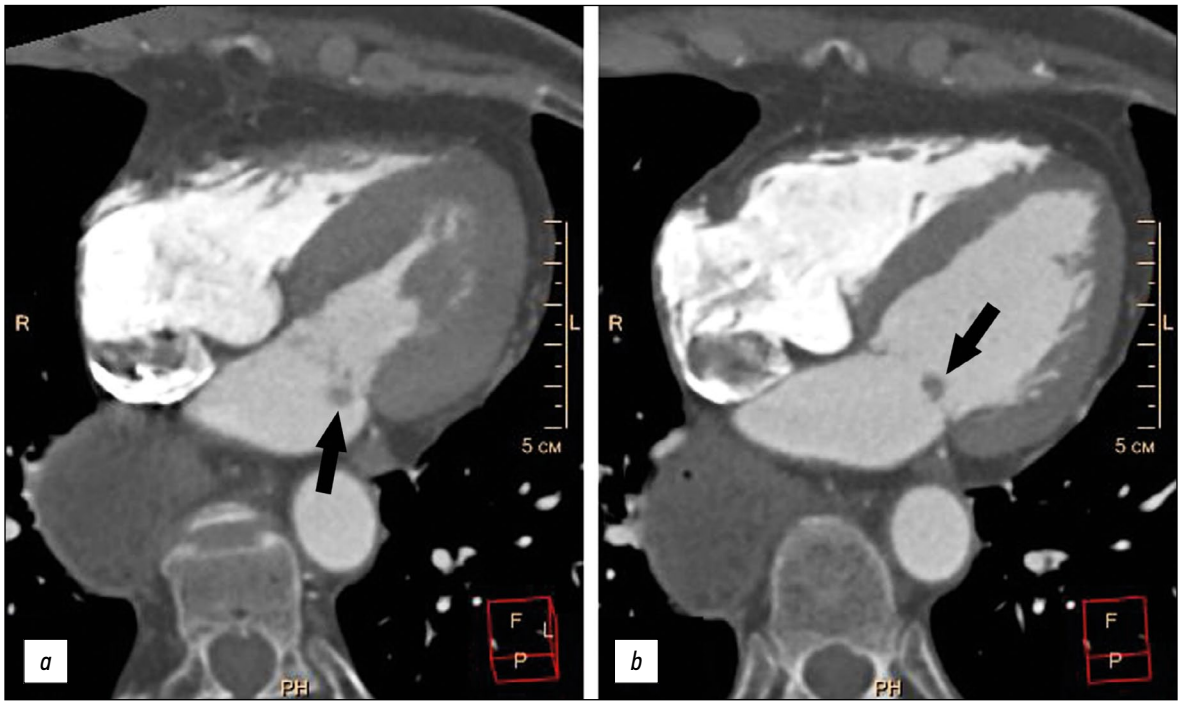

Fig. 1. Multispiral computed tomography of thoracic organs, four-chamber planar heart reconstruction, arterial contrast phase: *a*, left ventricular systolic phase; *b*, left ventricular diastolic phase. Additional rounded structure on the posterior mitral valve leaflet (black arrows).

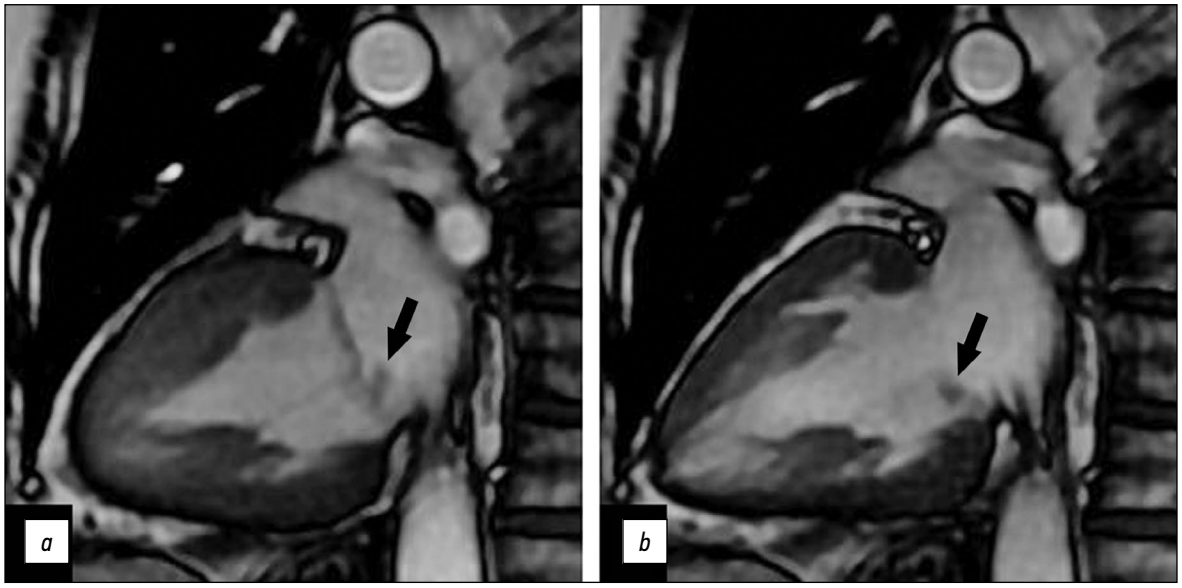

Fig. 2. Magnetic resonance imaging of the heart, two-chamber view: *a*, left ventricular systolic phase; *b*, left ventricular diastolic phase. Additional mass on the posterior mitral valve leaflet (black arrows).

postcontrast images to obtain tissue mass characteristics. A contrast agent (gadopentetic acid) was injected at 0.2 ml/kg body weight.

After delayed contrast enhancement, an increased signal was observed compared to the native T1-WI series (Fig. 3).

The patient underwent mass excision with mitral valve suture plasty under cardiopulmonary bypass. Moreover, the postoperative period proceeded without any complications.

The histological study of the mass showed a characteristic morphological picture of a myxoma.

DISCUSSION

Myxoma is the most common primary cardiac tumor; however, the number of cases in the general population is extremely small. Moreover, myxoma, which affects the heart valve leaflets, is the rarest pathology. Such changed variants were first described in 1934 [8].

According to foreign literature, the number of described cases is precisely unknown; however, the approximate prevalence of this localization among myxomas is approximately 1.5% [9, 10].

Echocardiographic examination and MRI are the methods of choice for suspected cardiac masses. Differential diagnosis with vegetation on the heart valves and papillary fibroelastoma is necessary for an atypical tumor localization [5, 6].

The vegetations are more frequently located on the atrial surface of the mitral valve, as demonstrated in our clinical case; however, imaging techniques identified a pedicle that is more indicative of a mass. MRI with delayed contrast revealed vegetations with uneven accumulation of contrast agent,

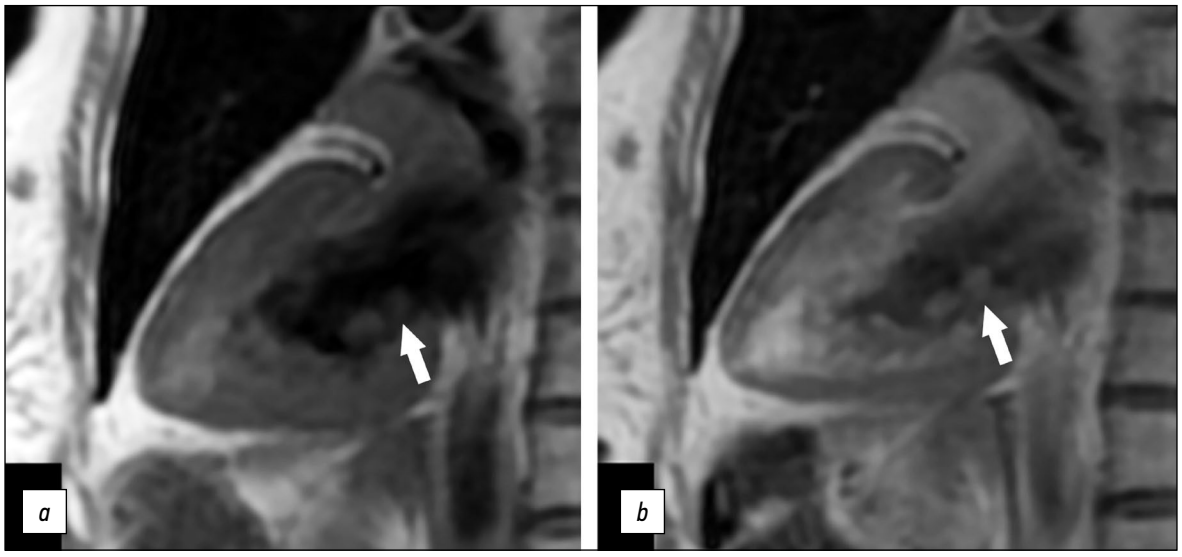

Fig. 3. Magnetic resonance imaging of the heart, two-chamber view: *a*, native T1-WI series, TSE; *b*, postcontrast T1-WI series, TSE. Additional mass on the posterior mitral valve leaflet (white arrows).

which complicated the differential diagnosis of vegetations and masses [11, 12], whereas no clinical data for infectious endocarditis with valves vegetations were available in the described case.

Papillary cardiac fibroelastoma is the second most common benign primary tumor. This mass is characterized by its small size (usually <15 mm), rounded shape, and short pedicle. Typical localization includes the atrial surface of the mitral valve or the aortic surface of the aortic valve [2, 13].

CONCLUSIONS

The reported clinical case did not reveal any specific characteristics of cardiac myxoma despite the use of modern imaging techniques. However, the presence of a mobile mass of tumorous nature required surgical treatment, after which histological examination allowed a myxoma diagnosis of an extremely rare localization.

ADDITIONAL INFORMATION

Funding source. The article had no sponsorship.

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

Authors' contribution. All 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.

Consent for publication. Written consent was obtained from the patient for publication of relevant medical information and all of accompanying images within the manuscript.

REFERENCES

1. Centofanti P, Di Rosa E, Deorsola L, et al. Primary cardiac tumors: early and late results of surgical treatment in 91 patients. *Ann Thorac Surg*. 1999;68(4):1236–1241. doi: 10.1016/s0003-4975(99)00700-6

2. Hoey ET, Shahid M, Ganeshan A, et al. MRI assessment of cardiac tumours: part 1, multiparametric imaging protocols and spectrum of appearances of histologically benign lesions. *Quant Imaging Med Surg*. 2014;4(6):478–488. doi: 10.3978/j.issn.2223-4292.2014.11.23

3. Zheltovsky YV, Batekh VI, Podkamenny VA, et al. Diagnosis and treatment with a heart mix. *Acta Biomedica Sci*. 2017;2(6):21–26. (In Russ).

4. Lam KY, Dickens P, Chan AC. Tumors of the heart. A 20-year experience with a review of 12,485 consecutive autopsies. *Arch Pathol Lab Med*. 1993;117(10):1027–1031.

5. Li X, Chen Y, Liu J, et al. Cardiac magnetic resonance imaging of primary cardiac tumors. *Quant Imaging Med Surg*. 2020;10(1):294–313. doi: 10.21037/qims.2019.11.13

6. Aggeli C, Dimitroglou Y, Raftopoulos L, et al. Cardiac masses: the role of cardiovascular imaging in the differential diagnosis. *Diagnostics*. 2020;10(12):1088. doi: 10.3390/diagnostics10121088

7. Kallstrom E, Kallus E, Erbe K, et al. Differentiation of left atrial myxomas by multimodality imaging. *J Diagnostic Med Sonography*. 2020;36(1):52–63. doi: 10.1177/8756479319872153

8. Jaleski TC. Myxoma of the heart valves: report of a case. *Am J Pathol*. 1934;10(3):399–406.

9. Wold LE, Lie JT. Cardiac myxomas: a clinicopathologic profile. *Am J Pathol*. 1980;101(1):219–240.

10. Yoon JH, Kim JH, Sung YJ, et al. Cardiac myxoma originating from the anterior mitral valve leaflet. *J Cardiovasc Ultrasound*. 2011;19(4):228–231. doi: 10.4250/jcu.2011.19.4.228

11. Rajiah P, Moore A, Saboo S, et al. Multimodality imaging of complications of cardiac valve surgeries. *Radio Graphics*. 2019;39(4):932–956. doi: 10.1148/rg.2019180177

12. El Ouazzani J, Jandou I, Christophe Thuaire I. Thrombus or vegetation? Importance of cardiac MRI as a diagnostic tool based on case report and literature review. *Ann Med Surg (Lond)*. 2020;60:690–694. doi: 10.1016/j.amsu.2020.12.007

13. Anand S, Sydow N, Janardhanan R. Papillary fibroelastoma diagnosed through multimodality cardiac imaging: a rare tumour in an uncommon location with review of literature. *BMJ Case Rep*. 2017;2017:bcr2017219327. doi: 10.1136/bcr-2017-219327

СПИСОК ЛИТЕРАТУРЫ

1. Centofanti P., Di Rosa E., Deorsola L., et al. Primary cardiac tumors: early and late results of surgical treatment in 91 patients // Ann Thorac Surg. 1999. Vol. 68, N 4. P. 1236–1241. doi: 10.1016/s0003-4975(99)00700-6

2. Hoey E.T., Shahid M., Ganeshan A., et al. MRI assessment of cardiac tumours: part 1, multiparametric imaging protocols and spectrum of appearances of histologically benign lesions // Quant Imaging Med Surg. 2014. Vol. 4, N 6. P. 478–488. doi: 10.3978/j.issn.2223-4292.2014.11.23

3. Желтовский Ю.В., Батеха В.И., Подкаменный В.А., и др. Диагностика и лечение миксом сердца // Acta Biomedica Sci. 2017. Т. 2, № 6. С. 21–26.

4. Lam K.Y., Dickens P., Chan A.C. Tumors of the heart. A 20-year experience with a review of 12,485 consecutive autopsies // Arch Pathol Lab Med. 1993. Vol. 117, N 10. P. 1027–1031.

5. Li X., Chen Y., Liu J., et al. Cardiac magnetic resonance imaging of primary cardiac tumors // Quant Imaging Med Surg. 2020. Vol. 10, N 1. P. 294–313. doi: 10.21037/qims.2019.11.13

6. Aggeli C., Dimitroglou Y., Raftopoulos L., et al. Cardiac masses: the role of cardiovascular imaging in the differential diagnosis // Diagnostics. 2020. Vol. 10, N 12. P. 1088. doi: 10.3390/diagnostics10121088

7. Kallstrom E., Kallus E., Erbe K., et al. Differentiation of left atrial myxomas by multimodality imaging // J Diagnostic Med Sonography. 2020. Vol. 36, N 1. P. 52–63. doi: 10.1177/8756479319872153

8. Jaleski T.C. Myxoma of the heart valves: report of a case // Am J Pathol. 1934. Vol. 10, N 3. P. 399–406.
9. Wold L.E., Lie J.T. Cardiac myxomas: a clinicopathologic profile // Am J Pathol. 1980. Vol. 101, N 1. P. 219–240.
10. Yoon J.H., Kim J.H., Sung Y.J., et al. Cardiac myxoma originating from the anterior mitral valve leaflet // J Cardiovasc Ultrasound. 2011. Vol. 19, N 4. P. 228–231. doi: 10.4250/jcu.2011.19.4.228
11. Rajiah P., Moore A., Saboo S., et al. Multimodality imaging of complications of cardiac valve surgeries // RadioGraphics. 2019. Vol. 39, N 4. P. 932–956. doi: 10.1148/rg.2019180177
12. El Ouazzani J., Jandou I., Christophe Thuaire I. Thrombus or vegetation? Importance of cardiac MRI as a diagnostic tool based on case report and literature review // Ann Med Surg (Lond). 2020. Vol. 60. P. 690–694. doi: 10.1016/j.amsu.2020.12.007
13. Anand S., Sydow N., Janardhanan R. Papillary fibroelastoma diagnosed through multimodality cardiac imaging: a rare tumour in an uncommon location with review of literature // BMJ Case Rep. 2017. Vol. 2017. P. bcr2017219327. doi: 10.1136/bcr-2017-219327

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DOI: https://doi.org/10.17816/DD90282

Односторонний изолированный перелом крыловидного отростка клиновидной кости: клинический случай

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АННОТАЦИЯ

Переломы крыловидного отростка часто сочетаются с переломами по типу Ле-Фор и могут наблюдаться при других переломах лицевых костей, таких как переломы стенок лобных пазух и носо-глазнично-решётчатые переломы. Изолированные переломы крыловидного отростка встречаются крайне редко.

В отличие от переломов по типу Ле-Фор, которые необходимо лечить хирургическим путём с фиксацией нестабильных отломков для восстановления формы и функции и стабилизацией крыловидного отростка, изолированные переломы пластинок крыловидного отростка не требуют хирургического лечения.

В статье описывается редкий случай изолированного одностороннего перелома крыловидного отростка у 71-летней пациентки с черепно-мозговой травмой и гематомой у основания правой глазницы, полученными в результате потери сознания.

Компьютерная томография показала односторонний перелом пластинки крыловидного отростка справа с признаками эмфиземы в жевательно-челюстном пространстве с ипсилатеральной стороны. Кроме того, у пациентки выявлен перелом медиальной стенки вехрнечелюстной пазухи справа с признаками гемосинуса. Переломы основания черепа или повреждения твёрдой мозговой оболочки не обнаружены. Пациентка получала консервативное лечение.

Ключевые слова: переломы крыловидного отростка клиновидной кости; переломы по типу Ле-Фор; компьютерная томография.

Как цитировать

Balzano R.F., Testini V., Cammarota A., Guglielmi G. Односторонний изолированный перелом крыловидного отростка клиновидной кости: клинический случай // *Digital Diagnostics.* 2022. Т. 3, № 1. С. 71–77. DOI: https://doi.org/10.17816/DD90282

Рукопись получена: 13.12.2021 **Рукопись одобрена:** 01.02.2022 **Опубликована:** 09.03.2022

ЭКО•ВЕКТОР

DOI: https://doi.org/10.17816/DD90282

Unilateral isolated fracture of the pterygoid plate: a case report

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ABSTRACT

Pterygoid plate fractures are often associated with Le Fort fractures and accompanied by other facial fractures such as frontal sinus and naso-orbital-ethmoid fractures; isolated pterygoid plate fractures are extremely rare.

Le Fort fractures must be surgically treated with fixation of unstable fracture segments to re-establish bone form and function, and the pterygoid process must be surgically stabilized; however, surgical treatment is unnecessary in isolated pterygoid plate fractures.

Here, we report a rare case of isolated unilateral fracture of the pterygoid process in a 71-year-old female patient who had a syncopal episode with secondary head injury and a hematoma at the base of the right orbit.

A computed tomography scan showed unilateral right pterygoid plate fracture with signs of emphysema in the ipsilateral masticatory space. The patient also had a fracture of the medial wall of the right maxillary sinus with hemosine, but no fractures of the skull base or theca. She was treated conservatively.

Keywords: pterygoid plate fractures; Le Fort Fractures; computed tomography.

To cite this article
Balzano RF, Testini V, Cammarota A, Guglielmi G. Unilateral isolated fracture of the pterygoid plate: a case report. *Digital Diagnostics.* 2022;3(1):71–77. DOI: https://doi.org/10.17816/DD90282

Received: 13.12.2021 **Accepted:** 01.02.2022 **Published:** 09.03.2022

DOI: https://doi.org/10.17816/DD90282

单侧孤立性翼突板骨折：临床病例

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简评

翼突骨折通常与勒福(Le Fort)分型骨折相关，并且可能与其他面部骨折一起发生，例如额窦壁骨折和鼻眶筛骨骨折。孤立的翼突骨折极为罕见。

与勒福(Le Fort)分型骨折不同，必须通过手术固定不稳定的碎片以恢复翼突的形态和功能并稳定翼突，孤立的翼板骨折不需要手术治疗。

本文描述了一名71岁女性患者的蝶骨翼突单侧孤立性骨折的罕见病例，该患者颅脑外伤，右眼窝底部血肿，由意识丧失引起。

计算机断层扫描显示右侧翼突板单侧骨折，同侧咀嚼上颌间隙有肺气肿迹象。此外，该患者还发现了右侧上颌窦侧壁骨折，有血窦征象。未检测到颅底骨折或硬脑膜损伤。患者接受了保守治疗。

关键词：蝶骨翼突骨折； Le Fort型骨折； CT扫描。

To cite this article
Balzano RF, Testini V, Cammarota A, Guglielmi G. 单侧孤立性翼突板骨折：临床病例. *Digital Diagnostics*. 2022;3(1):71–77.
DOI: https://doi.org/10.17816/DD90282

收到： 13.12.2021 **接受：** 01.02.2022 **发布日期：** 09.03.2022

BACKGROUND

Pterygoid plate fractures are usually associated with all Le Fort midface fractures (Le Fort I, II, and III, according to the plane of injury).

Isolated fractures of the pterygoid plate are extremely rare. Herein, we present a case of an isolated fracture of the right pterygoid plate in an adult female.

DESCRIPTION OF THE CASE

A 71-year-old female patient presented to the emergency department for an head injury secondary to a syncopal episode with a consequent fall to the ground. Her general physical examination results were unremarkable. No facial palsy was observed. Previous medical and surgical histories were noncontributory and she had not been unconscious.

The patient exhibited a marked swelling of the right side of the face and had a hematoma at the base of the right orbit. The skin of the right cheek and zygomatic region displayed some degree of paresthesia.

The patient was referred to the radiology department for noncontrast-enhanced high-resolution computed tomography (CT) on a 64-slice scanner, which showed unilateral right pterygoid plate fracture with signs of emphysema in the ipsilateral masticatory space (Fig. 1a, 1b). The CT investigation also documented the fracture of the medial wall of the right maxillary sinus with hemosine (Fig. 2a, 2b, 2c).

Fractures of the skull base or theca were not evident, nor were there any changes in the cerebral nerve tissue density. Surgery treatment was unnecessary.

DISCUSSION

The main causes of facial fractures are motor vehicular accidents, assaults, falls, sports injuries, gun-shot injuries, etc [1].

Knowledge of the musculoskeletal system of the facial skeleton is important for diagnosing facial fractures. In practice, between the buttresses of the face that represent the areas of relatively increased bone thickness that support the functional units of the face, the posterior maxillary buttress is found, which is a bone column at the pterygomaxillary junction [2], a site of several fracture types, including the Le Fort fractures, as first described in 1901 [3].

These fractures are classified into 3 distinct groups based on the fracture direction as horizontal, pyramidal, or transverse.

The Le Fort I fracture involves the nasal cavity anterolateral margin. This type of fracture may result from a force directed in a downward direction against the upper teeth.

In Le Fort II fractures, the fracture line extends to the lower orbital margins, which results from a force to the lower or mid maxilla.

The Le Fort III fractures involve the zygomatic arch and are caused by the nasal bridge and upper maxilla impact [4].

The pterygoid plate is involved in all types of Le Fort fractures and may result in a pterygomaxillary separation [5]. Le Fort fractures are often associated with other facial fractures, such as frontal sinus fractures, and with naso-orbital-ethmoid fractures [6].

Isolated pterygoid plate fractures are extremely rare. The study of Garg et al. [7] revealed that approximately two-thirds

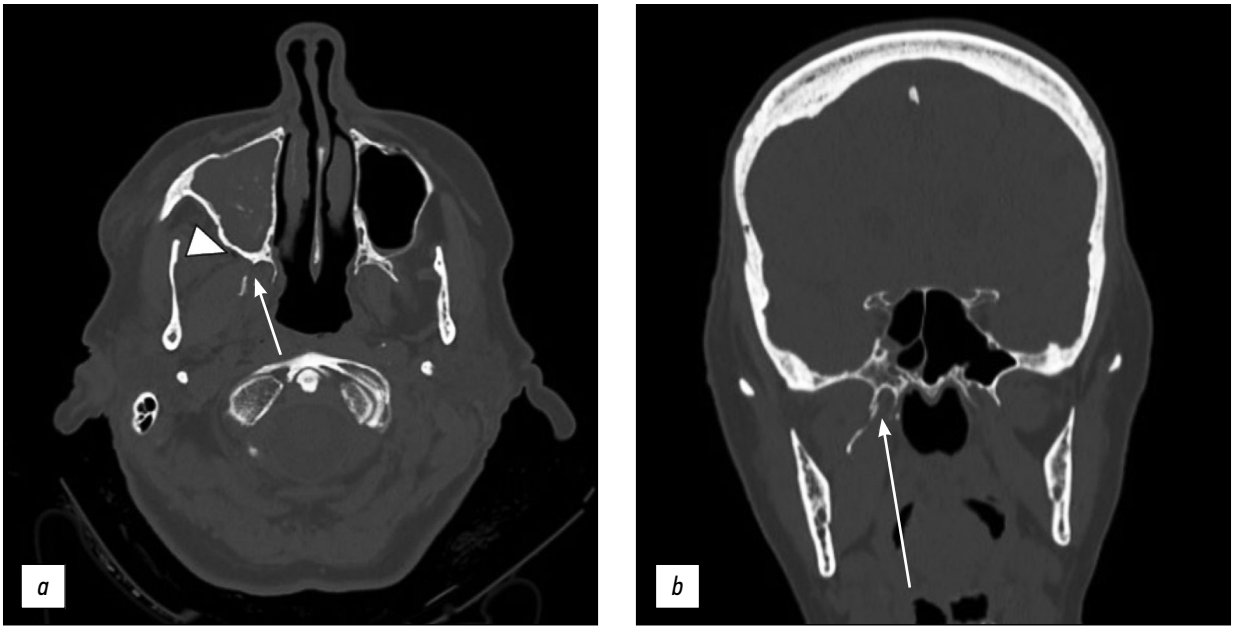

Fig 1: Axial (*a*) and coronal (*b*) CT scan with a bone window showing unilateral right pterygoid plate fracture (arrows) with air bubbles of emphysema (arrowheads) in the ipsilateral masticatory space.

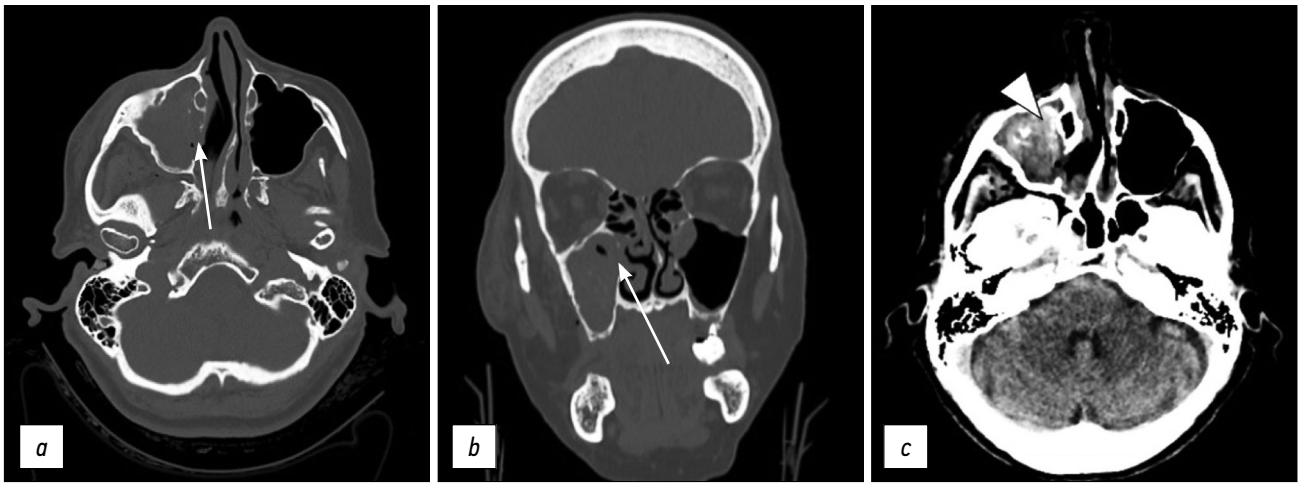

Fig 2: Axial (*a*) and coronal (*b*) CT scan with bone window documents the fracture of the medial wall of the right maxillary sinus (arrows). Soft window (*c*) shows hemosine in the right maxillary sinus (arrowhead).

of patients with pterygoid plate fractures had an associated Le Fort fracture. Therefore, fractures of the pterygoid plate do not necessarily equate to the presence of a Le Fort fracture. Pterygoid plate fractures are often an extension of the skull base and vault fractures or the likely consequence of impingement caused by a displaced mandible fracture [7]. In 2014, Anh Q. Truong et al. [8] described an association between lateral pterygoid plate fractures and mandibular fractures. A retrospective study by Garg et al. [7] revealed that 78 patients (just over a third) did not have Le Fort fractures out of 209 patients with pterygoid plate fractures, whereas other fractures were found in these patients, such as fractures of the sphenotemporal buttress, temporal bone, and zygomatic–maxillary complex, and displaced mandibular fractures. Similar results have been reported from other studies [9].

In 2017, Surya [6] described a case of an isolated fracture of the pterygoid plate caused by a foreign body penetration.

There are several mechanisms of injury to the pterygoid plate by a direct traumatic force (penetrating trauma) or indirect (traction of the pterygoid muscle) that propagate along with the areas of weakness within the facial structures. In sphenotemporal buttress fractures, connections with the temporal, zygomatic, and sphenoid bones are lost and the fracture line extends to the pterygoid plate [8].

Pterygoid plaques are the site of origin of the medial and lateral pterygoid muscles, [10] thus any trauma to the pterygoid plaques could potentially cause discomfort with chewing, jaw movement, and speech.

Le Fort fractures must be surgically treated after stabilizing the patient's vital signs. Le Fort fractures require unstable fracture segment fixation on stable structures [11]. The management goals are form and function restoration.

In Le Fort fractures, the pterygoid process must also be surgically stabilized [12]. The pterygoid plate is a structure that is not easily accessible under general conditions due to its positional characteristics. The lateral pterygoid muscle is attached to the posterior surface of the pterygoid plates. Healing of the intentionally fractured plate could have several problems due to these anatomical features. Gradual displacement or movement of a fractured piece of the pterygoid plate can occur due to the action of the lateral pterygoid muscle. Furthermore, considering the presence of the vessels in proximity to the pterygoid process, particularly the descending palatine artery in the anterior part and the pterygoid venous plexus in the posterior part, is necessary. The blood vessels wrapped around the bone must be properly detached and managed due to the high risk of massive bleeding if the plate fracture is inappropriately managed; therefore, correct osteotomy direction and proper pterygoid plate separation are required [12].

Our case is therefore a rare example of an isolated pterygoid plate fracture without associated Le Fort or mandibular fractures. Our patient presented only the fracture of the medial wall of the ipsilateral maxillary sinus.

Thin-slice high-resolution CT imaging is the gold standard for diagnosing facial fractures and making decisions for treatment. The axial and reformatted CT images also show the degree of bone fragment displacement and contiguous soft tissue alterations [13].

Isolated pterygoid plate fractures are not treated surgically. For patients with isolated pterygoid plate fracture, a soft diet is recommended until the fracture heals to avoid jaw pain [14].

CONCLUSION

Approximately, one-third of pterygoid plate fractures are unrelated to Le Fort fractures but are present alone or associated with other facial skeleton fractures. The radiologist's knowledge of these other types of fracture is important for making a differential diagnosis in patients with facial trauma. CT imaging is essential to diagnose fractures, describe the fragment location in displaced fractures, and guide the surgeon in choosing the treatment.

ADDITIONAL INFORMATION

Funding source. This publication was not supported by any external sources of funding.

Competing interests. Authors declare no explicit and potential conflicts of interests associated with the publication of this article.

Authors' contribution. All 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.

Consent for publication. Written consent was obtained from the patient for publication of relevant medical information and all of accompanying images within the manuscript.

REFERENCES

1. Boffano P, Roccia F, Zavattero E, et al. European Maxillofacial Trauma (EURMAT) project: a multicentre and prospective study. *J Craniomaxillofac Surg*. 2015;43(1):62–70. doi: 10.1016/j.jcms.2014.10.011

2. Winegar BA, Murillo H, Tantiwongkosi B. Spectrum of critical imaging findings in complex facial skeletal trauma. *Radiographics*. 2013;33(1):3–19. doi: 10.1148/rg.331125080

3. Le Fort R: Etude experimentale sur les fractures de la machoire superieure. *Rev Chir*. 1901;23:208–507.

4. Patel BC, Wright T, Waseem M. Le Fort Fractures. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.

5. Choi JW, Kim MJ. Treatment of panfacial fractures and three-dimensional outcome analysis: the occlusion first approach. *J Craniofac Surg*. 2019;30(4):1255–1258. doi: 10.1097/SCS.0000000000005528

6. Surya M, Soni P, Bharti R, Jamwal I. Isolated fracture of lateral pterygoid plate by penetrating foreign body — a rarity indeed. *Pol J Radiol*. 2017;82:137–140. doi: 10.12659/PJR.900407

7. Garg RK, Alsheik NH, Afifi AM, Gentry LR. Pterygoid plate fractures: not limited to Le Fort Fractures. *J Craniofac Surg*. 2015;26(6):1823–1825. doi: 10.1097/SCS.0000000000001901

8. Truong AQ, O'Brien DC, Strong EB, Dublin A. Lateral pterygoid plate fractures associated with mandible fractures. *JAMA Facial Plast Surg*. 2014;16(6):437–439. doi: 10.1001/jamafacial.2014.645

9. Unger JM, Gentry LR, Grossman JE. Sphenoid fractures: prevalence, sites, and significance. *Radiology*. 1990;175(1):175–180. doi: 10.1148/radiology.175.1.2315477

10. Murray GM, Phanachet I, Uchida S, et al. The human lateral pterygoidmuscle: a review of some experimental aspects and possible clinical relevance. *Aust Dent J*. 2004;49(1):2–8. doi: 10.1111/j.1834-7819.2004.tb00042.x

11. Phang SY, Whitehouse K, Lee L, et al. Management of CSF leak in base of skull fractures in adults. *Br J Neurosurg*. 2016;30(6):596–604. doi: 10.1080/02688697.2016.1229746

12. Choi NR, Shin SH, Kim SS, et al. Healing pattern of intentional pterygoid plate fracture after posterior movement of maxilla through Le Fort I osteotomy. J Craniomaxillofac Surg. 2018;46(10):1828–1833. doi: 10.1016/j.jcms.2018.08.003

13. Kaeppler G, Cornelius CP, Ehrenfeld M, Mast G. Diagnostic efficacy of cone-beam computed tomography for mandibular fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2013;116 (l):98–104. doi: 10.1016/j.oooo.2013.04.004

14. De Oliveira DM, Vasconcellos RJ, Filho JR, Cypriano RV. Fracture of the coronoid and pterygoid processes by firearms: case report. *Braz Dent J*. 2007;18(2):168–170. doi: 10.1590/s0103-64402007000200016

СПИСОК ЛИТЕРАТУРЫ

1. Boffano P., Roccia F., Zavattero E., et al. European Maxillofacial Trauma (EURMAT) project: a multicentre and prospective study // J Craniomaxillofac Surg. 2015. Vol. 43, N 1. P. 62–70. doi: 10.1016/j.jcms.2014.10.011

2. Winegar B.A., Murillo H., Tantiwongkosi B. Spectrum of critical imaging findings in complex facial skeletal trauma // Radiographics. 2013. Vol. 33, N 1. P. 3–19. doi: 10.1148/rg.331125080

3. Le Fort R. Etude experimentale sur les fractures de la machoire superieure // Rev Chir. 1901. Vol. 23. P. 208–507.

4. Patel B.C., Wright T., Waseem M. Le Fort Fractures. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.

5. Choi J.W., Kim M.J. Treatment of panfacial fractures and three-dimensional outcome analysis: the occlusion first approach // J Craniofac Surg. 2019. Vol. 30, N 4. P. 1255–1258. doi: 10.1097/SCS.0000000000005528

6. Surya M., Soni P., Bharti R., Jamwal I. Isolated fracture of lateral pterygoid plate by penetrating foreign body — a rarity indeed // Pol J Radiol. 2017. Vol. 82. P. 137–140. doi: 10.12659/PJR.900407

7. Garg R.K., Alsheik N.H., Afifi A.M., Gentry L.R. Pterygoid plate fractures: not limited to Le Fort Fractures // J Craniofac Surg. 2015. Vol. 26, N 6. P. 1823–1825. doi: 10.1097/SCS.0000000000001901

8. Truong A.Q., O'Brien D.C., Strong E.B., Dublin A. Lateral pterygoid plate fractures associated with mandible fractures // JAMA Facial Plast Surg. 2014. Vol. 16, N 6. P. 437–439. doi: 10.1001/jamafacial.2014.645

9. Unger J.M., Gentry L.R., Grossman J.E. Sphenoid fractures: prevalence, sites, and significance // Radiology. 1990. Vol. 175, N 1. P. 175–180. doi: 10.1148/radiology.175.1.2315477

10. Murray G.M., Phanachet I., Uchida S., et al. The human lateral pterygoidmuscle: a review of some experimental aspects and possible clinical relevance // Aust Dent J. 2004. Vol. 49, N 1. P. 2–8. doi: 10.1111/j.1834-7819.2004.tb00042.x

11. Phang S.Y., Whitehouse K,. Lee L., et al. Management of CSF leak in base of skull fractures in adults // Br J Neurosurg. 2016. Vol. 30, N 6. P. 596–604. doi: 10.1080/02688697.2016.1229746

12. Choi N.R., Shin S.H., Kim S.S., et al. Healing pattern of intentional pterygoid plate fracture after posterior movement of maxilla through Le Fort I osteotomy // J Craniomaxillofac Surg. 2018. Vol. 46, N 10. P. 1828–1833. doi: 10.1016/j.jcms.2018.08.003

13. Kaeppler G., Cornelius C.P., Ehrenfeld M., Mast G. Diagnostic efficacy of cone-beam computed tomography for mandibular fractures // Oral Surg Oral Med Oral Pathol Oral Radiol. 2013. Vol. l16, N 1. P. 98–104. doi: 10.1016/j.oooo.2013.04.004

14. De Oliveira D.M., Vasconcellos R.J., Filho J.R., Cypriano R.V. Fracture of the coronoid and pterygoid processes by firearms: case report // Braz Dent J. 2007. Vol. 18, N 2. P. 168–170. doi: 10.1590/s0103-64402007000200016

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DOI: https://doi.org/10.17816/DD90277

Разрыв яичка у молодого пациента: диагностическая ценность ультразвукового исследования с контрастным усилением

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АННОТАЦИЯ

Разрыв яичка, возникший в результате тупой травмы мошонки, характеризуется повреждением белочной оболочки, что приводит к экструзии семенных канальцев.

Методы визуализации, в частности ультразвуковое исследование, играют важнейшую роль в оценке травмы мошонки и позволяют определить дальнейшую тактику ведения пациента — консервативное лечение или хирургическое вмешательство. Ультразвуковое исследование в стандартном B-режиме и цветовое допплеровское картирование являются основными методами визуализации при оценке травмы яичка, однако малоинформативны в отношении степени его повреждения. Наиболее важной информацией для хирурга являются целостность или разрыв белочной оболочки и степень повреждения жизненно важных тканей яичка. О последнем сложно судить, исходя лишь из данных стандартной ультрасонографии, по причине гиперваскуляризации яичка, возникающей вследствие отёка, нарушающего сосудистый кровоток. В случае сомнительных результатов цветового допплеровского картирования необходимо прибегать к другим современным методам визуализации, в частности к ультразвуковому исследованию с контрастным усилением, позволяющим определять жизнеспособность травмированного яичка.

В данной статье описывается клинический случай тупой травмы яичка у 15-летнего футболиста.

Ключевые слова: разрыв яичка; травма мошонки; цветовая допплеровская ультрасонография; ультразвуковое исследование с контрастным усилением; клинический случай.

Как цитировать

Eusebi L., Paparella M.T., Marconi A., Guglielmi G. Разрыв яичка у молодого пациента: диагностическая ценность ультразвукового исследования с контрастным усилением // *Digital Diagnostics.* 2022. Т. 3, № 1. С. 78–85. DOI: https://doi.org/10.17816/DD90277

Рукопись получена: 13.12.2021 **Рукопись одобрена:** 02.03.2022 **Опубликована:** 30.03.2022

DOI: https://doi.org/10.17816/DD90277

Testicular rupture in a young patient: diagnostic value of contrast-enhanced ultrasonography

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ABSTRACT

Testicular rupture after a blunt scrotal trauma is characterized by tearing of the tunica albuginea that result in the extrusion of the seminiferous tubules.

Imaging, particularly ultrasonography, plays a crucial role in the assessment of scrotal trauma and directs patient management toward conservative or surgical treatment. Conventional B-mode and color Doppler ultrasonography are the main imaging techniques in the evaluation of the testicle in trauma but may underestimate the extent of injury. The most important information for the surgeon is the integrity or interruption of the tunica albuginea and the extent of vital testicular tissue. The latter is often difficult to assess with conventional ultrasonography because the injured testicle is often hypovascular even in vital regions due to testicular edema that compromises vascular flow. The selective use of advanced techniques such as contrast-enhanced ultrasonography is important in identifying testicular viability when color Doppler ultrasonography is equivocal.

This case report describes the evaluation and management of a blunt testicular trauma in a 15-year-old football player.

Keywords: testicular rupture; scrotal trauma; color Doppler ultrasound; contrast-enhanced ultrasound; clinical case.

To cite this article
Eusebi L, Paparella MT, Marconi A, Guglielmi G. Testicular rupture in a young patient: diagnostic value of contrast-enhanced ultrasonography. *Digital Diagnostics.* 2022;3(1):78–85. DOI: https://doi.org/10.17816/DD90277

Received: 13.12.2021 **Accepted:** 02.03.2022 **Published:** 30.03.2022

ECO•VECTOR

DOI: https://doi.org/10.17816/DD90277

年轻患者睾丸破裂以及对比增强超声检查的诊断价值

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简评

由于阴囊钝性伤发生的睾丸破裂的特点是鞘膜受损，导致细精管挤压。

显现法，尤其是超声，在评估阴囊损伤方面发挥着至关重要的作用，并允许确定患者管理的进一步策略 —— 保守治疗或外科手术。标准B模式超声和彩超是评估睾丸损伤的主要显现法，但对睾丸损伤的程度意义不大。 外科医生最重要的信息是鞘膜的完整性或破裂以及睾丸重要组织的损伤程度。由于水肿破坏了血管血流，导致睾丸的血管形成过多，仅从标准的超声检查的数据很难判断后者。如果彩色多普勒绘图的结果不确定，则必须使用其他现代成像方式，如造影剂增强超声，以确定受伤睾丸的生存能力。

本文描述了一名15岁足球运动员睾丸钝性伤的临床病例。

关键词： 睾丸破裂； 阴囊损伤； 彩色多普勒超声检查； 对比增强超声； 病例。

To cite this article
Eusebi L, Paparella MT, Marconi A, Guglielmi G. 年轻患者睾丸破裂以及对比增强超声检查的诊断价值. *Digital Diagnostics.* 2022;3(1):78–85. DOI: https://doi.org/10.17816/DD90277

收到： 13.12.2021 **接受：** 02.03.2022 **发布日期：** 30.03.2022

BACKGROUND

Scrotal trauma in young men accounts for less than 1% of all trauma-related injuries [1]. Testicular ruptures are seen in approximately 1.5% of cases of blunt scrotal trauma [2]. Less than 60 cases have been reported over the past decade [3]. The testicles are protected in their mobility within the scrotum by the tunica albuginea, laxity of the overlying skin, and contraction reflex of the cremasteric muscles. The tunica albuginea, with its great tensile strength, plays a crucial role in protecting the testicle; it can withstand a force of up to 50 kg without breaking [2]. The laxity of the genital skin can protect the underlying organs from blunt trauma allowing them to slip away from the point of contact; nevertheless, excessive skin laxity can lead to serious injury if the genital skin remains trapped in rotating machinery, causing avulsion and rupture of one or both testicles [4]. Sports activities account for more than 50% of all cases of testicular injuries, and motor vehicle collisions is another cause of scrotal trauma [5, 6]. Blunt injuries are noninvasive injuries due to the high energy transferred during contact with a solid object (e.g., from a kick in the groin or from the impact of a baseball or hockey bat). The main injury mechanism is the crushing of the testicle against the pubic symphysis or between the thighs. In most men, the right testicle is injured more frequently because it has an anatomical position slightly higher than that of the left testicle [7]. Scrotal trauma causes hemorrhage and infarction of the testicular parenchyma, which could lead to necrosis. In severe injuries, the disruption of the tunica albuginea accompanied by parenchymal protrusion can occur. It represents an indication for urgent surgery to salvage the testis [8]. Moreover, early repair is crucial, as rupture can damage the blood–testis barrier, with subsequent antibody formation against sperm cells leading to infertility [9]. This case study describes the evaluation and management of a blunt testicular trauma in a 15-year-old football player.

DESCRIPTION OF THE CASE

A healthy 15-year-old male teen was hit in the scrotum with a kick in the groin during a football match. He had an immediate and severe pain. After a few hours, although symptoms had improved, he presented to our emergency department with persistent swelling and purplish discoloration of the left scrotum. He did not report any other injuries. The genitourinary examination revealed that the left hemiscrotum was about two times larger than the right with severe ecchymosis. The left testicle was difficult to palpate because of pain and swelling, whereas the right testicle had a normal size and did not reveal any palpable abnormalities. The cremasteric reflex was not elicited on the left side. Scrotal ultrasonography (US) showed moderate scrotal edema and hematocele with a discontinuity in the tunica albuginea characterized by an abnormal contour (Figure 1). Color Doppler US (CDUS) documented a loss of vascularization in the upper pole that extruded into the broken portion of the testicle of approximately 2.5 cm (Figure 2) but no evidence of torsion or infarction. Urology consultation was requested, and a contrast-enhanced US (CEUS) was performed, which confirmed the diagnosis of testicular rupture and determined the amount of the vital parenchyma (Figure 3). The patient was hospitalized for urgent examination of the left hemiscotum based on the US results. During surgery, a large hematocele was evacuated, and a closer inspection of the testicle revealed a lesion of the tunica albuginea. Primary closure of the tunica was performed (Figure 4). The patient made an uneventful recovery, and he was discharged after 4 days.

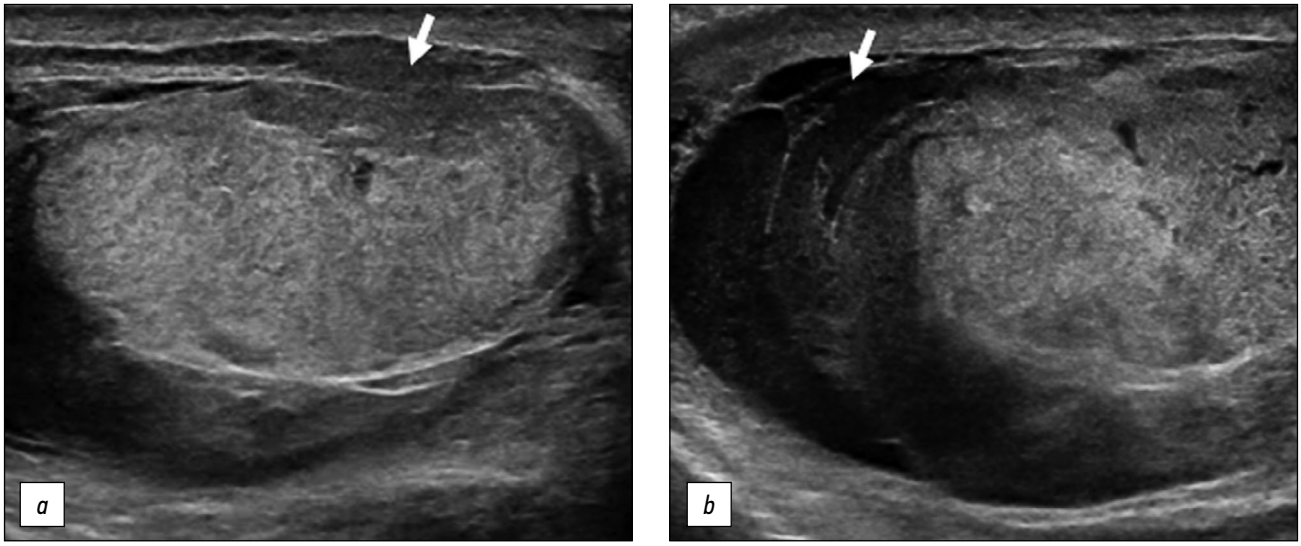

Figure 1. B-mode ultrasonography images. (*a*) Interruption of the tunica albuginea with the protrusion of echogenic material (arrow) that represents an index of breaking. (*b*) Hematocele of moderate size (arrow) and a heterogeneous appearance of testicular parenchyma, attributable to an intratesticular contusion.

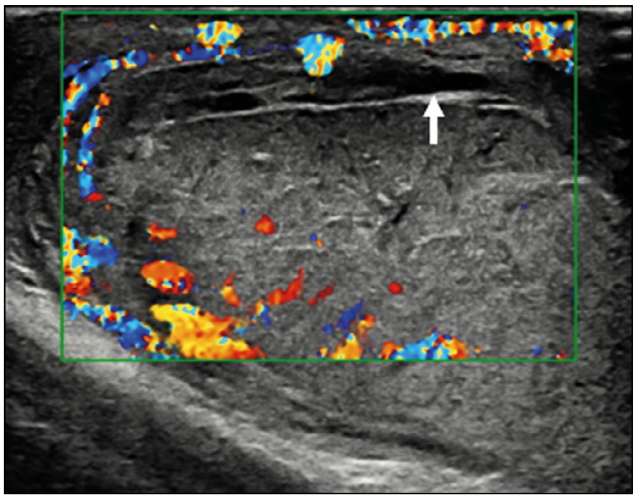

Figure 2. Color Doppler ultrasonography image showing an irregular testicular morphology with an avascular area at the breaking point (arrow).

DISCUSSION

The differential diagnosis of scrotal lesions includes epididymitis, orchitis, incarcerated inguinal hernia, testicular infarction, testicular fracture or rupture, testicular torsion, appendicular torsion, dislocated testicles, hydrocele, or hematocele [10]. CDUS is the first-line imaging modality for studying traumatic pathology of the scrotum according to the guidelines of the European Association of Urology [11]. Thus, evaluating vascular perfusion and testicular integrity is important to distinguish testicular rupture from other lesions. Using modern ultrasonic equipment, sensitivity and specificity of 95%–100% are now possible for the diagnosis of testicular rupture [12]. The normal tunica albuginea appears as a thin hypoechoic line surrounding the testicular parenchyma. It can be difficult to appreciate it in the presence of hematocele. The regularity of the testicular contour should be checked in addition to the integrity of the tunica albuginea. Essentially, when testicular rupture occurs, the testicle loses its normal oval morphology because of parenchymal extrusion [13]. Thus, the irregularity of the testicle's morphology is an indirect sign of ruptured tunica albuginea. Additional US findings include heterogeneous echotexture, rupture of the vaginal tunic, fracture lines through the testicle, decrease or loss of blood flow, scrotal thickening, and hematocele formation. CDUS is indispensable in the evaluation of a post-traumatic scrotum [14] since the rupture of the tunica albuginea is always associated with a rupture of the tunica vasculosa (composed of capsular arteries), resulting in a loss of the vascular signal of the underlying parenchyma. This aspect is extremely important because it can help determine the viability of the testicular parenchyma [15]. However, CDUS can be equivocal in acute cases because it may not detect low-flow states, particularly in pediatric patients [16], and is considered unreliable in defining ischemia [17] that could cause a delay in appropriate surgical treatment. CEUS can be proposed in cases where conventional US diagnosis remains inconclusive. CEUS is very sensitive to reveal the parenchymal vascularity and its changes in the damaged testicle [18]. The official guidelines of the European Federation of Societies for Ultrasound in Medicine and Biology describe the usefulness of CEUS in many areas [19]. Usually, 4.8 mL of SonoVue™ (Bracco Spa, Milan) is used.

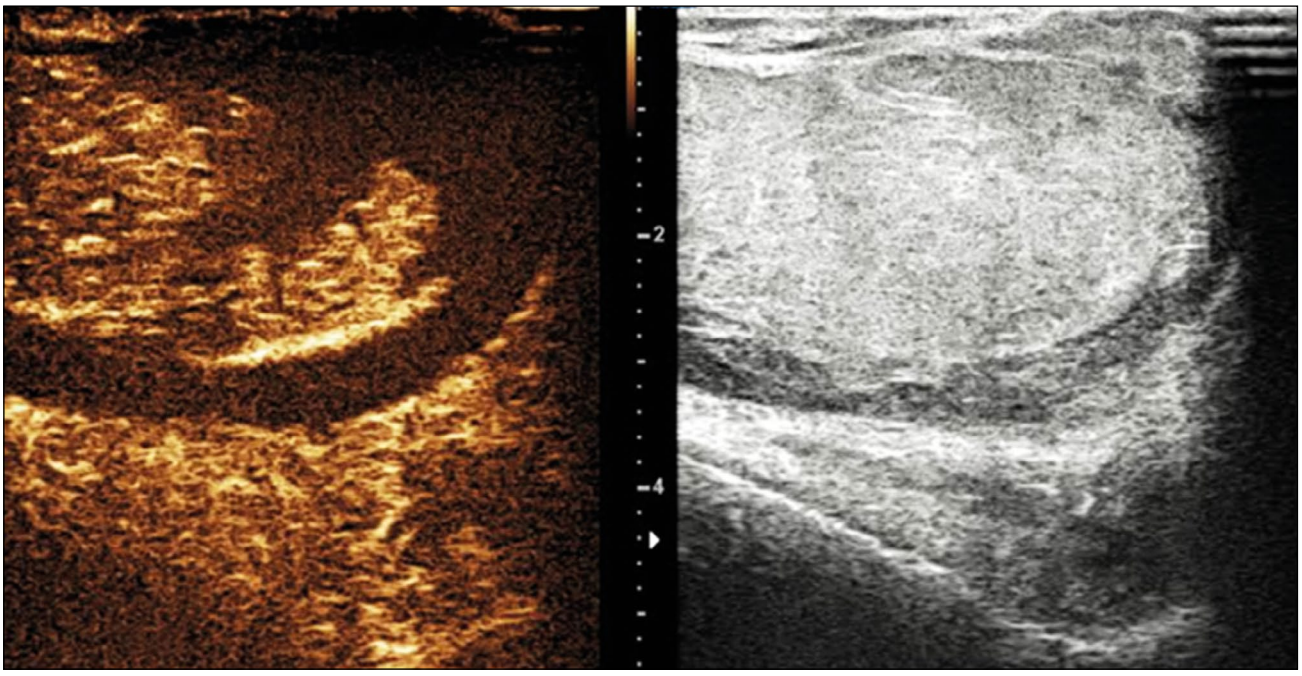

Figure 3. Contrast-enhanced ultrasonography image determines the extent of vital parenchyma, helping in the preoperative decision-making process, and allows the recovery of vital testicular tissue, avoiding the need for orchidectomy.

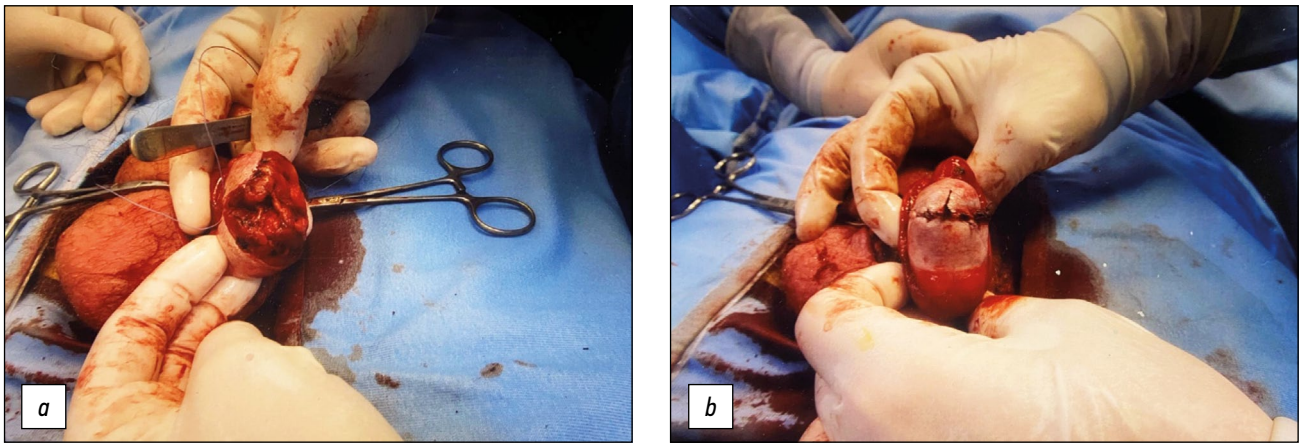

Figure 4. Intraoperative images. (*a*) Confirmed rupture of the tunica albuginea. (*b*) Primary albuginea closure.

Contrast agents for CEUS examination are not nephrotoxic, the phospholipidic shell is metabolized by the liver, and the sulfur hexafluoride gaseous component is exhaled through the lungs. The technique can be performed in patients with kidney failure and does not require previous laboratory tests. In addition, ultrasonic contrast agents (UCAs) have a lower risk of adverse reactions than contrast agents commonly used in computed tomography and magnetic resonance imaging. The CEUS is also inexpensive, fast, portable, repeatable, and safe with multiple injections, all without radiation exposure [20]. The arterial phase in CEUS is the most important tool of the examination. The testicle and epididymis enhance quickly, but it can vary from individual to individual. Arteries enhance first, followed in seconds by the reinforcement of the entire parenchyma. The scrotal wall tends to enhance lesser than the content. The enhancement decreases in a variable period usually 3 min. The normal testicular parenchyma is homogeneous with an echogenic surface line indicating the tunica albuginea. On CEUS, the testicle should enhance homogeneously with a striated pattern representing UCAs within the normal intratesticular vascular anatomy [20]. CEUS more clearly depicts the fracture lines, interruption of the tunica albuginea, and both intratesticular and extratesticular hematomas [21]. It can assess exact extent of viable testis, allowing the urologist to decide when the partial salvage of the organ is a good solution [22]. In addition, small testicular tumors may appear avascular in CDUS; thus, the differentiation of infarction can be difficult. CEUS can distinguish vascularized from non-vascularized focal testicular lesions, which help exclude malignancy. Finally, the Scrotal and Penile Imaging Working Group of the European Society of Urogenital Radiology provided position statements with the aim of guiding the use of imaging, especially multiparametric US, in scrotal trauma. Accordingly, CEUS can be used to identify the presence or absence of flow when CDUS is not diagnostic; identify testicular ruptures, fracture lines, hematomas, and ischemic changes in equivocal cases in conventional US; and distinguish between avascular and poorly vascularized lesions, to differentiate hematomas from tumors [23].

CONCLUSION

Scrotal US is the first-line imaging modality for the diagnosis of testicular trauma. Currently, CEUS is the first-line imaging modality for studying the traumatic pathology of the scrotum. CEUS has the potential to become an indispensable tool in the assessment of acute scrotal trauma, providing accurate and diagnostic imaging and helping increase the confidence of the doctor. The use of contrast media in US may be an optimal solution for a prompt resolution of equivocal US findings, combining the facility of US and information on the parenchymal vascularity offered by CEUS. This is particularly relevant for the surgical decision as to whether or not to undertake emergency surgery and, above all, whether the affected testicle is salvageable. The current management strategy for testicular rupture is surgical exploration and repair within 72 h to maximize the rescue.

ADDITIONAL INFORMATION

Funding source. This study was not supported by any external sources of funding.

Competing interest. Authors declare no explicit and potential conflicts of interests associated with the publication of this article.

Authors' contribution. All authors made a substantial contribution to the conception of the work; acquisition, analysis, and 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. L. Eusebi and M.T. Paparella contributed equally to the research work related to the topic and manuscript writing; A. Marconi helped in literature research and data acquisition; G. Guglielmi was involved in the critical revision of the manuscript.

Consent for publication. Written consent was obtained from the patient for the publication of relevant medical information and all accompanying images.

REFERENCES

1. Deurdulian C, Mittelstaedt CA, Chong WK, Fielding JR. US of acute scrotal trauma: optimal technique, imaging findings, and management. Radiographics. 2007;27(2):357–369. doi: 10.1148/rg.272065117
2. Bhatt S, Dogra VS. Role of US in testicular and scrotal trauma. Radiographics. 2008;28(6):1617–1629. doi: 10.1148/rg.286085507
3. Sadjo SA, Destinval C, Lemelle JL, Berte N. Testicular rupture after blunt scrotal trauma in children: a case report and literature review. Trauma Case Rep. 2021;33:100482. doi: 10.1016/j.tcr.2021.100482
4. Wessells H, Long L. Penile and genital injuries. Urol Clin North Am. 2006;33(1):117–126. doi: 10.1016/j.ucl.2005.11.003
5. Haas CA, Brown SL, Spirnak JP. Penile fracture and testicular rupture. World J Urol. 1999;17(2):101–106. doi: 10.1007/s003450050114
6. Munter DW, Faleski EJ. Blunt scrotal trauma: emergency department evaluation and management. Am J Emerg Med. 1989;7(2):227–234. doi: 10.1016/0735-6757(89)90143-5
7. Mulhall JP, Gabram SG, Jacobs LM. Emergency management of blunt testicular trauma. Acad Emerg Med. 1995;2(7):639–643. doi: 10.1111/j.1553-2712.1995.tb03604.x
8. Huang DY, Pesapane F, Rafailidis V, et al. The role of multiparametric ultrasound in the diagnosis of paediatric scrotal pathology. Br J Radiol. 2020;93(1110):20200063. doi: 10.1259/bjr.20200063
9. Wright S, Hoffmann B. Emergency ultrasound of acute scrotal pain. Eur J Emerg Med. 2015;22(1):2–9. doi: 10.1097/MEJ.0000000000000123
10. Wang A, Stormont I, Siddiqui MM. A review of imaging modalities used in the diagnosis and management of scrotal trauma. Current Urology Reports. 2017;18(12):98–103. doi: 10.1007/s11934-017-0744-1
11. Kitrey ND, Djakovic N, Gonsalves M, et al. EAU guidelines on urological trauma. European Association of Urology; 2016. Available from: https://uroweb.org/individual-guidelines/non-oncology-guidelines/
12. Cannis M, Mailhot T, Perera P. Bedside ultrasound in a case of blunt scrotal trauma. West J Emergency Med. 2013;14(2):127–129. doi: 10.5811/westjem.2012.8.12630
13. Bhatt S, Ghazale H, Dogra VS. Sonographic evaluation of scrotal and penile trauma. Ultrasound Clin. 2007;2(1):45–56. doi: 10.1016/j.cult.2007.01.003
14. Pepe P, Panella P, Pennisi M, Aragona F. Does color Doppler sonography improve the clinical assessment of patients with acute scrotum? Eur J Radiol. 2006;60(1):120–124. doi: 10.1016/j.ejrad.2006.04.016
15. Muttarak M, Thinyu S, Lojanapiwat B. Clinics in diagnostic imaging (114). Rupture of the right testis. Singapore Med J. 2007;48(3):264–268.
16. Yusuf G, Konstantatou E, Sellars ME, et al. Multiparametric sonography of testicular hematomas: features on grayscale, color Doppler, and contrast-enhanced sonography and strain elastography. J Ultrasound Med. 2015;34:1319–1328. doi: 10.7863/ultra.34.7.1319
17. Hedayati V, Sellars ME, Sharma DM, Sidhu PS. Contrast-enhanced ultrasound in testicular trauma: role in directing exploration, debridement and organ salvage. Br J Radiol. 2012;85(1011):e65–e68. doi: 10.1259/bjr/95600238
18. Badea R, Lucan C, Suciu M, et al. Contrast enhanced harmonic ultrasonography for the evaluation of acute scrotal pathology. A pictorial essay. Med Ultrason. 2016;18(1):110–115. doi: 10.11152/mu.2013.2066.181.esy
19. Sidhu PS, Cantisani V, Dietrich CF, et al. The EFSUMB guidelines and recommendations for the clinical practice of contrast-enhanced ultrasound (CEUS) in non-hepatic applications: update 2017 (short version). Ultraschall Med. 2018;39(2):154–180. doi: 10.1055/s-0044-101254
20. Yusuf GT, Rafailidis V, Moore S, et al. The role of contrast-enhanced ultrasound (CEUS) in the evaluation of scrotal trauma: a review. Insights Imaging. 2020;11(1):68. doi: 10.1186/s13244-020-00874-7
21. Trinci M, Cirimele V, Ferrari R, et al. Diagnostic value of contrast-enhanced ultrasound (CEUS) and comparison with color Doppler ultrasound and magnetic resonance in a case of scrotal trauma. J Ultrasound. 2020;23(2):189–194. doi: 10.1007/s40477-019-00389-y
22. Valentino M, Bertolotto M, Derchi L, et al. Role of contrast enhanced ultrasound in acute scrotal diseases. Eur Radiol. 2011;21(9):1831–1840. doi: 10.1007/s00330-010-2039-5
23. Ramanathan S, Bertolotto M, Freeman S, et al. Imaging in scrotal trauma: a European Society of Urogenital Radiology Scrotal and Penile Imaging Working Group (ESUR-SPIWG) position statement. Eur Radiol. 2021;31(7):4918–4928. doi: 10.1007/s00330-020-07631-w

СПИСОК ЛИТЕРАТУРЫ

1. Deurdulian C., Mittelstaedt C.A., Chong W.K., Fielding J.R. US of acute scrotal trauma: optimal technique, imaging findings, and management // Radiographics. 2007. Vol. 27, N 2. P. 357–369. doi: 10.1148/rg.272065117
2. Bhatt S., Dogra V.S. Role of US in testicular and scrotal trauma // Radiographics. 2008. Vol. 28, N 6. P. 1617–1629. doi: 10.1148/rg.286085507
3. Sadjo S.A., Destinval C., Lemelle J.L., Berte N. Testicular rupture after blunt scrotal trauma in children: A case report and literature review // Trauma Case Rep. 2021. Vol. 33. P. 100482. doi: 10.1016/j.tcr.2021.100482
4. Wessells H., Long L. Penile and genital injuries // Urol Clin North Am. 2006. Vol. 33, N 1. P. 117–126. doi: 10.1016/j.ucl.2005.11.003
5. Haas C.A., Brown S.L., Spirnak J.P. Penile fracture and testicular rupture // World J Urol. 1999. Vol. 17, N 2. P. 101–106. doi: 10.1007/s003450050114
6. Munter D.W., Faleski E.J. Blunt scrotal trauma: emergency department evaluation and management // Am J Emerg Med. 1989. Vol. 7, N 2. P. 227–234. doi: 10.1016/0735-6757(89)90143-5
7. Mulhall J.P., Gabram S.G., Jacobs L.M. Emergency management of blunt testicular trauma // Acad Emerg Med. 1995. Vol. 2, N 7. P. 639–643. doi: 10.1111/j.1553-2712.1995.tb03604.x
8. Huang D.Y., Pesapane F., Rafailidis V., et al. The role of multiparametric ultrasound in the diagnosis of paediatric scrotal pathology // Br J Radiol. 2020. Vol. 93, N 1110. P. 20200063. doi: 10.1259/bjr.20200063
9. Wright S., Hoffmann B. Emergency ultrasound of acute scrotal pain // Eur J Emerg Med. 2015. Vol. 22, N 1. P. 2–9. doi: 10.1097/MEJ.0000000000000123
10. Wang A., Stormont I., Siddiqui M.M. A review of imaging modalities used in the diagnosis and management of scrotal trauma // Current Urology Reports. 2017. Vol. 18, N 12. P. 98–103. doi: 10.1007/s11934-017-0744-1
11. Kitrey N.D., Djakovic N., Gonsalves M., et al. EAU guidelines on urological trauma. European Association of Urology, 2016. Режим доступа: https://uroweb.org/individual-guidelines/non-oncology-guidelines/. Дата обращения: 15.02.2022.
12. Cannis M., Mailhot T., Perera P. Bedside ultrasound in a case of blunt scrotal trauma // West J Emergency Med. 2013. Vol. 14, N 2. P. 127–129. doi: 10.5811/westjem.2012.8.12630
13. Bhatt S., Ghazale H., Dogra V.S. Sonographic evaluation of scrotal and penile trauma // Ultrasound Clin. 2007. Vol. 2, N 1. P. 45–56. doi: 10.1016/j.cult.2007.01.003
14. Pepe P., Panella P., Pennisi M., Aragona F. Does color Doppler sonography improve the clinical assessment of patients with acute scrotum? // Eur J Radiol. 2006. Vol. 60, N 1. P. 120–124. doi: 10.1016/j.ejrad.2006.04.016

15. Muttarak M., Thinyu S., Lojanapiwat B. Clinics in diagnostic imaging (114). Rupture of the right testis // Singapore Med J. 2007. Vol. 48, N 3. P. 264–268.
16. Yusuf G., Konstantatou E., Sellars M.E., et al. Multiparametric sonography of testicular hematomas: features on grayscale, color Doppler, and contrast-enhanced sonography and strain elastography // J Ultrasound Med. 2015. Vol. 34, N 7. P. 1319–1328. doi: 10.7863/ultra.34.7.1319
17. Hedayati V., Sellars M.E., Sharma D.M., Sidhu P.S. Contrast-enhanced ultrasound in testicular trauma: role in directing exploration, debridement and organ salvage // Br J Radiol. 2012. Vol. 85, N 1011. P.e65–e68. doi: 10.1259/bjr/95600238
18. Badea R., Lucan C., Suciu M., et al. Contrast enhanced harmonic ultrasonography for the evaluation of acute scrotal pathology. A pictorial essay // Med Ultrason. 2016. Vol. 18, N 1. P. 110–115. doi: 10.11152/mu.2013.2066.181.esy
19. Sidhu P.S., Cantisani V., Dietrich C.F., et al. The EFSUMB guidelines and recommendations for the clinical practice of contrast-enhanced ultrasound (CEUS) in non-hepatic applications: update 2017 (short version) // Ultraschall Med. 2018. Vol. 39, N 2. P. 154–180. doi: 10.1055/s-0044-101254
20. Yusuf G.T., Rafailidis V., Moore S., et al. The role of contrast-enhanced ultrasound (CEUS) in the evaluation of scrotal trauma: a review // Insights Imaging. 2020. Vol. 11, N 1. P. 68. doi: 10.1186/s13244-020-00874-7
21. Trinci M., Cirimele V., Ferrari R., et al. Diagnostic value of contrast-enhanced ultrasound (CEUS) and comparison with color Doppler ultrasound and magnetic resonance in a case of scrotal trauma // J Ultrasound. 2020. Vol. 23, N 2. P. 189–194. doi: 10.1007/s40477-019-00389-y
22. Valentino M., Bertolotto M., Derchi L., et al. Role of contrast enhanced ultrasound in acute scrotal diseases // Eur Radiol. 2011. Vol. 21, N 9. P. 1831–1840. doi: 10.1007/s00330-010-2039-5
23. Ramanathan S., Bertolotto M., Freeman S., et al. Imaging in scrotal trauma: a European Society of Urogenital Radiology Scrotal and Penile Imaging Working Group (ESUR-SPIWG) position statement // Eur Radiol. 2021. Vol. 31, N 7. P. 4918–4928. doi: 10.1007/s00330-020-07631-w

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DOI: https://doi.org/10.17816/DD104745

Междисциплинарный банк данных в онкоэндокринологии: радиойодрефрактерный дифференцированный рак щитовидной железы

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АННОТАЦИЯ

Высокие достижения в персонализированной доказательной медицине, и онкологии в развитых странах связаны с развитием клинических карцер-регистров пациентов (SEER, NCDB и др.), которые представляют собой мультимодальные и междисциплинарные банки данных. Они являются матрицей данных для развития аналитических и прогностических инструментов в изучении особенностей диагностики, клинического течения болезней, ответа на терапию, оценки влияния прогностических факторов и пр. С точки зрения медицинских цифровых банков данных, избыточность и дублированность данных не так критичны, как неполнота или противоречивость информации при принятии медицинских решений.

Цель статьи — анонс мультимодального банка данных пациентов с радиойодрефрактерным дифференцированным раком щитовидной железы, который, по сути, является современным междисциплинарным цифровым медицинским регистром.

Наряду с демографическими и нозологическими данными, характерными для эпидемиологических регистров, в мультимодальных банках данных учитываются ключевые клинические и параклинические данные: результаты лабораторных, морфологических и инструментальных методов исследования, различные методы визуализации (ультразвуковое исследование; компьютерная и магнитно-резонансная томография; однофотонная эмиссионная компьютерная томография, совмещённая с компьютерной томографией; позитронно-эмиссионная томография, совмещённая с компьютерной томографией). В мультимодальных банках данных представлены результаты молекулярно-генетического профиля опухоли, клиническая польза которого в выборе тактики лечения сегодня не подвергается сомнению. Все эти данные накапливаются в мультимодальных банках данных с отметкой о времени выполнения, результатах пересмотра (второе мнение), учёта стандартизированных качественно-количественных параметров (факторов), потенциально влияющих на клиническое течение, ответ на лечение, развитие осложнений и исход.

Ключевые слова: банк данных; мультимодальный карцер-регистр; рефрактерный; дифференцированный; рак щитовидной железы; радиойодтерапия.

Как цитировать

Румянцев П.О., Байдак А.Г. Мультимодальный банк данных в онкоэндокринологии: радиойодрефрактерный дифференцированный рак щитовидной железы // *Digital Diagnostics*. 2022. Т. 3, № 1. С. 86–93. DOI: https://doi.org/10.17816/DD104745

Рукопись получена: 11.03.2022 **Рукопись одобрена:** 08.04.2022 **Опубликована:** 11.04.2022

ЭКО•ВЕКТОР

DOI: https://doi.org/10.17816/DD104745

Interdisciplinary databank in oncoendocrinology: radioiodine refractory differentiated thyroid cancer

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ABSTRACT

High achievements in personalized evidence-based medicine and oncology, particularly in developed countries, are associated with the successful development of "clinical" carceral registries of patients (SEER, NCDB, etc.), which are multimodal data banks. They are a data matrix for the development of analytical and prognostic tools in the study of diagnostic features, clinical disease course, therapy response, assessment of prognostic factors, etc. From the point of view of medical digital data banks, data redundancy and duplication are not as critical as information incompleteness or inconsistency when making medical decisions.

This study aimed to present a multimodal database of patients with radioiodine refractory differentiated thyroid cancer, which is essentially a modern interdisciplinary digital medical registry.

Along with demographic and nosological data that is typical for epidemiological registers, the multimodal data banks consider key clinical and paraclinical data, such as the results of laboratory, morphological, and instrumental research methods, and various imaging methods, such as ultrasound, computed tomography (CT), magnetic resonance imaging, single-photon emission computed tomography/CT, and positron emission tomography/CT. The multimodal data banks present the molecular genetic profile results of the tumor, of which the clinical usefulness in the choice of treatment tactics is undoubted today. All these data are accumulated in the multimodal data banks, noting the execution time and the revision results (second opinion), considering standardized qualitative and quantitative parameters (factors) that potentially affect the clinical course, treatment response, complication development, and outcomes.

Keywords: data bank; multimodal; cancer registry; refractory; differentiated; thyroid cancer; radiotherapy.

To cite this article
Rumiantsev PO, Baidak AG. Interdisciplinary databank in oncoendocrinology: radioiodine refractory differentiated thyroid cancer. *Digital Diagnostics*. 2022;3(1):86–93. DOI: https://doi.org/10.17816/DD104745

Received: 11.03.2022 **Accepted:** 08.04.2022 **Published:** 11.04.2022

DOI: https://doi.org/10.17816/DD104745

肿瘤内分泌学中的多模式数据库：放射性碘难治性分化型甲状腺癌

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简评

个性化循证医学和肿瘤学方面的高成就，尤其是在发达国家，与成功开发了多模式数据库"临床"癌症患者登记系统（SEER、NCDB 等）有关。它们是用于开发分析和预后工具的数据矩阵，用于研究诊断特征、疾病的临床过程、对治疗的反应、评估预后因素的影响等。从医疗数字数据库的角度来看，在做出医疗决策时，数据的冗余和重复并不像信息的不完整或不一致那么重要。

本文目的是宣布一个放射性碘难治性分化型甲状腺癌患者的多模式数据库，该数据库本质上是一个现代跨学科数字医疗登记系统。

除了流行病学登记的典型人口统计学和疾病学数据外，多模式数据库还考虑了关键的临床和临床旁数据：实验室结果、形态学和仪器研究方法、各种成像方法（超声、CT、MRI、SPECT/CT、PET/计算机断层扫描）。多模式数据库展示了肿瘤分子遗传学谱的结果，其在治疗策略选择中的临床实用性在今天是毫无疑问的。所有这些数据都累积在多模式数据库中，并在执行时间、审查结果（第二意见）上进行标记，同时考虑到可能影响临床过程、治疗反应的标准化定性和定量参数（因素），并发症和结果的发展。

关键词： 数据库；多模式；恶性肿瘤登记；难治性；分化型；甲状腺癌；放射性碘治疗。

To cite this article
Rumiantsev PO, Baidak AG. 肿瘤内分泌学中的多模式数据库：放射性碘难治性分化型甲状腺癌. *Digital Diagnostics*. 2022;3(1):86–93. DOI: https://doi.org/10.17816/DD104745

收到： 11.03.2022 **接受：** 08.04.2022 **发布日期：** 11.04.2022

INTRODUCTION

In Russia, the incidence of thyroid cancer (TC) has increased more than twice the number, from 4.41 per 100,000 populations in 1998 to 9.53 in 2019 [1, 2], primarily due to the additional detection of papillary microcarcinomas resulting from widely used ultrasound (US) examinations.

Approximately, 70%–80% of the presently detected thyroid carcinomas have a favorable prognosis, particularly when detected at early stages. Moreover, postoperative iodine-131 therapy is not indicated for this patient group [3]. On average, 10% of patients with differentiated thyroid cancer (DTC) show radioiodine refractoriness (RR) [4].

INTERDISCIPLINARY DATABANKS

At present, registries for patients with cancer (Surveillance, Epidemiology, and End Results, National Cancer Database, and others) or interdisciplinary databanks (IDB) are the major tools worldwide that are used for studying the features of clinical disease course and therapy response and assessing the influence of prognostic factors [5]. The integration of specialists of different profiles on a single information platform allows rapid communication and expert support for medical decision-making [6]. The primary stakeholder for accurate and rapid medical decision-making is the patient; therefore, patient involvement as a "donor" of anamnestic and operative medical information (extracts, tests, disks, and glasses), both in paper and electronic digital formats, is necessary. Redundancy and data duplication are not critical in terms of medical interactive databanks, whereas incomplete or inconsistent information is critical in medical decision-making.

Therefore, the European Union Committee of Experts on Rare Diseases operates to obtain consolidated data on patients who suffer from rare diseases, including rare cancers with an incidence of <6 per 100,000 population and TC also belongs to it [7]. Currently, Russia has several active registries at different healthcare levels.

INTERDISCIPLINARY PATIENT DATABANK PROJECT FOR RADIOIODINE-REFRACTORY DTC

This study aimed to popularize the Interdisciplinary Patient Databank Project for Radioiodine-Refractory Differentiated TC (IDB RR-DTC), which is essentially a modern clinical registry and is supported by the Association of Endocrine Surgeons (https://as-endo.ru/) and the Association for the Development of Theranostics (https://www.theranostics.pro/).

Significant clinical and paraclinical data are considered in the developed IDB RR-DTC, namely, results of laboratory, morphological, and instrumental methods of examination and various imaging techniques (US, computed tomography [CT], magnetic resonance imaging [MRI], single-photon emission CT/CT [SPECT/CT], and positron emission tomography/CT [PET/CT]), in addition to demographic and nosological data characteristic of epidemiological registries. IDB RR-DTC plans to record (when completed) the results of the molecular genetic profile of tumors, which clinical benefit in the choice of treatment tactics is no longer in doubt. All these data will be accumulated in the IDB RR-DTC with a note on the time of execution and revision results (second opinion), including standardized qualitative and quantitative parameters (factors) that potentially influence the clinical course, treatment response, complications, and outcomes.

Several studies showed that tumor growth and TC progression are closely related to somatic point mutations in the *BRAF, RAS*, and *RET* genes. These mutations contribute to activating the mitogen-activated protein kinase and phosphoinositide 3-kinase proliferation signaling pathways, which are crucial in TC development [8]. Clinicians should keep in mind that patients with a Bethesda IV, V, and VI cytology report may be prescribed molecular genetic testing in the *BRAF, TERT, RAS, RET/PTC,* and *PAX8/PPAR*-γ genes, as recommended by the Ministry of Health of the Russian Federation [9].

The IDB RR-DTC project collects information on molecular genetic testing results for known mutations in the *BRAF, TERT, RAS, RET/PTC*, and *PAX8/PPAR*-γ genes for subsequent analysis.

The created IDB RR-DTC uses templates for entering anamnestic data (to show data in one form), editing the existing history, adding dated changes, and attaching documents in PDF format.

This databank is an integration project for developing digital medicine to address the following healthcare challenges:

- A multidisciplinary paradigm of multimodal data collection and analysis unified for prompt and evidence-based patient care;
- Digital resource creation that is available to the interested doctor to record and analyze his/her own experience and prompt peer expert support in real clinical practice;
- An innovative digital platform for multicenter scientific and practical research;
- A matrix for clinical and epidemiological research, radiomics development, deep machine learning, and artificial intelligence in medicine;
- New RR-DTC case predictions and their verification and optimal treatment tactic selection;
- Evidence-based experience consolidation in the effective and safe treatment of patients (e.g., surgery, radioiodine therapy, hormone therapy, and targeted therapy).

DOI: https://doi.org/10.17816/DD104745

Table. Structure of data stored and processed in the Interdisciplinary Patient Databank Project for Radioiodine-Refractory Differentiated Thyroid Cancer (IDB RR-DTC)

Section	Parameters
Demographics	• Surname, first name, patronymic, date of birth, gender, and address
History	• Family history • Radiation history (neck irradiation and being in a radiation exposure area)
Diagnosis(s)	• ICD-10 code • The histological type of carcinoma
Primary tumor grade	• Tumor grade (TNM and clinical stage) • Parameters of the primary tumor (size, number, invasiveness, histological variant, and characteristics) • Localization, size, and number of metastases (removed/affected), and capsule infiltration
Genetics (tumor)	• *BRAF, RET, NTRK, TERT, PAX8/PPAR-γ, RAS* (mutation detection method, laboratory tests, and results)
Instrumental diagnostics	*Date* • US • Endoscopy • X-ray *Tumor dynamics assessment (RECIST):* • CT/MRI (± contrasting) • SPECT(/CT) • PET/CT
Surgery	*Date of surgery* *MF* • Surgical volume: on the thyroid gland, on regional lymph nodes (including ASL), outside the neck • Use of intraoperative neuromonitoring • Complications (surgical treatment): *Date of registration* • Postoperative laryngeal paresis/paralysis • Grade of postoperative hypoparathyroidism • Other (specify)
Radioiodine diagnostics (RD) and radioiodine therapy (RT)	*Date of procedure* *MF* • Radioisotope: Iodine-123, Iodine-131, and Iodine-124 • Activity (MBq/mKi): automatic recalculation • SPECT(/CT) • PET/CT Distribution and accumulation of radiopharmaceuticals in projecting the thyroid bed, regional neck lymph nodes, retroperitoneal lymph nodes, lungs, bones, and other localizations of pathological accumulation The presence of radioiodine-resistant metastases (RR date to be registered), localization and size of foci, and progression (RECIST 1.1.) *Complications (RT):* • Postoperative laryngeal paresis/paralysis • Grade of postoperative hypoparathyroidism • Other
Laboratory diagnostics	*Date of analysis* • TTH • FT (4) • TG • TgAb • CEA • Cyfra 21.1 • Proteinuria (AE) • Creatinine (AE) • AspAT (AE) • ALAT (AE)

Table. Ending

Section	Parameters
Laboratory diagnostics	• Bilirubin (AE) • Hemoglobin (AE) • Leukocytes (AE) • Neutrophils (AE) • Platelets (AE)
Histology	*Date of examination* • # of examination (glass, blocks) • MF • Histological type and carcinoma variant • Size and localization of the dominant tumor in the thyroid • Presence and character of carcinoma intrinsic capsule • Invasion/infiltration of thyroid capsule carcinoma • Carcinoma multifocality in the thyroid • Angioinvasion in the thyroid • Number of removed ASL lymph nodes • Number of metastatic ASL lymph nodes
Hormone therapy	*Date of administration* • Daily dose, μg
Radioiodine resistance (summary)	RR date (see RD/RT section) Total activity of iodine-131 (including that at which RR was registered, GBq/mKi)
Targeted therapy	*Date (administration, correction, and withdrawal)* • Drug (INN) • Daily dose, mg • Reasons for drug withdrawal
Adverse events (complications) of targeted therapy	*AE registration date* • ECOG, st. • Arterial hypertension, st. • Diarrhea, st. • Nausea and vomiting, st. • Fatigue, st. • Decrease in body weight and loss of appetite, st. • Renal toxicity (proteinuria), st. • Rash (hand–foot syndrome), st. • Bleeding threat, st. • Liver toxicity (AspAT, ALAT, bilirubin), st. • Hypothyroidism, st. • Myelosuppression, st.

Note: *TTH*, thyrotropic hormone; *TG*, thyroglobulin; *TgAb*, thyroglobulin antibodies; *FT,* free tetraiodothyroxine; *ASL*, anatomical and surgical level of regional lymph nodes; *MF*, medical facility; *AE*, adverse events.

ACTUAL CONTENT

At present, the IDB RR-DTC project is already available at http://reestr.medical-data.ru/mbd/ for the general medical community both for review and participation. The accessible version is the result of the efforts of 11 doctors, covering the observation data of 228 patients from 48 regions of the Russian Federation. All doctors who treat patients with RR-DTC, including oncologists, surgeons, radiologists, nuclear medicine specialists, endocrinologists, chemotherapists, pathologists, and geneticists, are welcome to join the project. The developers offer to directly register in the system when entering the website. The IDB RR-DTC interface (Fig. 1) is easy-to-use for any doctor since the project was designed and implemented by a doctor.

Sections to be filled out correspond to the classic medical history and outpatient records. Doctors can broaden their professional horizons without leaving the workplace, learn teamwork, exchange experience in managing patients with RR-DTC, become involved in scientific and analytical work, and become coauthors of publications in both domestic and foreign scientific medical journals by participating in the project.

The multimodal data bank (clinical, laboratory, and radiological) creation develops and facilitates interdisciplinary collaboration, which, in turn, forms the basis

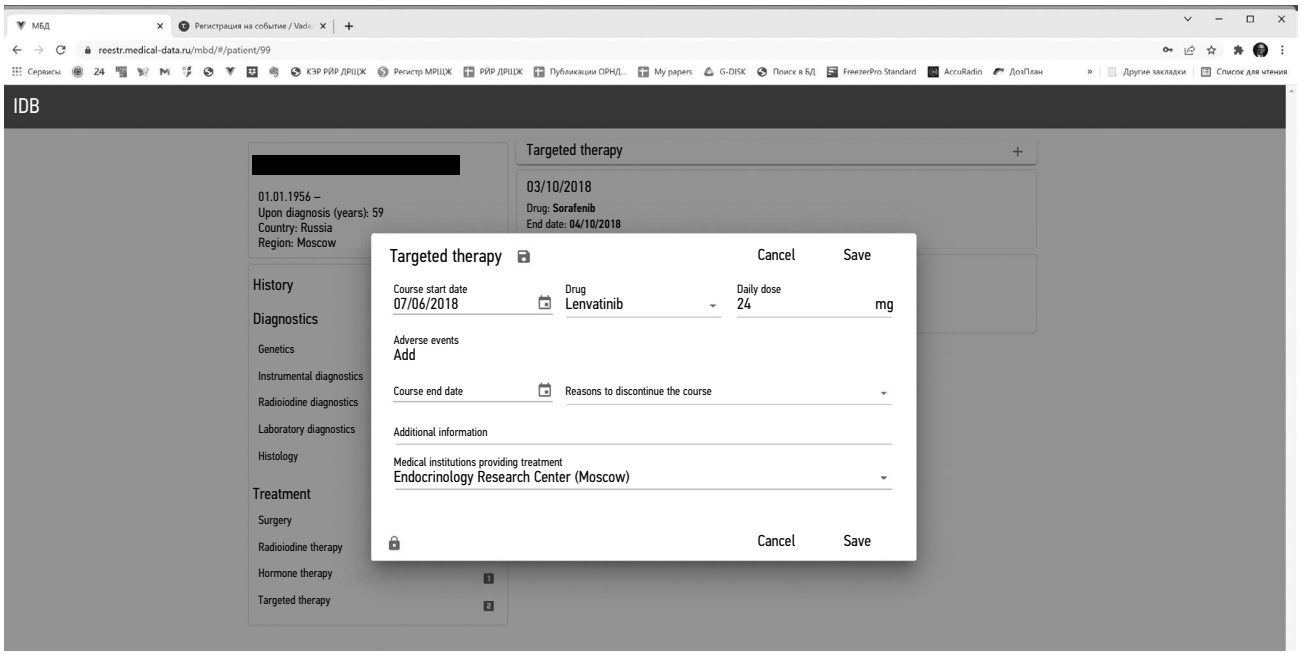

Fig. 1. The interface of the Interdisciplinary Patient Databank Project for Radioiodine-Refractory Differentiated Thyroid Cancer (IDB RR-DTC).

for multicenter and national clinical and epidemiological evidence-based studies and the improvement of diagnostic, treatment, and rehabilitation technologies for patients with cancer. This is true for neuroendocrine tumors that are highly aggressive and refractory to standard disease treatment.

ADDITIONAL INFORMATION

Funding source. The publication is prepared with financial support of EISAI company. Authors are completely responsible for the content as well as reduction remarks.

Competing interest. Authors declare the absence of competing interests.

Authors' contribution. Rumiantsev P.O. — idea, design, content of the article; Baidak A. — figures, technical assistance. All 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.

Acknowledgements. The authors express their gratitude to Association of theranostics development, Group of clinics "SOGAZ-Medicine", Association of endocrine surgeons, Russian society of specialists in head and neck tumors.

REFERENCES

1. Chissov VI, Starinsky VV, Petrova GV. Malignant neoplasms in Russia since 2008 (morbidity and mortality). Moscow: P.A. Herzen Federal State Medical Research Institute of Rosmedtechnology; 2010. 256 p. (In Russ).

2. Kaprin AD, Starinsky VV, Petrova GV. The state of oncological care for the population of Russia in 2019. Moscow: P.A. Herzen Moscow State Medical Research Institute — branch of the FSBI NMIC of Radiology of the Ministry of Health of Russia, 2020. 236 p. (In Russ).

3. Pacini F, Fuhrer D, Elisei R, et al. 2022 ETA Consensus Statement: what are the indications for post-surgical radioiodine therapy in differentiated thyroid cancer? *Eur Thyroid J.* 2022;11(1):e210046. doi: 10.1530/ETJ-21-0046

4. Rumyantsev PO, Fomin DK, Rumyantseva UV. Criteria of resistance of highly differentiated thyroid cancer to therapy with radioactive iodine. *Tumors Head Neck.* 2014;(3):4–9. (In Russ).

5. Rumyantsev PO, Slashchuk KY, Korenev SV, et al. Interdisciplinary data bank in oncoendocrinology. Medullary thyroid cancer and syndromes of multiple endocrine neoplasia type 2. *Endocrine Sur.* 2019;13(3):105–117. (In Russ). doi: 10.14341/serg11270

6. Almazov AA, Rumyantsev PO, Kupreev PP, et al. Medical decision support systems; analysis of multimodal data, the difference between "human" and "machine" approaches, social problems of collection and turnover of biomedical data. *Doctor Information Technol.* 2020;(2):28–35. (In Russ). doi: 10.37690/1811-0193-2020-2-28-35

7. Gatta G, van der Zwan JM, Casali PG, et al. Rare cancers are not so rare: the rare cancer burden in Europe. *Eur J Cancer.* 2011;47(17):2493–2511. doi: 10.1016/j.ejca.2011.08.008

8. Filetti S, Durante C, Hartl D, et al. Thyroid cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol.* 2019;30(12):1856–1883. doi: 10.1093/annonc/mdz400

9. Clinical recommendations "Differentiated thyroid cancer". Moscow; 2020. 47 p. (In Russ).

СПИСОК ЛИТЕРАТУРЫ

1. Чиссов В.И., Старинский В.В., Петрова Г.В. Злокачественные новообразования в России с 2008 году (заболеваемость и смертность). Москва: ФГУ МНИОИ им. П.А. Герцена Росмедтехнологий, 2010. 256 с.

2. Каприн А.Д., Старинский В.В., Петрова Г.В. Состояние онкологической помощи населению России в 2019 году. Москва: МНИОИ им. П.А. Герцена — филиал ФГБУ НМИЦ радиологии Минздрава России, 2020. 236 с.

3. Pacini F., Fuhrer D., Elisei R., et al. 2022 ETA Consensus Statement: what are the indications for post-surgical radioiodine therapy in differentiated thyroid cancer? // Eur Thyroid J. 2022. Vol. 11, N 1. P. e210046. doi: 10.1530/ETJ-21-0046

4. Румянцев П.О., Фомин Д.К., Румянцева У.В. Критерии резистентности высокодифференцированного рака щитовидной железы к терапии радиоактивным йодом // Опухоли головы и шеи. 2014. № 3. С. 4–9.

5. Румянцев П.О., Слащук К.Ю., Коренев С.В., и др. Междисциплинарный банк данных в онкоэндокринологии. Медуллярный рак щитовидной железы и синдромы множественных эндокринных неоплазий 2 типа // Эндокринная хирургия. 2019. Т. 13, № 3. С. 105–117. doi: 10.14341/serg11270

6. Алмазов А.А., Румянцев П.О., Купреев П.П., и др. Системы поддержки принятия врачебных решений; анализ мультимодальных данных, разница «человеческого» и «машинного» подходов, социальная проблематика сбора и оборота биомедицинских данных // Врач и информационные технологии. 2020. № 2. С. 28–35. doi: 10.37690/1811-0193-2020-2-28-35

7. Gatta G., van der Zwan J.M., Casali P.G., et al. Rare cancers are not so rare: the rare cancer burden in Europe // Eur J Cancer. 2011. Vol. 47, N 17. P. 2493–2511. doi: 10.1016/j.ejca.2011.08.008

8. Filetti S., Durante C., Hartl D., et al. Thyroid cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up // Ann Oncol. 2019. Vol. 30, N 12. P. 1856–1883. doi: 10.1093/annonc/mdz400

9. Клинические рекомендации «Дифференцированный рак щитовидной железы». Москва, 2020. 47 с.

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