Good syndrome combined with neutropenia and multiple microbial pulmonary infections: case report and review of the literature

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Research Article

Keywords: Good syndrome, thymoma, hypogammaglobulinemia, neutropenia, multiple microbial pulmonary infections

Posted Date: December 21st, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3759233/v1

Additional Declarations: No competing interests reported.

Abstract

Introduction

Good syndrome (GS) is a rare acquired immunodeficiency disease characterized primarily by thymoma and hypogammaglobulinemia that predisposes to the risk of recurrent infections with multiple pathogens.

Case representation

We describe the case of a 37-year-old male GS with a history of thymoma resection who was hospitalized for multiple pulmonary infections with neutropenia and whose empirical antimicrobial therapy and promotion of granulopoiesis resulted in the resolution of the pulmonary infections and return of the neutrophil count to normal. The patient was hospitalized again for lung infection with neutropenia. Experienced antimicrobial treatment and promotion of granulocytosis were ineffective, and the alveolar lavage fluid was detected by high-throughput sequencing (NGS) to be infected with Bordetella parapertussis, Streptococcus pneumoniae, cytomegalovirus, Torque teno virus, Candida albicans, and Pneumocystis jirovecii, and the patient's neutrophil counts returned to normal after targeted anti-infective treatment and immunity-enhancing therapy. After targeted anti-infection and immunity-boosting treatment, the patient's lung infection subsided and his neutrophil count normalized.

Conclusion

When patients with thymoma have recurrent abnormal infections, immunologic testing should be performed to clarify whether GS is present, and anti-infective therapy should be aggressively administered.

Introduction

In 1954, Robert Good first described three patients with thymoma and hypogammaglobulinemia, giving rise to Good syndrome (GS). GS, also known as thymoma-associated immunodeficiency syndrome, occurs in middle-aged adults in their 40s and 60s and is a rare primary immunodeficiency disorder causing immune dysfunction that makes patients susceptible to bacterial, viral, fungal, and opportunistic infections. GS is clinically characterized by thymoma, hypogammaglobulinemia, low peripheral B-lymphocyte counts, decreased CD4 + lymphocytes, and inverted CD4+/CD8 + T-cell ratio. Here, we report a case of multiple microbial pulmonary infections in a GS patient with neutropenia and discuss potential treatment options.

Case description

In July 2017, a 32-year-old male who had been a smoker for 15 years underwent a series of examinations and tests after consulting the hematology department for a 1-day fever with temperature fluctuating between 36.7 and 38.7°C accompanied by progressively worsening malaise, dizziness, blurred vision, and pallor; his laboratory findings (Table S1:Selected hematological and immunological indices of the patients) showed red blood cell count (RBC), hemoglobin (HGB), reticulocyte count (RET), white blood cells (WBC), neutrophils (NE), B and CD4 + T lymphocytes, immunoglobulin G (IgG), immunoglobulin M (IgM), and immunoglobulin A (IgA) were significantly decreased. Folic acid: >20ng/ml, vitamin B12: 1279pg/ml, ferritin: 1229 ng/ml; Bone marrow aspiration showed active myeloproliferative activity, granulocyte: red = 2.13:1. The proportion of young granulocytes in the granulocyte lineage was high, and granulocytes were characterized by an imbalance of nuclear and plasma development, megaloblastic changes, internal and external plasma, multilobular, and granulomatous defects, etc. The proportion of red lineage was normal, with late juveniles as the most common. The proportion of erythrocytes was normal, with predominantly late juvenile erythrocytes, and juvenile erythrocytes were characterized by megaloblasts, enucleation, nuclear fragmentation, nuclear consolidation, binucleation, etc. Mature erythrocytes were heterogeneous, partly oversized, with fair filling, and were characterized by polychromatophilic erythrocytes, and occasional fragmentation. Lymphocytes, monocytes, and macrophages were not abnormal. An enhanced CT scan of the chest showed a soft tissue mass in the anterior superior mediastinum, which showed marked heterogeneous enhancement with arcuate calcification, and was considered a thymoma. Therefore, he was referred to the Department of Thoracic Surgery and underwent thymoma resection. After thymectomy, the pathology showed immunohistochemistry results supporting a B2 thymoma, with no tumor tissue in the surrounding adipose tissue and lymph nodes. The patient recovered well after the surgery, and the patient's blood counts have improved significantly since 1 month after admission. In September 2018, the patient developed cough and sputum with low-grade fever due to cold and exertion, and the bone marrow aspiration report showed that granulomatous hyperplasia was predominantly in the middle and young granulocytes, with coarsening of intracytoplasmic granules. The proportion of red blood cells was normal, with predominantly middle and late juvenile red blood cells, and mature red blood cells were basically of the same size and filled in moderately well. Lymphocytes, monocytes, and macrophages were not abnormal. After 3 weeks of cefoperazone sulbactam sodium and recombinant human granulocyte colony-stimulating factor (rhG-CSF), the patient's pulmonary infection symptoms disappeared, and the neutrophil count was significantly increased, while the lymphocyte count was slightly elevated and below normal. In September 2019, the patient was again admitted to the hospital with a lung infection and blood counts suggestive of granulocytopenia.After 2 weeks of cefoperazone sulbactam sodium and recombinant human granulocyte-macrophage colony-stimulating factor (rhGM-CSF), neutrophil counts returned to normal, whereas the lymphocyte counts were elevated but lower than normal.The patient presented again in April 2023 with a fever, with a temperature of up to 38.5°C, as well as a cough and sputum, and was seen in our emergency department, where he was treated with anti-infective therapy with ertapenem with peramivir for 5 days; the patient's symptoms did not improve, so he was transferred to the respiratory department for further treatment. After recording the patient's temperature was elevated in the morning and at night, fluctuating from 38°C to 39°C, and the fever lasted

for 1 week. Laboratory findings showed a decrease in RBC, HGB, RET, WBC, NE, LYM, IgG, IgM, IgA, B lymphocytes, and CD4 + T lymphocytes; a negative nucleic acid test for novel coronavirus; a negative test for tuberculosis gamma-interferon (blood); a negative staining for antacid (sputum); a negative test (G-test) for 1,3-β-D glucan: 232.9 pg/ml; galactomannan antigen test (GM) test: 0.05. Abdominal ultrasound suggested splenomegaly. Chest CT showed (Figure S1: Patient's CT image and report from 2023-04-12): 1. Thickening of the bronchial wall in multilobar segments of both lungs with multiple patches, cords, and ground glass shadows, thickening of multiple interlobular septa of both lungs, considering infection, and a small amount of pleural effusion on the right side; 2. Thickening of the bronchial wall in multilobar segments of both lungs and bronchial dilatation in the middle lobe of the right lung and the lower lingual segments of the upper lobe of the left lung. Bronchoscopy showed no obvious abnormality in the bronchial tubes of each lobe segment of both lungs. Alveolar lavage was performed, and the alveolar lavage fluid was subjected to high-throughput sequencing technology (NGS), which revealed 358 Bordetella parapertussis, 250 Streptococcus pneumoniae, 7 Candida albicans, 174 cytomegaloviruses, 297 Torque teno virus, and 1 Pneumocystis jirovecii; the bacterial culture (alveolar lavage fluid), antacid staining (alveolar lavage fluid) did not show any obvious abnormality, combined with the patient's history of thymoma resection, immunological examination and the results of NGS, the final diagnosis of GS with neutropenia and multiple microbial pulmonary infections was made. the patient was treated with cefoperazone sulbactam sodium, enrofloxacin malate, and cotrimoxazole as antibacterial, fluconazole as antifungal, the ofloxacin and intravenous gammaglobulin (IVIG) to improve the patient's immune system, and rhG-CSF to promote the production of granulocytes, and the patient's symptoms significantly relieved after one week of follow-up CT examination. The patient's symptoms were significantly relieved, and a follow-up CT chest scan (Figure S2: Patient's CT image and report from 2023-04-23) showed that compared with the previous film, 1. the bronchial wall thickening of multilobar segments in both lungs and the thickening of multiple lobular septa were reduced compared with the previous; 2. the extent of the multiple plaques, cords, and ground-glass shadows in both lungs were reduced compared with the previous; 3. the pleural effusion on the right side was reduced compared with the previous; and the thickening of the pleura on the right side was reduced compared with the previous. After discharge from the hospital, the patient needed regular weekly IVIG injections and close monitoring of WBC, NE, LYM, IgG, IgM, IgA, B lymphocytes, and CD4 + T lymphocytes.

Literature review

We searched the literature using the Pubmed database. Keywords used in the search included GS syndrome and thymoma. A total of 97 case reports containing 104 patients were searched between 2003–2023 based on the inclusion criteria. By analyzing 104 case reports of GS over the past 20 years, patients with GS are prone to comorbid hematologic disorders, autoimmune disorders (AID), and infectious diseases.

1. Hematologic disorders in patients with GS

Hematopenia of various cell lines, including red blood cells, white blood cells, lymphocytes, platelets, and eosinophils, frequently occurs in patients with GS. As shown in Table S2: comorbid hematologic disorders in 104 GS patients, of the 104 patients reported, the most common comorbid hematologic disorder was PRCA, with a prevalence of 14.4%, followed by aplastic anemia and myelodysplastic syndromes, both at 2.9%. Rarely, GS has also been reported in combination with pure leukocyte aplasia, granulocyte deficiency, macrocytic anemia, hemolytic anemia, paroxysmal sleep hemoglobinuria, and thrombocytopenia.

2. AID in patients with GS

GS syndrome has an abnormal CD4+/CD8 + T-cell ratio and therefore is also very susceptible to comorbid AIDS. Table S3: Combined AID in 104 GS patients shows that of the 104 patients with GS who have been reported to have comorbid AID, the most common was lichen planus in about 13.5% of cases, followed by myasthenia gravis in about 12.5% of cases. Myasthenia gravis is also one of the most common complications associated with thymoma, and comorbidities have also been reported with polymyositis, ulcerative colitis, pemphigus, macrophage activation syndrome, focal segmental glomerulosclerosis, and other AIDs have also been reported.

3. Infectious diseases in patients with GS

Due to the dysfunction of humoral and cellular immune defenses, patients with GS are susceptible to a range of multiple and recurrent bacterial, viral, fungal, and opportunistic infections, which usually invade the lungs, intestines, meninges, retinas, oral cavity, resulting in pneumonia, enterocolitis, encephalitis, retinitis, and oral cavity infections. As shown in Table S4: Comorbid infectious diseases in 104 GS patients, the common pathogens causing pneumonia in 104 GS patients were Streptococcus pneumoniae, COVID-19, Pseudomonas aeruginosa, and Pneumocystis carinii. While enteritis, encephalitis, and retinitis were mostly infected with cytomegalovirus. The oral cavity is susceptible to invasion by Pseudomonas aeruginosa causing oral candidiasis. In addition to the common inflammatory diseases mentioned above, patients with GS are also prone to bacteremia, sepsis, meningitis, and hepatitis.

Discussion

The pathogenesis of GS remains unknown. Two main hypotheses exist: one suggests that cytokines secreted by bone marrow stromal cells influence the growth and differentiation of T and B cells; the other suggests that T-cell autoantibodies in thymomas inhibit the production of immunoglobulin by B cells and the growth of pre-B cells. Almost all GS patients have reduced levels of immunoglobulin, the production of which is dependent on B-cell secretion. TACI and BAFF-R, members of the tumor necrosis factor receptor (TNFR) superfamily expressed on B cells, may be associated with the reduction of B cells in GS patients. Sáenz-Cuesta [1] and Margraf RL [2] described two GS patients with TACI mutations, and Lougaris V [3] described a case of BAFF-R carrying two missense mutations in GS. Del Pino Molina L [4]

studied B-cell differentiation in the bone marrow of GS patients and found that GS patients had a very low number of precursor B-cells in the bone marrow and that Sáenz differentiation was arrested after the pre-B-cell stage. Therefore, the hypothesis that T-cell autoantibodies in thymoma inhibit B-cell production of immunoglobulin and the growth of precursor B-cells has received more attention and is more convincing for B-cell reduction in GS patients. The origin of GS remains a mystery due to the immaturity of genetic testing in the past and the lack of genetic studies of GS.

Many of the symptoms of GS are caused by the thymoma itself. About half of patients with thymoma may have no obvious symptoms and are only detected on an incidental chest radiograph or CT. In our case, the patient presented with fever and severe anemia (HGB: 5.2 g /dL), and the thymoma was detected only by enhanced CT of the chest. Symptomatic patients with thymoma mainly present with localized symptoms in the chest caused by tumor invasion or compression of adjacent mediastinal structures, including cough, chest pain, recurrent respiratory infections, dyspnea, dysphagia, hoarseness, Horner's syndrome, superior vena cava syndrome, pericardial tamponade, spinal cord compression, and other symptoms. Systemic symptoms include fever, weight loss, fatigue, loss of appetite, and night sweats. Thymoma often has specific manifestations, combining many AIDs such as myasthenia gravis, PRCA, hypogammaglobulinemia, optic neuromyelitis optica, multiple systemic lupus erythematosus, rheumatoid arthritis, autoimmune thyroid disorders, autoimmune pituitary disorders, focal segmental glomerulosclerosis, and many other disorders. Common AIDs in the 104 GS patients were lichen planus and myasthenia gravis. The characteristic rash of lichen planus is purplish-red polygonal flat papules and plaques, mostly on the flexion side of the wrist and forearm. Lichen planus can also involve the mucous membranes, and it most often occurs in the oral cavity, with heavy white reticulation on the mucous membranes of both cheeks. Patients with myasthenia gravis often feel blurred vision or limb soreness and discomfort at the onset of the disease, and fatigue worsens in hot weather or menstrual periods. With the development of the disease, skeletal muscle fatigue and weakness, notable features of muscle weakness in the afternoon or evening after exertion, morning or rest after alleviation, this phenomenon is called "morning light and twilight heavy". The exclusion of these diseases relies on the patient's symptoms, signs, and autoantibody tests. In this case, the patient with GS had no symptoms or signs related to AIDS, and the autoantibody tests were negative. The general treatment in dealing with AID consists of three main strategies, the first of which is aimed at effective tumor-specific treatment (surgery, neoadjuvant chemotherapy followed by surgery and radiotherapy) for primary tumors and potential metastases of pathogenic malignancies, while the second and third strategies include immunosuppressive or immunomodulatory therapies as well as therapeutic measures to antagonize potentially dangerous signs or symptoms of AID.

Patients with GS often have hematologic changes, not only from simple thymoma-induced hematologic diseases such as PRCA, PWCA, and AA but also from non-simple thymoma-induced hematologic diseases such as MDS, thrombocytopenia, granulocyte deficiency, etc. Therefore, the changes in blood counts in patients with GS need to be alerted to the possibility of combined hematologic diseases, and bone marrow aspiration is needed to evaluate the possibility of myelosuppression. suppression is possible. In this case report, the patient's first bone marrow aspiration results were suggestive of mild

pathological hematopoiesis in the granulosa and erythrocyte lineages, but unfortunately, the patient declined further investigations such as bone marrow aspiration, cytogenetic and immunological tests at that time. After the removal of the thymoma and blood transfusion, the patient's white blood cell count returned to normal, and his red blood cells and hemoglobin improved significantly from the time of admission. One year after the removal of the thymoma, the patient was again admitted to the hospital with a lung infection characterized by neutrophil deficiency, while the red blood cells and hemoglobin were unaffected, and the results of bone marrow aspiration only suggested granulomatous hyperplasia, so that the infection was considered to be related. Subsequently, the patient was admitted to the hospital with several pulmonary infections with granulocytopenia, and the granulocytes returned to normal levels with the use of human granulocyte colony-stimulating factor and recombinant human granulocyte-macrophage colony-stimulating factor. The patient's lymphocyte count levels were often below normal, consistent with the diagnosis of GS. Two causes are considered for the patient's granulocytopenia: 1. Increased consumption of neutrophils in the bloodstream or at sites of inflammation during severe infections, and 2. Hypersplenism leads to the retention of large numbers of neutrophils in the spleen and increased destruction. Treatment of granulocytopenia requires active treatment of the primary disease, prevention of infection, and use of rhG-CSF or rhGM-CSF to promote granulocyte production.

Multiple infections with recurrent infections in patients with GS are not uncommon in reported case reports, and the patient with GS in this article also had this feature of multiple infections with pneumonia by pathogens such as Bordetella parapertussis, Streptococcus pneumoniae, cytomegalovirus, Torque teno virus, Candida albicans, and Pneumocystis jirovecii. Bordetella parapertussis can cause acute respiratory infection in patients. Streptococcus pneumoniae is one of the causative agents of pneumonia in patients. Cytomegalovirus in immunocompromised hosts often produces early symptoms of the syndrome such as fatigue, fever, malaise, anorexia, night sweats, and arthralgia or myalgia in the early stages of the disease. Torque teno virus loads are abnormally high in immunocompromised or immunosuppressed patients. Immunocompromise is a risk factor for Candida albicans infection of the lungs in our patient. Pneumocystis jirovecii is an opportunistic pathogen that is often found in the lungs of humans and spreads through respiratory secretions, and is not pathogenic in immunocompetent individuals. It does not cause disease in people with normal immune function. When the host is weakened, it can multiply in the alveoli, causing thickening of the respiratory membranes and interstitial pneumonitis, which results in dysfunction of the lungs and is the causative agent of Pneumocystis jirovecii pneumonia. Streptococcus pneumoniae, cytomegalovirus, and Candida albicans are common pathogens of lung infections in patients with GS, which can be detected clinically by bacterial culture, serological testing, or fungal culture, whereas reports of lung infections with Pneumocystis jiroveci in patients with GS are uncommon, and there may be a lack of NGS testing of alveolar lavage fluid from the patients.NGS, a commonly used second-generation sequencing technology in clinical practice, allows for the large-scale and simultaneous analysis of hundreds of highly sensitive pathogens. NGS is a commonly used second-generation sequencing technology in clinical practice, which can simultaneously detect hundreds of highly sensitive pathogens on a large scale. The clinical application of NGS to

alveolar lavage fluid can improve the detection rate of pathogens in lung infections and reveal the distribution of pathogens and types of infections in patients with lung infections of different underlying diseases, which is of high clinical value for GS, which is susceptible to complicated infections. 94 case reports did not report NGS testing of alveolar lavage fluid from patients with GS, and only Zhang [5]diagnosed Mycoplasma lysodeikticum meningitis by finding Mycoplasma lysodeikticum DNA sequences in the cerebrospinal fluid of a patient with GS by NGS testing. After determining the presence of pathogen infection, in addition to targeted antibacterial, antifungal, and antiviral treatments, improving the patient's immunity by elevating the patient's serum IgG concentration through IVIG injections is also an important means of preventing infection.

In conclusion, in patients with thymoma, regular monitoring of immunoglobulin levels is needed to prevent delayed diagnosis of GS. When empirical antimicrobial therapy is ineffective in patients with GS, detection of specific pathogens by NGS should be considered, and targeted anti-infective therapy is needed if combined with fungal and opportunistic infections, in addition to which regular IVIG injections are an effective strategy to reduce the rate of infection and the need for hospitalization in patients with GS.

Declarations

Acknowledgments

The authors would like to thank Dr Weiying Liu for critical appraisal of our manuscript and fruitful feedback.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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Availability of Data and Material

Not applicable.

Code Availability

Not applicable.

Declarations

Ethics Approval

Not applicable.

Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Consent for Publication

The authors affirm that human participants provided informed consent for publication of the images in Supplementary Fig. 1. Fig. 2.

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