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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии
საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

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GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

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WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx**. Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - <http://www.spinesurgery.ru/files/publish.pdf> и http://www.nlm.nih.gov/bsd/uniform_requirements.html В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректур авторам не высылаются, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or computer-printed on a single side of standard typing paper, with the left margin of 3 centimeters width, and 1.5 spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - 12 (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf

In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned
Requirements are not Assigned to be Reviewed.**

ავტორთა საქურაღებოლ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx**. შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრაფიების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შედეგების ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფხიხლებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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POST-CT-GUIDED BIOPSY PNEUMOTHORAX, ACCORDING TO THE COAXIAL TECHNIQUE WITH AN 18-GAUGE NEEDLE: EPIDEMIOLOGICAL, DIAGNOSTIC AND THERAPEUTIC ASPECTS

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Abstract.

Introduction: Transthoracic CT-guided biopsy performed with the coaxial technique is a minimally invasive procedure that facilitates the diagnosis of lung lesions (nodules or masses) and/or mediastinopulmonary lesions suspected of malignancy. This procedure is the source of several complications, the most frequent of which is pneumothorax.

Objective: To describe the epidemiological, diagnostic, and therapeutic aspects of iatrogenic pneumothorax after CT-guided biopsy performed using the coaxial technique.

Patients and Methods: Prospective longitudinal study, conducted over a period of 2 years and 10 months, from April 1, 2023, to February 1, 2026, at the Mohammed V Military Teaching Hospital in Rabat, including all patients who presented with a pneumothorax following a transthoracic CT-guided biopsy, according to the coaxial technique, confirmed clinically and/or radiologically.

Results: The study included 30 cases of pneumothorax following CT-guided biopsy according to the coaxial technique. Biopsies were performed in 217 patients, and the incidence of pneumothorax was 13.8%. The median age was 68 years [58.8-71.5], with a predominance of males (90%). The most frequent characteristics observed among patients with pneumothorax were pulmonary emphysema (73.3%), lower-lobe lesions (33.3%), and central lesions with a median depth of 3.6 cm [2.9-4.2]. Procedure-related characteristics included practitioner status and biopsy needle diameter (18-gauge). Most patients were asymptomatic (60%). Diagnosis was established by chest CT during the procedure in 26.7% of cases and by chest X-ray after the procedure in 73.3% of cases. Small pneumothorax was the most common presentation (40%). Treatment was conservative in 53.3% of cases, and intervention was required in 46.7% (7 cases drained and 7 cases exsufflated). A complication was observed in 5 cases, after initial treatment. Only one patient underwent thoracoscopic pleurodesis after 14 days of chest drainage. The median length of hospital stay was 4 days [2-5.75].

Conclusion: Pneumothorax is a major complication of CT-guided transthoracic biopsy, whether performed coaxially or non-coaxially. In our descriptive series, pulmonary emphysema, lower-lobe location, and lesion depth were frequent characteristics among patients who developed pneumothorax. We believe that the radiologist's experience is a determining

factor in preventing a very high incidence of pneumothorax cases.

Key words. Iatrogenic pneumothorax, CT-guided biopsy, diagnosis, treatment.

Introduction.

CT-guided transthoracic biopsy is a minimally invasive procedure that facilitates the diagnosis of suspicious pulmonary nodules or masses and/or mediastinopulmonary lesions. This procedure is performed according to two techniques: coaxial and non-coaxial. However, the use of these techniques exposes patients to complications, the most common of which is iatrogenic pneumothorax, with an incidence ranging from 23% to 27%, depending on whether the procedure is performed coaxially or non-coaxially [1]. Similarly, this complication, which is generally benign (asymptomatic) [2], is promoted by two groups of factors: unavoidable factors (pulmonary emphysema, lesions smaller than 2 cm located in the lower part of the lung and ≥ 2.5 cm deep in relation to the pleura) and avoidable factors (the technical competence of the practitioner, the diameter of the biopsy needle, and the type of lung biopsy technique) [1]. Its diagnosis is easily established during the procedure using a chest CT scan and/or after the procedure using a chest X-ray [2]. Its treatment considers its symptomatology and volume, ranging from conservative management to exsufflation and chest drainage, or even pleurodesis via video-assisted thoracoscopic surgery in cases of persistent pneumothorax. Following the observation of frequent cases of iatrogenic pneumothorax after CT-guided transthoracic biopsy in our hospital, and due to the lack of data on this iatrogenic pathology, we conducted a prospective longitudinal study with the aim of describing the epidemiological, diagnostic, and therapeutic aspects of iatrogenic pneumothorax following CT-guided biopsy.

Patients and Methods.

Type of study:

This was a prospective longitudinal study.

Patient recruitment:

Doctors in the pulmonology department recorded all cases of pneumothorax occurring after CT-guided transthoracic biopsy indicated for suspicious pulmonary and/or mediastinopulmonary lesions, either during or after the procedure. The thoracic

surgery team was then contacted to manage this complication. Cases of CT-guided transthoracic pulmonary and/or mediastinopulmonary biopsy were recorded in a registry maintained by the pulmonology department.

Inclusion criteria:

- Patients presenting with symptomatic or asymptomatic iatrogenic pneumothorax.
- Patients aged 18 years and older, of all sexes.
- Patients presenting with iatrogenic pneumothorax following CT-guided biopsy for pulmonary and/or mediastinopulmonary lesions.

Non-inclusion criteria:

- Patients presenting with iatrogenic pneumothorax following CT-guided biopsy who refuse treatment.
- Patients presenting with iatrogenic pneumothorax unrelated to CT-guided biopsy.

Data collection:

The data were collected using a structured questionnaire, which was completed in the presence of the conscious adult patient. These data included the following information:

- Socio-demographic data (age, sex).
- Characteristics reported in the literature as non-modifiable risk factors: basal lesions, small lesions (< 2 cm), pulmonary emphysema, lesions surrounded by emphysematous bullae, and central lesions with a depth relative to the pleura (≥ 2.5 cm).
- Procedure-related characteristics reported in the literature as modifiable factors: the size of the biopsy needle and the practitioner's level of experience.
- Clinical data: Including functional, general, and physical signs.
- Paraclinical data: Including chest X-ray and chest CT scan findings, which made it possible to establish or confirm the diagnosis of pneumothorax.
- Diagnostic data: Including the diagnosis, specifying its clinical form and extent, as interpreted by the radiologist on CT scans and by the thoracic surgeon on chest X-rays, in accordance with the 2010 British Thoracic Society (BTS) guidelines [3].
- Data related to treatment: Including the type of treatment (conservative management, chest drainage, or exsufflation), the drainage site in cases of chest drainage, and the duration of treatment in days.
- Morbidity-mortality data: Including clinical outcomes, types of complications, and number of deaths.
- Data related to the treatment of complications: Including talc pleurodesis by thoracoscopy, exsufflation, and/or chest drainage.

Data analysis:

Data analysis was carried out using Jamovi version 2.3.19 software. Qualitative variables were expressed as frequencies and percentages, whereas quantitative variables were expressed as the mean and standard deviation when normally distributed (Gaussian), or as the median and interquartile range when non-normally distributed (non-Gaussian).

Ethical considerations:

Regarding ethical considerations, patient anonymity was preserved and verbal consent was obtained. The use of verbal

consent was approved by the institutional review board of the Mohammed V Military Teaching Hospital and was considered appropriate due to the non-interventional design of the study and the absence of additional risk to participants.

Results.

Epidemiological Aspect.

Incidence of pneumothorax:

Over a 2-year and 10-month study period, 217 patients were admitted to the interventional radiology department for CT-guided transthoracic biopsy to diagnose suspicious pulmonary and/or mediastinopulmonary lesions. Among these patients, 30 developed iatrogenic pneumothorax, representing an incidence of 13.8%. No cases of pneumothorax were associated with pulmonary hemorrhage or other complications.

Socio-demographic characteristics:

The median age was 68 [58.8–71.5] years, ranged from 30 to 81 years. Of the 30 cases of iatrogenic pneumothorax, 27 patients (90%) were men and 3 (10%) were women, yielding a male-to-female ratio of 9:1.

Characteristics observed among patients who developed pneumothorax:

These characteristics were described in two groups for descriptive purposes: non-modifiable patient/lesion characteristics and procedure-related characteristics.

The non-modifiable characteristics observed among patients with pneumothorax included:

- Pulmonary emphysema: Twenty-two patients (73.3%) had pulmonary emphysema, including 8 (26.7%) with a suspicious lesion surrounded by emphysematous bullae.
- Basal lesions: Ten patients (33.3%) had lesions in the inferior lobes: 6 (20%) in the right lung and 4 (13.3%) in the left lung.
- Central lesions and depth ≥ 2.5 cm: Ten patients (33.3%) who developed pneumothorax had central lesions, with a median lesion depth of 3.6 cm [2.9-4.2].
- Small lesions (< 2 cm): Only 6 patients (20%) who developed pneumothorax had suspicious lesions smaller than 2 cm. The distribution of these characteristics is presented in Table I.

The procedure-related characteristics observed included:

- Practitioner's status: All CT-guided biopsies were scheduled and performed exclusively by two professors of radiology.
- Size of the biopsy needle: The coaxial technique was the only method used by the two interventional radiologists and was performed using an 18-gauge semi-automatic Bard Monopty needle.

Diagnostic Aspect.

Functional signs:

Of the 30 patients who developed iatrogenic pneumothorax, 18 (60%) were asymptomatic, while 12 (40%) were symptomatic.

General signs:

In our sample, the median respiratory rate was 13 cycles per minute [12-19]. The median pulse oxygen saturation (SpO₂) was 98% [91.8-99%]. Only two patients (7.1%) experienced tachycardia. No arterial hypotension was detected.

Table 1. Distribution of patients according to characteristics observed among pneumothorax cases.

Characteristic	Corresponding value
Pulmonary emphysema**	22 (73.3%)
Emphysematous bulla surrounding the lesion **	8 (26.7%)
Lesion location **	Right lower lobe = 6 (20.0%) Left lower lobe = 4 (13.3%) Middle lobe = 2 (6.7%) Right upper lobe = 10 (33.3%) Left upper lobe = 5 (16.7%) Right mediastinopulmonary = 2 (6.7%) Left mediastinopulmonary = 1 (3.3%)
Central lesion**	10 (33.3%)
Depth* >= 2.5 cm	3.6 cm [2.9-4.2]
Small lesion** < 2 cm	6 (20.0%)

*Median and interquartile range. **Count and percentage.

Table 2. Distribution of patients according to clinical manifestations.

Category	Sign	Corresponding value
Functional signs	Dyspnea**	3 (10.0%)
Functional signs	Dyspnea + Chest pain	9 (30.0%)
Functional signs	Asymptomatic**	18 (60.0%)
General signs	Respiratory rate*	13 cycles/min [12-19]
General signs	SpO2 *	98% [91.8-99%]
General signs	Tachycardia**	2 (7.1%)
General signs	Low blood pressure**	0 (0%)
Physical signs	Pleural air effusion syndrome **	19 (63.3%)
Physical signs	Subcutaneous emphysema**	1 (3.3%)

*Median and interquartile range. **Count and percentage.

Table 3. Distribution of patients according to diagnosis.

Diagnosis**	Count (N, %)
Right pneumothorax	20 (66.7%)
Left pneumothorax	8 (26.7%)
Left compressive pneumothorax	2 (6.7%)
Total	30 (100%)

Count and percentage.

Table 4. Distribution of patients according to the size of pneumothorax.

Size of pneumothorax **	Count (N, %)
Small size	12 (40.0%)
Moderate size	11 (36.7%)
Large size	7 (23.3%)
Total	30 (100%)

Count and percentage.

Table 5. Distribution of patients according to the type of treatment.

Type of treatment**	Count (N, %)
Conservative treatment	16 (53.3%)
Exsufflation	7 (23.3%)
Thoracic drainage	7 (23.3%)
Total	30 (100%)

Count and percentage.

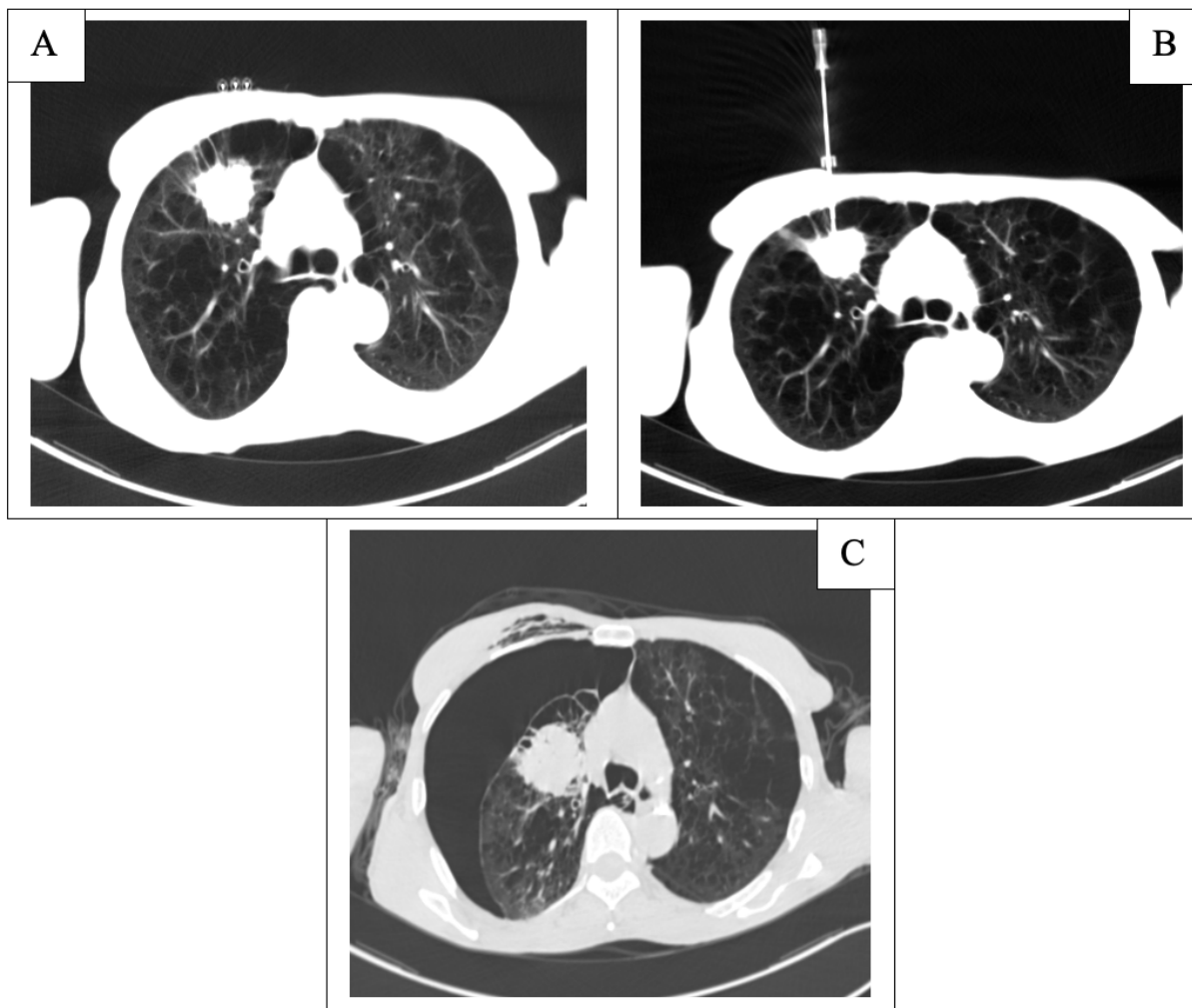


Figure 1. CT-guided biopsy performed with an 18-gauge needle using the coaxial technique. (A): Localized upper right lobe lesion surrounded by emphysematous bullae. (B): Biopsy of the suspicious lesion with an 18-gauge needle. (C): Large right-sided pneumothorax.

Physical signs:

Pneumothorax was the most common finding, occurring in 19 cases (63.3%). The distribution of patients according to clinical manifestations is presented in Table II.

Complementary exams:

Regarding paraclinical findings, 8 patients (26.7%) were diagnosed with pneumothorax during the procedure using chest CT scan (Figure 1), while 22 patients (73.3%) were diagnosed after the procedure using chest X-ray.

Diagnostic:

Iatrogenic right pneumothorax was the most common diagnosis, occurring in 20 patients (66.7%). No cases of pneumothorax were associated with pulmonary hemorrhage. The distribution of patients according to diagnosis is presented in Table III.

Size of pneumothorax:

Most iatrogenic pneumothorax cases following CT-guided biopsy for pulmonary and/or mediastinopulmonary lesions were of small size, occurring in 12 patients (40%). The distribution of patients according to the size of pneumothorax is presented in Table IV.

Therapeutic Aspect.

Type of treatment:

Many patients received only conservative treatment (rest and oxygen therapy), namely 16 patients (53.3%). The distribution of patients according to the type of treatment is presented in Table V.

Thoracic drainage approach and duration of thoracic drainage:

The thoracic drainage approach for patients who required chest drainage was performed in the mid-axillary line, in 4 patients (57.1%) on the right and 3 patients (42.9%) on the left. The median duration of chest drainage was 5 days [4.5–5.25].

Evolution:

Among the 30 patients treated for pneumothorax, 3 of 16 patients who received conservative treatment showed worsening pneumothorax, 1 of 7 patients who underwent chest drainage experienced persistent air leakage beyond 7 days, and 1 of 7 patients who underwent exsufflation also showed worsening pneumothorax.

Treatment of complications:

Among the patients who developed complications, two

underwent chest drainage via the mid-axillary line, two underwent exsufflation, and one underwent talc pleurodesis via single-port video-assisted thoracoscopic surgery.

Length of hospitalization:

The median length of hospital stay was 4 days [2–5.75] days.

Discussion.

CT-guided transthoracic biopsy for suspicious pulmonary and/or mediastinal lesions is associated with numerous complications, including pneumothorax, pulmonary hemorrhage, gas embolism, and tumor seeding of the pleura or chest wall [1,4,5]. However, according to the literature, pneumothorax remains the most common complication of this procedure, with an overall cumulative incidence of 25.9% [6]. In our study, the incidence was 13.8%, and no other complications were observed.

This differs from the study by Nour-Eldin et al. [1], where the incidence was higher, at 27% for coaxial techniques and 23.2% for non-coaxial techniques, with a simultaneous incidence of pneumothorax and pulmonary hemorrhage of 27.3%. This difference can be explained by our smaller sample size and the exclusive use of the coaxial technique.

The literature reports that pulmonary emphysema is a non-modifiable patient-related factor that significantly increases the incidence of pneumothorax [4,5]. In our series, it was the most frequent characteristic observed among patients who developed pneumothorax; however, no comparative analysis with patients without pneumothorax was performed in this study. Pulmonary emphysema often results from chronic smoking; according to a study conducted in Morocco by F. Badrir et al. [8], the prevalence of smoking is higher among men (32.7%) than women (4.5%). This may explain the increased incidence of pneumothorax observed in men with a median age of 68. Air trapped in parenchyma with reduced elasticity increases the risk of leakage into the pleural space post-biopsy due to the prevailing negative pressure in that space [1,9].

Basal location, a non-modifiable lesion-related factor, has been widely reported as a risk factor that significantly increases pneumothorax due to its anatomical relationship with the diaphragm. This proximity makes these lesions more vulnerable than those in the upper and middle lobes [1,2,6]. In our series, basal location was the second most frequent characteristic among pneumothorax cases.

Centrally located lesions were the next most frequent lesion-related factor, with a median depth relative to the pleura of 3.6 cm in 10 cases (33.3%). This is higher than the results reported by Gaurav Raj et al. [10], where among 10 lesions deeper than 2 cm from the pleura, six cases were complicated by pneumothorax. Other studies have also highlighted an association between lesion depth and pneumothorax, notably the retrospective evaluation of 311 biopsies by A.S. Elshafee et al. [2] and the study of 650 patients by Nour-Eldin et al. [1]. The latter aimed to determine risk factors for post-biopsy pneumothorax using coaxial and non-coaxial techniques and showed a significant association between pneumothorax and a biopsy needle path ≥ 2.5 cm. In our descriptive series, centrally located and deeper lesions were frequent characteristics among patients with pneumothorax.

The third non-modifiable lesion-related factor in our study was small lesion size (< 2 cm). This corroborates data from Yeow et al. [11], which showed that coaxial CT-guided lung biopsy of lesions smaller than 2 cm traversed by 2 cm of aerated lung was a significant risk factor for pneumothorax. This was also confirmed by Nour-Eldin et al. [1], who demonstrated an association between biopsies of lesions smaller than 2 cm and the occurrence of pneumothorax ($p = 0.02$) in both coaxial and non-coaxial groups. This could be explained by the frequent manipulation of the needle required to reach smaller targets, which increases parenchymal trauma. In our study, small lesion size was another characteristic frequently observed among pneumothorax cases.

Literature indicates that large-caliber biopsy needles (18-gauge or larger) increase the risk of pneumothorax when passing through emphysematous bullae or when the puncture is directed superiorly [6]. In our study, biopsies were performed exclusively using an 18-gauge semi-automatic coaxial needle. Among patients with pulmonary emphysema, eight cases had bullae surrounding the suspicious lesion; the passage of the large needle through these bullae likely increased the frequency of iatrogenic pneumothorax. Therefore, the use of smaller-gauge needles may be an effective preventive measure. This was confirmed by Kuban et al. [12], who showed that 19-gauge coaxial needles significantly reduce the risk of pneumothorax compared to 18-gauge needles.

The technical skill of the interventional radiologist is a modifiable risk factor that determines pneumothorax frequency, as it influences the ability to avoid unnecessary maneuvers and reduce procedure duration [1-11]. In our study, biopsies were performed exclusively by two highly qualified interventional radiologists, which may explain the low incidence of pneumothorax across 217 procedures.

Post-biopsy pneumothorax was detected via chest X-ray 24 hours after the procedure in 73.3% of cases and via CT scan during the procedure in 26.7% of cases. This differs from Elshafee et al. [2], where 98.5% of pneumothoraxes were detected by CT immediately post-biopsy and 1.5% were detected two hours later. This discrepancy stems from our protocol, where all asymptomatic patients underwent follow-up X-rays 24 hours post-biopsy before discharge. While X-rays are less sensitive than CT for early detection, they are more cost-effective; however, an X-ray performed on an asymptomatic patient immediately after the procedure might miss pneumothoraxes that manifest later.

In our study, most iatrogenic pneumothoraxes were of minimal volume, accounting for 40% of cases. This aligns with Gaurav Raj et al. [10], where minimal iatrogenic pneumothorax using the coaxial technique with an 18-gauge needle was the most frequent type (70.4%). This explains why most patients in our study remained asymptomatic. Only two patients exhibited tachycardia related to tension pneumothorax, and clinical symptoms were only present in cases of moderate-to-severe volume.

Classifying pneumothorax by severity allows for appropriate treatment selection. Interventions are rarely required, as most of these complications are benign [13,14]. In our study, patients with minimal to moderate asymptomatic pneumothorax received

conservative treatment with satisfactory outcomes in 13 out of 16 patients (81.3% success rate). This corroborates Nour-Eldin et al. [1], where conservative treatment was successful in 90.1% of cases.

For symptomatic moderate pneumothoraxes and large or tension pneumothoraxes, intervention was required: seven cases underwent chest tube drainage and seven underwent manual aspiration using a 16-gauge catheter. This intervention rate is higher than that reported by Gaurav Raj et al. [10], likely due to our larger sample size and a higher number of symptomatic patients. Furthermore, the frequent presence of pulmonary emphysema and deep lesions are primary indications for chest tube placement according to the literature [15].

Of the five complicated cases, four were resolved by chest drainage (two cases) or aspiration (two cases). However, the fifth patient required thoroscopic pleurodesis after 14 days of persistent air leakage. While literature suggests intervention after 7 days of leakage to prevent bronchopleural fistulas [1], no such fistulas or pleural infections were observed in this patient despite the delayed surgical intervention.

The primary limitations of this study include its small sample size of only 30 pneumothorax cases, which the authors acknowledge may account for differences in incidence rates compared to larger established literature. Additionally, the study's single-center design and exclusive focus on the coaxial technique performed by only two highly experienced radiologists limits the generalizability of the results to other clinical settings or less experienced practitioners. Finally, the cohort exhibited a significant demographic imbalance, with a 90% male predominance largely attributed to local smoking trends, potentially limiting the applicability of the risk factor analysis to female patients.

Conclusion.

Pneumothorax remains a primary complication of CT-guided biopsies for pulmonary and/or mediastinal lesions suspected of malignancy, with an observed incidence of 13.8%. In this descriptive series, pulmonary emphysema, lesion depth, lower-lobe location, and small lesion size were frequent characteristics among patients who developed pneumothorax.

According to the literature, the expertise of the interventional radiologist and the utilization of small-gauge biopsy needles can effectively reduce the incidence of pneumothorax. Although the condition is generally asymptomatic, it is readily diagnosed during the procedure via CT scan or post-procedurally using a chest X-ray.

The management of pneumothorax is determined by its volume and clinical symptomatology. Conservative management is preferred for asymptomatic minimal or moderate pneumothorax. However, intervention is required for symptomatic moderate cases and all large pneumothoraxes. These interventions include manual aspiration (exsufflation) and chest tube drainage; in cases of persistent air leakage despite drainage, thoroscopic pleurodesis may be indicated. Such complications often result in extended hospital stays, particularly for patients requiring drainage, thereby increasing overall healthcare costs.

No conflict of interest to declare.

Verbal informed consent was obtained.

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