Respiratory Medicine Case Reports 33 (2021) 101427

Contents lists available at ScienceDirect

Respiratory Medicine Case Reports

journal homepage: www.elsevier.com/locate/rmcr

Case report

Pulmonary amyloidosis mimicking interstitial lung disease and malignancy - A case series with a review of a pulmonary patterns

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ARTICLE INFO

Keywords:
Pulmonary amyloidosis
Congo red
Amyloid protein
Case report

ABSTRACT

Background: Amyloidosis is an uncommon condition, which results from accumulation of misfolded extracellular insoluble protein in tissues and organs of the body, causing its damage and dysfunction. Histologically, after staining with Congo red, the amyloid deposits show an apple-green birefringence under polarized light microscope. Amyloidosis can affect all organ systems and is classified into hereditary or acquired, localized or systemic. Respiratory involvement occurs in 50% of the patients with amyloidosis and it may take tracheobronchial, nodular parenchymal, diffuse alveolar septal and lymphatic forms.

Methods: We report four cases of pulmonary amyloidosis. A female patient with localized form of tracheobronchial and nodular parenchymal pulmonary amyloidosis, which was initially misdiagnosed as sarcoidosis. A male patient who was referred to our department for further evaluation of multiple tumors in lungs accompanied by mediastinal lymphadenopathy, liver and peritoneal tumors. A male patient with suspect of lung malignancy. A male patient with diagnosed idiopathic pulmonary fibrosis and the possibility of malignancy.

Results: All the diagnoses were established by demonstration of amyloid protein in tissue specimens obtained in transbronchial or open lung biopsies.

Conclusions: Due to its nonspecific clinical and radiological findings, amyloidosis can often mimic other diseases and should be considered as one of the differential diagnoses. In order to confirm the diagnosis, proving the presence of amyloid deposition with positive Congo red staining in respiratory specimen is mandatory.

1. Introduction

Amyloidosis is a heterogeneous group of diseases, which results from accumulation of misfolded extracellular insoluble protein in tissues and organs of the body, causing its damage and dysfunction [1]. The pathogenic process of conversion from well-folded soluble form into a predominantly antiparallel ß-sheet secondary structure is complex and regulated by various environmental conditions [1,2]. At least 36 proteins have been identified as causative of amyloidosis [1,3,4]. The International Society of Amyloidosis (ISA) divides amyloidosis into systemic (with most common types of light-chain) (AL) amyloidosis; amyloid A (AA), due to chronic inflammatory diseases; β2-microglobulin amyloidosis-dialysis-related and hereditary transthyretin-related amyloidosis (point mutation in transthyretin (TTR) gene)) and localized form (predominantly AL amyloidosis). While systemic form requires treatment including e.g. high-dose chemotherapy, autologous stem cell transplantation, treatment of the localized form may remain symptom-orientated[3,4]. Respiratory involvement occurs in 50% of the patients with amyloidosis and may develop in all its subtypes [5]. The gold standard for diagnosis confirmation is histological staining with Congo red. The amyloid deposits show an apple-green birefringence under a polarized light microscope. Specific fibril type may be identified by immunohistochemical analysis, although in many cases subclassification remains undiscovered[3]. Most common anatomical distribution patterns in pulmonary amyloidosis are tracheobronchial, nodular parenchymal, diffuse alveolar septal, vascular and lymphatic. In rare cases pleural involvement was described [6–8]. The clinical symptoms are nonspecific and vary depending on localization and extend from dypnoea, cough, to bronchial obstructions signs, such as wheezing or recurrent lower respiratory tracts infections, which can mimic other pulmonary diseases[9]. We present retrospective

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https://doi.org/10.1016/j.rmcr.2021.101427
Received 1 February 2021; Received in revised form 30 March 2021; Accepted 7 May 2021
Available online 11 May 2021

Abbreviations

AA amyloidosis	inflammation associated amyloidosis
AL amyloid	immunoglobulin light chain associated amyloidosis
ALAT	alanine amino transferase
ANA	antinuclear antibody
ANCA	antineutrophil cytoplasmic antibody
anti-CCP	anti-cyclic citrullinated protein
ASAT	aspartate amino transferase
ATTR	transthyretin associated
BAL:	bronchoalveolar lavage
CRP	C-reactive protein
CT	computer tomography
CO2	carbon dioxide;
CTD	connective tissue disease
DLCO	diffusing capacity of the lung for carbon monoxide;
ENA	antibodies against extractable nuclear antigen
eGFR	estimated glomerular filtration rate
ERCP	endoscopic retrograde cholangiopancreatography
FGD	18-F- fluorodeoxyglucose
GGT	gamma glutamyl tranfserase
FNB	fine needle biopsy
Hb	hemoglobin
HRCT	high resolution computed tomography
IgA	immunoglobulin A
IgE	immunoglobulin E
IgG	immunoglobulin G
IgM	immunoglobulin M
IPF	idiopathic pulmonary fibrosis
LDH	lactate dehydrogenase
Nd-YAG	neodymium-doped yttrium aluminum garnet;
NT-proBNP	N-terminal pro-B-type natriuretic protein
MALT	mucosa-associated lymphoid tissue
M-protein	monoclonal protein
PET	positron emission tomography
RF	rheumatoid factor
SAA	serum amyloid A protein
TLC	total lung capacity
UIP	usual interstitial pneumonia

review from the I Department of Lung Diseases of the National Tuberculosis and Lung Disease Research Institute, with biopsy-proven different types of pulmonary amyloidosis.

2. Case reports

Case 1. bronchial and diffuse nodular pulmonary amyloidosis

A 55-year-old woman, a former smoker, with history of 10 packyears of smoking, was admitted to surgical ward elsewhere due to the obstructive jaundice. An endoscopic retrograde cholangiopancreatography (ERCP) with stent placement was performed. Due to abnormal result of a chest X-ray, a chest computer tomography (CT) was performed, which showed diffuse nodular lesions in both lungs. The patient was referred to the pulmonary department and underwent a fiberoptic bronchoscopy, which revealed an obstruction of the bronchus to the right posterior segment of the lower lobe. A biopsy was performed and pathological examination demonstrated non-necrotizing granulomas surrounded by concentric scar tissue (fibrosis). Lung function test showed mild restriction with total lung capacity (TLC) of 79% of predicted value and diffusing capacity of the lung for carbon monoxide (DLCO) reduced to 72% of predicted value. The patient was diagnosed with stage III sarcoidosis and due to progressive dyspnoea on exertion, he was treated with systemic glucocorticosteroids (30 mg of prednisone). No improvement was achieved. The patient was admitted to our pulmonary department for further evaluation. A chest-CT was performed, which showed multiple partial calcified nodules extending from 5 to 20 mm in diameter, with predominance to both lower lobes of the lungs (Fig. 1 A,B) accompanied by bronchial involvement (obstruction of the bronchi to segment 2,6,7 of the right lobe), areas of parenchymal consolidation and septal thickening. A tissue specimen was reevaluated and positively stained with Congo red and showed green birefringence under polarized light microscope. The diagnosis of pulmonary amyloidosis was confirmed. Routine blood tests such as CRP, Hb, leukocytes, creatinine, eGFR, ASAT, ALAT, GGT, LDH, calcium, albumin, NT-proBNP, IgA, IgM, IgG levels, urine analysis with 24h proteinuria and calcinuria, connective tissue disease (CTD) diagnostic with RF, ANA, ANCA were performed and presented no significant abnormalities. Echo and abdominal ultrasound showed no other organ involvement. In order to exclude systemic involvement, hematological diagnostic was performed: serum immunotyping revealed no monoclonal gammapathy, bone marrow biopsy and adipose tissue biopsy showed no specific lesions. The glucocorticoid therapy was terminated. In 10 years observation, the patient reported worsening of dyspnoea on exertion, radiological test showed progression and evolvement of the bilateral nodules and parenchymal consolidations. Multiple calcifications were to observe. (Fig. 1 C,D). Echo indicated the possibility of development of pulmonary hypertension. Lung function tests were stable, except for DLCO, which decreased to 55%. Due to the localized form, symptom-oriented therapy and further observation were indicated.

Case 2. pulmonary involvement in systemic amyloidosis

A 45- year-old male with no history of chronic diseases was referred to our hospital for further evaluation of multiple nodules in both lung and pulmonary lymphadenopathy detected on a chest-CT scan performed at a gastroenterology department in the other hospital, where he was treated due to obstructive jaundice. He underwent an ERCP with stent placement. The brush cytology obtained at ERCP was negative for malignant cells. As metastases were suspected in the multiple lung nodules with possible primary malignancy in the gastrointestinal tract, a diagnostic laparoscopy was conducted, which showed multiple metastases on peritoneum and liver surface. However, histologically, the specimens obtained in biopsy, presented chronic inflammation with no indication of malignancy. At admission to our department, the patient was in a good condition with no pulmonary symptoms. Chest CT (Fig. 2.) showed bilateral hilar, axillary and epigastric lymphadenopathy, multiple lung and subpleural nodules in a perilymphatic distribution with predominance to both upper and middle lobe. A diagnostic flexible bronchoscopy with transbronchial lung biopsy were performed. A tissue specimen obtained in diagnostic laparoscopy was reevaluated and together with lung specimen positively stained with Congo red and showed green birefringence under polarized light microscope. A routine blood investigation revealed anaemia. Serum immunotyping, Echo and lung function tests showed no significant abnormalities. A systemic amyloidosis with pulmonary involvement was highly suspected. For further evaluation, diagnostic (bone marrow biopsy) and treatment, the patient was referred to a hematooncological department.

Case 3. primary nodular pulmonary amyloidosis

A 61- year-old man with a history of hypertension, psoriasis in remission and benign prostatic hyperplasia was presented to our hospital in order to evaluate disease dynamics. He was earlier diagnosed elsewhere due to haematoptysis. The conducted chest CT demonstrated polymorphic peripheral consolidations in both lungs, predominately to

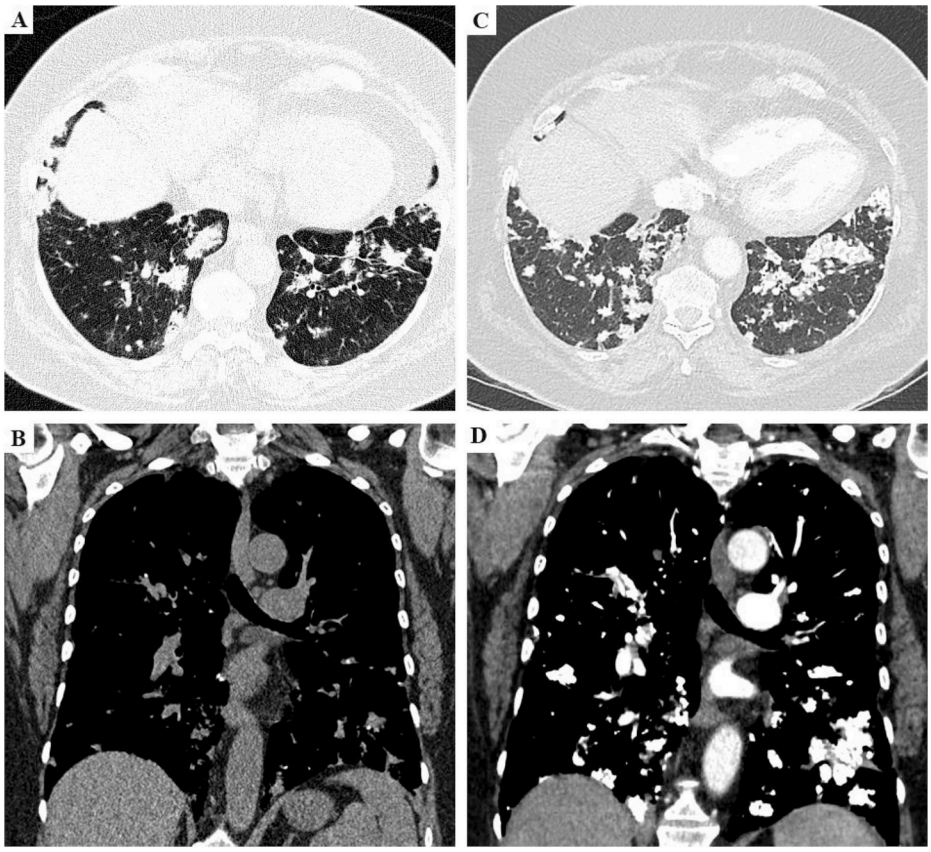

Fig. 1. Computed tomography scans showed bilateral diffuse nodules and areas of parenchymal consolidations (A,B). Follow-up computed tomography scan after 10 years observation showed progression and evolvement of the bilateral multiple consolidations and nodules (C). Consolidations and nodules are calcified (D).

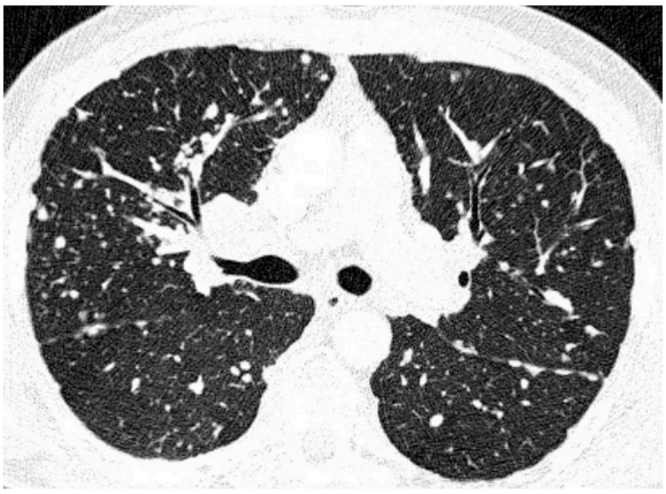

Fig. 2. Computed tomography scan showing multiple lung and subpleural nodules in a perilymphatic distribution in both upper lobes.

lower lobes, extending from 5 to maximal 38 mm in diameter. There was no lymphadenopathy nor pleural effusion described. A fiberoptic bronchoscopy revealed no abnormalities and cytology sample examination showed no malignant cells. As malignancy was suspected, sequentially he underwent a right sided posterolateral thoracotomy with resection of the nodule in order to establish the diagnosis. Results of pathological examination of lung tissue showed birefringence to polarized light and positivity to Congo red. Serum immunotyping was negative for monoclonal gammaopathy, serum-free kappa and lambda levels were not elevated, serum kappa/lambda ratio was average. Routine blood investigations revealed no abnormalities, tests for CTD (RF, ANA, aCCP) were negative. Bone marrow aspiration cytology, colonic mucosa and adipose tissue biopsy were negatively stained with Congo red. At admission to our department, one year after the symptoms begin, the patient complained of dyspnoea on exertion and unspecific chest pain. Serum immunotyping revealed slightly elevated b-1 globulin level and serum-free lambda level. Echo suggested the possibility of development of pulmonary hypertension. Abdominal ultrasound reported prostatic hypertrophy and renal cysts. Lung function tests were normal. Control chest CT revealed mild progression of the disease with maximal diameter of the nodule to 44 mm (Fig. 3.). The specimen was sent to reference centre in Italy for further evaluation. It was positively immunostained with anti-lambda light chains polyclonal antibody. A diagnosis of localized form of amyloidosis AL lambda was established. The patient was discharged with a follow-up program and symptom oriented treatment.

Case 4. Nodular and diffuse alveolar septal pulmonary amyloidosis

A 78- year-old male patient, former smoker with history of 5 pack-years, with stable coronary heart disease, chronic cardiac insufficiency, hypertension, atrial fibrillation, under pulmonary supervision in our department due to idiopathic pulmonary fibrosis (IPF) since 2013, was hospitalized due to suspicion of pulmonary neoplasia. High resolution computer tomography (HRCT) performed in 2013 revealed signs of usual interstitial pneumonia (UIP) (Fig. 4B) accompanied by irregular subpleural consolidations in both lungs, extending to maximal 18 mm in diameter. The patient was diagnosed with idiopathic pulmonary fibrosis. In the 3-year follow-up period no significant disease progression was observed. In 2017, during qualification to antifibrotic therapy, a follow-up HRCT showed progression of the subpleural consolidations. A

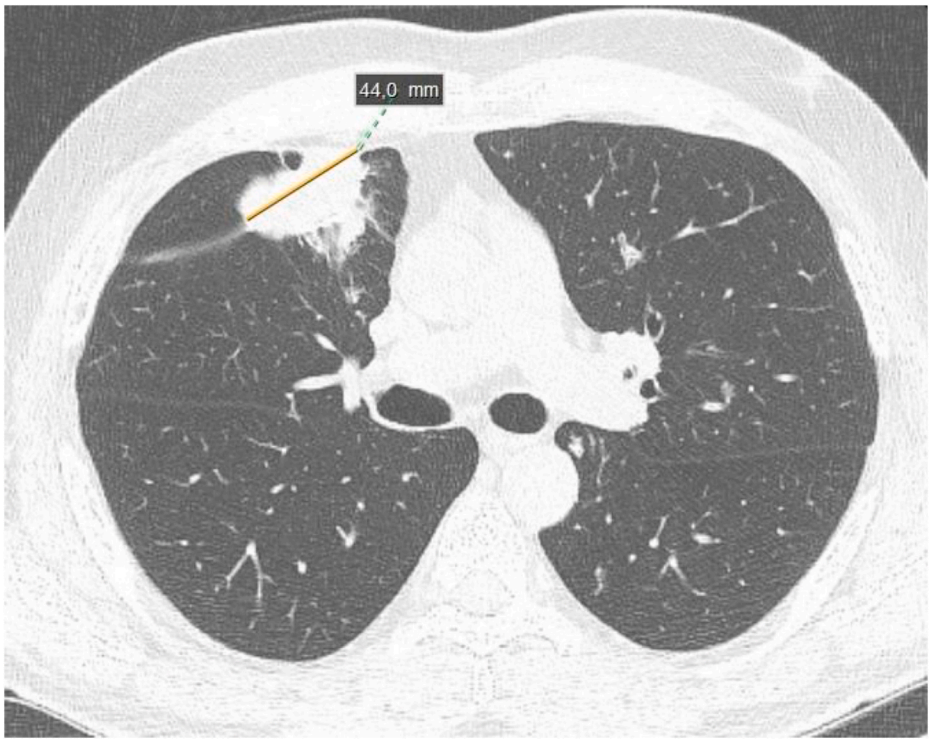

Fig. 3. Computed tomography scan showing a tumour with 44 mm in maximal diameter in the right lung.

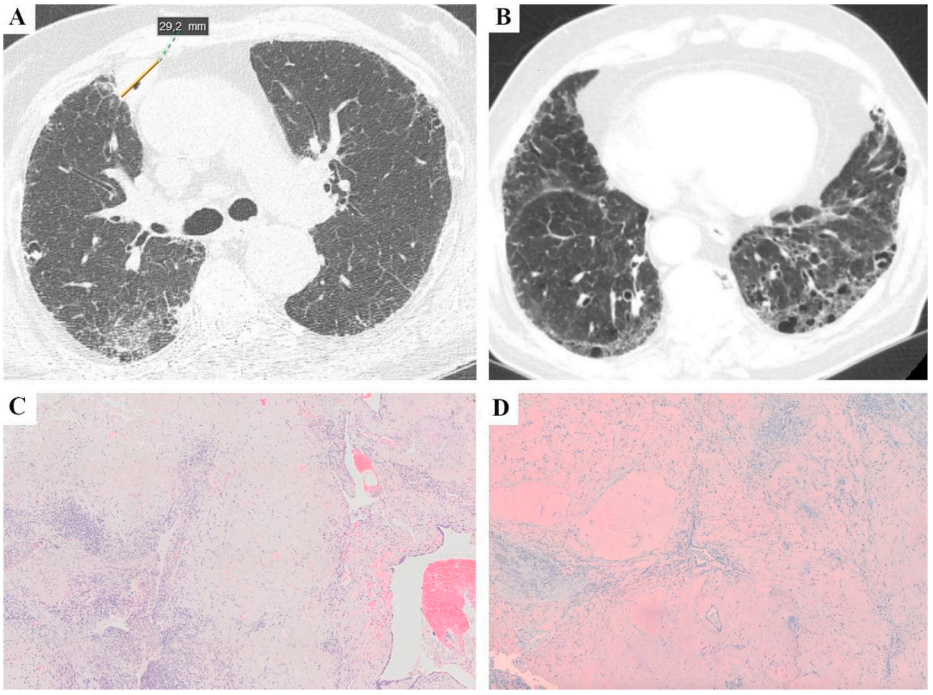

Fig. 4. Computed tomography scan showing a tumour in 3rd segment of the right lung (A) with diffuse subpleural traction bronchiectasis and honeycombing (UIP pattern) (B). Microscopic examination of the tissue specimen with hematoxylin and eosin staining under low magnification showing diffuse pulmonary amyloidosis. A fragment of lung parenchyma with amorphouseosinophilic material. Inflammatory infiltrates composed of lymphocytes and plasma cells are visible around the amyloid deposits (C). Congo red staining under low magnification showed amyloid deposits (D). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

fiberoptic bronchoscopy revealed no abnormalities. As malignancy was suspected, 18-F- fluorodeoxyglucose (FDG) positron emission tomography (PET-CT) was conducted and characterized one nodule in 3rd segment of the right lung as suggestive of malignancy (Fig. 4A). Surgical excision of the tumour was delayed due to respiratory tract infection. After antibiotic therapy, another chest CT scan was performed and characterized the tumour as a cavity with soft tissue mass, probably aspergilloma. Bronchoalveolar lavage culture showed no growth of fungi or bacteria, serological tests (Aspergillus-antigen, IgG and IgE) were negative for Aspergillus infection. The patient underwent a surgical resection of the tumour. Histologically, specimens contained amyloid deposits in alveolar septal, perivascular, peribronchial, subpleural distribution, as well inflammatory infiltrate, foreign body giant cells, ossifications and fibrosis with bronchiolisation were present. Deposits showed positivity to Congo red staining and green birefringence to polarized light (Fig. 4C and D). Tissue specimen culture revealed

Aspergillus fumigatus and the patient was treated with itraconazole. Overall clinical and radiological picture allowed to reevaluate the diagnosis of IPF to pulmonary amyloidosis. Echo showed decrease ejection fraction (EF) of the left ventricle of 50%, hypokinesis of interior and posterior segments of the left ventricle, probably due to coronary heart disease, also suggested the possibility of development of pulmonary hypertension. Abdominal ultrasound showed a renal cyst. Serum immunotyping and routine blood tests revealed no abnormalities. Tests for CTD showed ANA in ratio 1:160. In 2018, the patient was diagnosed with gastric adenocarcinoma and his follow-up program in our department was interrupted due to oncologic treatment. There were no signs of any other organ involvement, nevertheless the patient did not undergo a bone marrow and adipose tissue biopsy. The patient died due to complications of the oncological treatment.

3. Discussion

Amyloidosis is a rare disease with an AL amyloidosis incidence of 1 case per 100000 person-years in Western countries and male and elderly predominance [1,7]. The pathogenesis of amyloidosis is complex and regulated by various environmental conditions [1,2]. The protein may acquire misfolded state due to intrinsic propensity, which often occur with aging (systemic wild-type TTR amyloidosis) and long-term presence of high concentration in serum (for instance: beta2-microglobulin in patients undergoing dialysis). Another pathogenic pathway is amino acid replacement in familial form of systemic hereditary TTR amyloidosis. In AA amyloidosis, chronic inflammatory state leads to longstanding serum amyloid A protein (SAA) production in the liver. The most common chronic diseases leading to SAA are Crohn disease, connective tissue diseases, chronic osteomyelitis, tuberculosis, syphilis, pyelonephritis and cystic fibrosis [5,8,11]. In primary AL amyloidosis, amyloid light-chain protein derived from monoclonal gammaglobulin light chains (either lambda or kappa) is deposited. This type is caused by preexisting multiple myeloma, Waldenström macroglobulinemia or progresses to one [1,2,4,5,12]. Regardless of the specific fibril type, amyloidosis can be divided into localized and systemic forms. Each disease is characterized by specific protein or peptide and a distinctive tissue is damaged. The deposition of insoluble protein around blood vessels, parenchymatous and mesechymatous can subvert the normal tissue architecture and lead to organ dysfunction. Other possible mechanism of amyloid cytotoxity is causing cell membrane disruption, increasing oxidation, direct peptide toxity and promoting apoptosis [2,5]. Respiratory involvement occurs in 50% of the patients with amyloidosis and may develop in all its subtypes [3–5], most frequently in AL type [4,5]. We presented 3 cases of localized amyloidosis form (Case 1, 3 and 4) and 1 case of systemic form (Case 3).

Usual radiologic examinations include HRCT, plain radiography, rarely PET-CT. The most frequent radiologic manifestations described in pulmonary amyloidosis are tracheobronchial, nodular parenchymal and diffuse alveolar septal pattern. Other thoracic findings include lymphadenopathy, pleural thickening with pleural effusions and laryngeal disease [4,5,8,10,13].

A tracheobronchial pattern (Case 1.) mostly occurs as a localized form of AL amyloidosis. Patients are often asymptomatic or like our patient, present progressive dyspnoea on exertion or other pulmonary symptoms like cough, haematoptysis, wheezing, recurrent lower respiratory tract infections due to bronchi obstruction [4–6]. CT imaging shows bronchial wall thickening, associated with calcifications, stenosis of bronchi lumen with mural nodulation, which can lead to athelectasis and post-obstructive air trapping. The differential diagnosis vary from calcifying neoplasm to granulomatous infectious (tuberculosis, histoplasmosis) and noninfectious (granulomatosis with polyangiitis, sarcoidosis, inflammatory bowel disease) diseases [6,13]. Our female patient (Case 1.) was primary misdiagnosed and treated for stage III sarcoidosis.

In nodular parenchymal pattern (Case 2,3) radiologically nodules can be solitary but often they are multiple with diameter less than 1cm, with bilateral, peripheral and subpleural, lower lobes predominance. Nodules are sharply defined, calcifications and cavitation may occur. A slow growth is observed and typical. Nodular type may be characterized as mass-like lesion with diameter >3cm. A differentiation from malignancy is often necessary. An F-FDG PET-CT may be performed, but the results are uncertain. Increased F-FDG uptake may be present in diseases other than malignancy like amyloidosis, tuberculosis, sarcoidosis, fungal disease, interstitial lung disease and rheumatoid nodules [4,9]. In our Case 4. nodule showed increased FDG uptake in PET-CT, with no malignancy proven. Probably caused by Aspergillus fumiagatus infection or inflammatory process due to amyloidosis itself. In literature sensitivity of FDG PET-CT scan was established to ca. 54% for nodular amyloidosis [4]. The most common differential diagnoses are neoplasms, granulomatous lung diseases, mucosa-associated lymphoid tissue (MALT) lymphoma and connective tissue diseases. In localized AL form, kappa chains type appears three times more often than lambda chain [4,6,9].

A diffuse alveolar septal pattern is a rare manifestation of amyloidosis in the lungs. Most frequently associated with systemic AL amyloidosis. HRCT findings result in reticular opacities, interlobular septal thickening and ground-glass opacities. Consolidations with calcification may be present. As lung interstitium affected is, most common differential diagnoses are pulmonary fibrosis, interstitial lung diseases in CTD or lymphangitic carcinomas. Our patient from Case 4. was primary misdiagnosed with idiopathic pulmonary fibrosis and malignancy. Therefore, histological examination is crucial [4,6,9].

Other rare intrathoracic manifestations are lymphadenopathy and pleural involvement with effusion. The presence of enlarged lymph nodes should be considered as possibility of systemic amyloidosis. Punctate and egg-shell-patterned calcifications may be observed. Mass effect with bronchial obstruction may lead to clinical symptoms. Recurrent pleural effusion results rather from amyloid deposition in the parietal pleura then inflammatory process and is a very rare disease complication [4,5].

The gold standard of amyloidosis diagnosis is a histologic confirmation. The amyloid deposits show positivity to Congo red staining and an apple-green birefringence under polarized light microscope. Specific fibril type may be identified by immunohistochemical analysis with antibody-based techniques, although in many cases subclassification remain undiscovered due to changes in amyloid protein conformation[3,6]. No specific biopsy type is recommended. In our cases, 2 patients underwent an open lung biopsy and 2 endoscopic fine needle biopsy (FNB). Open lung biopsy should be considered when less invasive methods (for instance CT-guided percutaneus FNB or transbronchial endoscopic FNB or transbronchial lung biopsy) were nonconclusive [4]. Once amyloidosis is diagnosed, a specific diagnostic approach is necessary in order to determine localized or systemic form and underlying/associated disease process. The presence of family history is important in hereditary form of TTR-amyloidosis. By presence of pulmonary amyloidosis other organ involvement should be excluded. Investigations such as routine blood tests (CRP, Hb, leukocytes, thrombocytes, creatinine, eGFR, ASAT, ALAT, GGT, LDH, ferritin, calcium, uric acid, albumin, NT-proBNP, troponin IgA, IgM, IgG levels, M-protein), urine analysis with 24h proteinuria and calcinuria, CTD diagnostic with RF, ANA, ENA, ANCA, a-CCP, lung function tests, abdominal ultrasound, Echo, adipose tissue, bone marrow and rectal mucosa biopsy, serum and urine immunophoresis with immunofixation, serum Ig-free light chains should be performed[4,6,8]. While systemic form requires treatment including e.g. high-dose chemotherapy, autologous stem cell transplantation, treatment of the localized form may remain symptom-orientated[3,4]. Choice of treatment in systemic AL amyloidosis depends on the organ involvement and should be directed by an experienced hematooncologist. Therapy varies from stem cell transplantation to chemotherapy with bortezomib or for more fragile patient oral therapy with dexamethasone and melphalan[4,6]. Treatment of AA amyloidosis is strictly associated with underlying condition

therapy, with the common aim of reducing the SAA concentration in serum [6,8]. Hereditary TTR amyloidosis treatment, next to supportive therapy is based on newly developed drugs such as inotersen, patisiran (both reduce transthyretin production) and tafamidis (prevents amyloid formation). Other known amyloid disrupters are doxycycline and tauroursodeoxycholic acid. A liver or multiple organ transplantation is often recommended [4,6]. Treatment approach in localized tracheobronchial amyloidosis form depends on the disease progression and clinical symptoms. Usually symptom-oriented and best supportive therapy is indicated. In the case of bronchial obstruction, endoscopic treatment such as Nd:YAG and CO2 laser, cryotherapy, argon plasma coagulation and prosthesis implantation are first-line choices. In some cases local radiation showed good local response. Nodular localized amyloidosis shows recurrence after resection, therefore rarely needs surgical excision. Therapy is based on treating underlying disease. Pleural effusion may be symptomatically treated with pleurodesis, thoracocentesis or chest tube placement [4,6,7]. Localized nodular amyloidosis appears to have good prognosis, tracheobronchial amyloidosis prognosis varies depending on the extend of bronchial involvement. Average survival in a systemic form of AL amyloidosis is 16 months. The overall survival rate is improving as a result of modern therapy, especially AA amyloidosis form[4,6].

4. Conclusion

Amyloidosis is an unusual cause of respiratory symptoms, which often are nonspecific and vary depending on localization and extend from dypnoea, cough, to bronchial obstructions signs, such as wheezing or recurrent lower respiratory tracts infections, which can mimic other pulmonary diseases such as neoplasm, interstitial lung disease, infectious diseases, CTD. Radiological manifestations are diverse, therefore, in order to confirm the diagnosis, a biopsy with positive staining to Congo-red is required. As treatment and prognosis vary in localized and systemic form, a specific diagnostic multidisciplinary approach to every amyloidosis case should be encouraged.

Disclaimers

None.

Sources of support

None.

Declaration of competing interest

All authors inform that there is none conflict of interest.

References

[1] G. Merlini, V. Bellotti, Molecular mechanism of amyloidosis, N. Engl. J. Med. 349 (2003) 583–596.
[2] M. Zaman, A. Khan, et al., Protein misfolding, aggregation and mechanism of amyloid cytotoxity: an overview and therapeutic strategies to inhibit aggregation, Int. J. Biol. Macromol. 134 (2019) 1022–1037.
[3] J. Baumgart, C. Stuhlmann-Laeisz, et al., Local vs. Systemic pulmonary amyloidosis- impact on diagnostics and clinical management, Virchows Arch. 473 (2018) 627–637.
[4] M. Baqir, A. Roden, T. Moua, Amyloid in the lung, Semin. Respir. Crit. Care Med. 41 (2020) 299–310.
[5] R. Rocha de Almeida, et al., Respiratory tract amyloidosis. State-of-Art review with focus on pulmonary involvement, Lung 193 (2015) 875–883.
[6] J.-S. Rech, P.-Y. Brillet, F. Jeny, et al., Amyloidosis, in: W.A. Wuyts, V. Cottin, P. Spagnolo, et al. (Eds.), Pulmonary Manifestations of Systemic Diseases (ERS Monograph). Sheffield, European Respiratory Society, 2019, pp. 296–318.
[7] A.K. Gandham, A.R. Gayathi, L. Sundararajan, Pulmonary Amyloidosis: a case series, Lung India 36 (2019) 229–232.
[8] Brunger A-F, Nienhuis H, Bijzet J, et al., Causes of AA Amyloidosis: a systemic review, Amyloid DOI:10.1080/13506129.2019.1693359.
[9] L.-N. Zhang, X.-Y. Hue, N. Wang, et al., Mimicking pulmonary multiple metastatic tumors: a case of primary nodular parenchymal pulmonary amyloidosis with review of literature, Oncol. Lett. 4 (2012) 1366–1370.
[10] J.-S. Rech, B. Arnulf, C. de Margerie-Mellon, et al., Lower respiratory tract amyloidosis: presentation, survival and prognostic factors. A multicenter consecutive case series, Am. J. Hematol. 94 (121) (2019) 1226.
[11] D. Patel, et al., Amyloidosis to chronic pulmonary aspergillosis: case report and a systemic review of literature, J. Mycol. Med. 29 (2019) 372–374.
[12] B. Moscatelli, G.B. Capoccetta, p Anselmi, et al., Kappa L-chain primary nodular lung amyloidosis; a case report, Amyloid 18 (Suppl 1) (2011) 116–118. Suppl. 1.
[13] B.R. Celli, A. Rubinow, A.S. Cohen, et al., Patterns of pulmonary involvement in systemic amyloidosis, Chest 74 (Issue 5) (1978) 543–547.