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Review article

Thrombosis in vasculitis: An updated review of etiology, pathophysiology, and treatment

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ABSTRACT

Introduction: Thromboembolic disease is a complication of many vasculitides. A common observation is that thromboembolic events coincide with the period of vasculitic disease, but the mechanism by which this occurs remains unclear. Inflammatory thrombosis is now recognized as a symptom of arteritis rheumatic, and vasculitides such as Behçet's syndrome (BS), and anti-neutrophil cytoplasmic antibodies (ANCA)-associated vasculitis (AAV) or giant cell arteritis (GCA). This systematic review aimed to explain recent findings related to etiology, pathophysiology, and treatment methods for BS, AAV, and medium/large-vessel vasculitis.

Methods: A comprehensive literature search on English sources from PubMed, Scopus, MEDLINE, Science Direct, ProQuest, AIM, CINAHIL, and ELDIS databases was used to find the relevant articles and reports. The relevant papers (having full text) were obtained until June 2023. Two independent reviewers screened the titles and abstracts of the obtained articles, and a third arbitrator resolved disputes between the reviewers.

Results and conclusion: It is becoming increasingly clear that certain systemic inflammatory diseases, like vasculitis, are linked to a higher risk of both venous and arterial thrombosis. An increased incidence of thromboembolic disease in AAV has been noted, particularly during times of active disease. Growing evidence supports the use of immunosuppression in the management of venous thrombosis in vasculitis. These patients also have a higher risk of developing ischemic disease.

1. Introduction

Vein thrombosis is a medical problem that occurs when a blood clot forms in a vein, and usually develops in the lower leg, thigh, or pelvis, but can also occur in arms [1]. This health problem can cause serious illness, disability, and in some cases, death. It can be appropriately treated with early diagnosis [2]. A common observation is that thromboembolic events coincide with the period of vasculitic disease, but the mechanism by which this occurs remains unclear [3]. Thrombosis is a common health problem, and 600,000 thrombosis events annually occur in the United States. Pulmonary embolisms occur when a clot breaks and reaches to the lungs through blood circulation [4]. The risk of thrombosis increases in the period of infection/inflammation and after major injuries and surgeries. Furthermore, lack of movement can raise the likelihood of blood clotting. Inflammation and serious infection also increase the risk of blood clots and subsequently thrombosis [5]. Infection thrombosis is taken into consideration to be a function of systemic

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autoimmune illnesses that include systemic lupus erythematosus, rheumatoid arthritis, or Sjögren Syndrome. Moreover, both venous thrombosis and arterial thrombosis represent a widely recognized manifestation of Behçet syndrome (BS) [6,7]. Recent reports have shown an increase in thromboembolic events during infection, particularly anti-neutrophil cytoplasmic antibodies (ANCA)-associated vasculitis (AAV) and large vasculitis [8,9]. These findings have important implications for management and clinical practice; for example, BS requires more anti-inflammatory drugs, whereas, in AAV or large vessel vasculitis (LVV), an aggressive anti-inflammatory treatment during surgery should specifically treat the artery [10,11].

There are many studies evaluating and discussing the etiology, pathophysiology, and treatment of thrombosis [3,11–14]. However, there is a need to provide a review study for gathering the important findings and discussing the previous results. As there is not any new review study on this subject, we tried to evaluate and explain recent findings related to etiology, pathophysiology, and treatment methods for the BS, AAV, and medium/large-vessel vasculitis along with the related venous/arterial involvements.

2. Search strategy

To conduct this review, a comprehensive literature search on English sources from PubMed, Scopus, MEDLINE, Science Direct, ProQuest, AIM, CINAHIL, and ELDIS databases was used to find the relevant articles and reports. The chosen keywords for searching were “Thrombosis”, “arterial thrombosis”, “Vasculitis”, “Behçet Syndrome”, “BS”, “ANCA”, “Antineutrophil Cytoplasmic Antibody”, “anti-neutrophil cytoplasmic antibodies”, “anti-neutrophil cytoplasmic antibodies-associated vasculitis”, “Vessel Vasculitis”, “Vasculitis and Thrombosis”, “venous thrombosis”.

The full texts and abstracts of the published articles were reviewed. All human studies with patients having thrombosis diseases were included in this review. Animal, case series and reports, expert opinion, and non-English studies were removed. Included studies must have been published in peer-reviewed journals. To minimize extraneous variables, validity, and reliability studies were excluded. The relevant papers were obtained until June 2023.

Two independent reviewers screened the titles and abstracts (through keywords in the relevant databases) of the obtained articles. Finally, a third arbitrator resolved disputes between the reviewers. Furthermore, an additional search was performed in order to include all the eligible articles.

3. Results

3.1. Behçet’s syndrome (BS)

BS is an unprecedented situation of unknown etiology, usually with mucocutaneous and ocular symptoms. BS is thought to be a type of thrombosis that occurs as a result of an immune system attack, rather than a heart disease that causes thrombosis [6]. Nerve involvement, usually in the skin and deep muscles, can be seen in up to 50 % of patients with BS [15]. Thrombosis is shown in 14–39 % of BS patients and venous involvement accounts for 75 % of all vascular complications. The abnormal pathogenesis directly determines the method of treatment, and the treatment and secondary prevention of thrombosis often rely on anti-inflammatory drugs rather than anticoagulant drugs [16].

In the Leiden Thrombosis Study, high VIII levels were associated with an increased risk of vascular thrombosis [17]. Patients with class VIII activity $\geq$150 IU/dL have a 5 to 6 times greater risk of developing venous thrombosis compared with individuals with class VIII activity $\geq$100 IU/dL [18]. Factor VIII levels in bipolar disorder patients are higher than in controls and in some cases associated with thrombosis, other studies have found similar results [19]. However, unlike other studies, the clinical trial noted that factor VIII level returned to normal after retesting, and the increase was due solely to the response to pain. This may explain the lack of association between thrombosis and elevated VIII levels in patients [20]. This is because level VIII varies with disease activity; acute phase reactants cannot predict thrombotic risk unless clinical studies show high levels [21]. In addition, studies examining factor VIII as a risk factor for venous thrombosis in idiopathic deep-vein-thrombosis (DVT) populations have shown that this factor is frequently present (up to five years in some cases) and is affected by different protein levels. Thus, the differences in VIII expression levels can be explained in part by different genes expressed in the literature that occur in different species [17]. Factors that contribute to the increased risk of thrombosis in BS include endothelial dysfunction (abnormal functioning of the cells lining the blood vessels), hypercoagulability (increased tendency for blood clotting), and inflammation of the blood vessels. These factors can disrupt the normal balance of clotting factors, including factor VIII. However, it’s important to note that the involvement of factor VIII in BS -related thrombosis is not well-studied or understood. The relationship between factor VIII levels and the risk of thrombosis in BS is complex and may vary among individuals. Other clotting factors, such as factor V and factor XII, have also been suggested to play a role in the increased clotting risk associated with BS [20,22,23].

P-selectin has been detected in the blood of BS patients [24]. Several studies have also reported high levels of platelet activation markers, such as platelet microparticles [25]. In addition, many studies have shown that BS patients with a history of thrombosis have higher plasma homocysteine levels [26,27]. Conflicting data on the role of some procoagulants in BS suggest that they may be one of the reasons cause thrombosis in some individuals [28,29]. Patients with BS have higher lipoprotein levels, which may be involved in thrombus formation by inhibiting fibrinolysis. In addition, higher blood levels of thrombin-activated fibrinolytic inhibitors, which may reduce the thrombolytic process, have been reported in patients with BS [3,30,31].

3.1.1. Types of involvement and clinical manifestations

Aneurysms are the most common cause of *arterial manifestations* in patients with BS [32,33]. Arterial occlusion and venous

thrombosis may occur in the same patient, associated with aneurysms. Therefore, the combination of thrombus and aneurysm is a unique feature of BS. Overall, cardiovascular events in patients with BS are rare, with an incidence of 1 %–6 %, mainly intracardiac thrombosis and heart disease [34]. The deep veins of the *lower extremities* are the most common site of venous thrombosis [35]. In addition, acute venous thrombosis in the legs often precedes the involvement of other large vessels. BS patients with *lower extremity vein thrombosis (LEVT)* had higher vascular outcomes and clinical severity scores compared to patients without BS. In addition, LEVT in patients with BS tends to be more bilateral [36,37].

Superficial thrombophlebitis (STM), usually involves the inferior vena cava (IVC) [38,39]. The STM includes the large and small muscles of the lower extremities, especially the large arteries. Histological examination showed that the thrombus was in the vessel lumen. On the other hand, intermediate vasculitis and septal panniculitis are present in the histopathological pattern of erythema nodosum [40].

Superior vena cava thrombosis (SVC), is manifested by swelling of the face and back, swollen jugular veins, and absence of a pulse [41]. The incidence of deep vein thrombosis was lower than in patients with IVC. Although there are concerns about the presentation, SVC thrombus in BS generally has a good course and a good prognosis [42].

Hepatic vein thrombosis is a rare complication of BS but has a high mortality rate [43]. *Dural sinus thrombosis* is an important contributing factor for juvenile patients, and has the highest prevalence of the parenchyma type, which is more common in males [44,45].

Pulmonary artery involvement (PAI), is rare and its reported prevalence is about 5 %. PAI can be serious and fatal, and is most commonly diagnosed on computed tomography (CT) imaging as a pulmonary aneurysm and less frequently as an "in situ" pulmonary artery thrombosis. Thrombosis is often a complication of underlying systemic vasculitis [46,47]. Venous thromboembolism (VTE) is the least common cause of pulmonary thromboembolism in BS [43]. *Intracardiac thrombosis*, is a rare event in BS and is associated with PAI [48,49]. *Peripheral artery aneurysms (PAA),* are aneurysms that affect arteries other than the aorta or the brain and are also fatal due to the risk of rupture [50]. The most common complication stemming from a peripheral aneurysm is the formation of blood clots that may block blood flow through an artery. In a study by Tüzün et al., 24 patients with abdominal aortic or peripheral aneurysm were identified, and the reported mortality rate was 17 % [51].

3.1.2. Management and treatment

Currently, the treatment of vascular thrombosis in BS patients relies on anti-inflammatory drugs to reduce vascular disease. Anti-inflammatory therapy (Azathioprine, Corticosteroids, cyclophosphamide, or cyclosporine A) will provide rapid and effective treatment of vascular lesions and prevent thrombus enlargement and recurrence [32]. The European League Against Rheumatism (EULAR) recommends the use of anti-inflammatory drugs such as Azathioprine and cyclosporine as the first treatment choice for DVT and superficial-venous thromboembolism (SVT) along with low dose Corticosteroids [52–54]. Some authors recommend the use of antibiotics alone or in combination with corticosteroids for CNS venous thrombosis [35]. The pathophysiology of thrombosis in BS supports the prothrombotic state of the body causing infection, dense thrombus formation in the arterial wall, low embolism rate, inconsistent information about coagulation abnormality, and the possibility of PAA and thrombus [55].

Thrombosis and other complications of BS are sometimes resistant to conventional antibiotics and therefore other treatment methods are needed. Based on the premise that inflammatory cells and proinflammatory cytokines, such as necrosis factor-alpha (TNFα) and γδT cells, significantly contribute to thrombosis; numerous reports suggest that utilizing anti-TNFα medications yields better outcomes in individuals with BS who have neurological and gastrointestinal symptoms [56,57]. However, there is a simpler method to check neurological complications in BS patients; the evaluation and management of neurological complications are provided in the guidelines of the "Japanese National Research Committee for Behçet's Disease" [58]. In this recommendation, an algorithm for the management of acute and chronic progressive types of this disease was established as a useful flowchart. This tool has 13 recommendations based on the results of uncontrolled evidence from open trials, retrospective cohort studies, and expert opinions, providing solutions for the optimal management of these patients. The strength of each recommendation was established based on the evidence level as well as the rate of agreement. These recommendations can be used for international studies, although future controlled clinical trials are required for validation of the recommendations [58].

In the last few years, success has been reported with anti-TNFα drugs in patients with vascular Behçet's disease resistant to anti-inflammatory drugs. However, experience with anti-TNFα drugs in the treatment of coronary artery disease is limited to the case reports [59]. A recent review of 369 patients treated with anti-TNFα drugs was published, but it was found only a small proportion of BS patients with vascular complications received anti-TNFα therapy [60].

3.2. Anti-neutrophil cytoplasmic antibodies (ANCA)-associated vasculitis (AAV)

A group of autoimmune diseases known as AAV have an unidentified cause and are characterized by vascular necrosis and inflammatory cell infiltration [61,62]. Nasal crusting, nasal congestion, epistaxis, uveitis, upper respiratory tract infections, and renal involvement are the symptoms of granulomatosis with polyangiitis [63]. Patients with microscopic polyangiitis typically have more advanced kidney disease and experience symptoms like rash and neurological symptoms [64]. One-third of patients experience a diagnosis delay of more than 6 months due to the relative rarity and non-specificity of AAV, which makes diagnosis difficult [65].

A thorough history and physical examination are necessary, and laboratory tests should assess inflammatory markers, kidney function, and serology [66]. These tests should also evaluate urine output, red blood cell counts, and urea and electrolytes. A diagnosis of endocarditis should be considered and excluded after the infection has been ruled out. More thorough examinations of the chest, brain, orbits, and otolaryngology may require the use of X-rays, CT scans, or magnetic resonance imaging (MRI) [67].

Biopsy should always be taken into consideration for suspected cases. In contrast, the start of treatment shouldn't be postponed pending the outcome of the blood test [68]. Vasculitis scores, such as those from the Birmingham Vasculitis Activity Scale (BVAS), can serve as crucial reminders. The BVAS should be used to measure disease activity, but its application needs to be explained [69]. The risk of ANCA testing may be higher in patients whose ANCA increases by more than fourfold or remains unchanged [70]. It is generally agreed that testing should be conducted more frequently as opposed to just being directed to ANCA testing. Patients with AAV are at risk for complications related to their condition and treatment [71,72].

3.2.1. Mechanism of thrombosis in AAV

Neutrophil activation has been identified as a key pathogenic factor of AAV. Neutrophil extracellular traps (NETs) are associated with thrombosis in AAV. In AAV, neutrophils produce more proteinase 3 (PR3) and myeloperoxidase (MPO) granules, particularly when inflammatory cytokines like tumor TNF are present [73]. Anti-PR3 or anti-MPO antibodies detect these granules, which leads to neutrophil degranulation. In the past ten years, it has become clear that the development of NETs following chromatin decondensation is a significant pathological feature in kidney biopsies from patients with glomerulonephritis caused by AAV [74]. Patients with active AAV have higher rates of NETosis than those with inactive AAV [75].

Endothelial cell injury AAV: endothelial cells (ECs) are important for homeostasis preventing blood from clotting. Damaged ECs release von Willebrand factor (VWF), causing platelet activation and thrombus formation. Exposure to other tissues initiates the coagulation cascade via factor VIIa [76,77].

Increases in coagulation factors such as factor VIII increase the coagulation cascade [78]. Prothrombin is converted by factor Xa to thrombin, a crucial step in the process of turning fibrinogen into fibrin, which is what makes up the majority of blood vessels [79]. The ability to produce endogenous thrombin in the blood indicates the ability to form a thrombus. Fibrinolysis usually occurs after vascularization, and in the presence of fibrin, tissue plasminogen activator (tPA) initiates fibrinolysis by converting plasminogen to plasmin. Fibrinolysis is indicated by D-dimer levels [80,81].

Defective fibrinolytic *activity in AAV:* in a study by Chen et al., it was reported that 10 of 11 patients with propylthiouracil-induced AAV had circulating AECA, but only 3 of them were in remission [82]. The anti-endothelial cell antibodies (AECA) were not found in AAV patients who had propylthiouracil-induced ANCA or in healthy controls who had untreated [83]. Another study with six patients who had anti-PR3 ANCA-positive granulomatous polyangiitis (GPA) did not find any AECA. However, anti-PR3 ANCA antibodies obtained from the sera of these individuals can bind to human vascular ECs (HUVEC) in vitro [84].

The endothelial damage and cell death caused by in vitro exposure of HUVECs to anti-proteinase 3 antibody and TNF-triggered neutrophils were alleviated by inhibiting myeloperoxidase in a different experiment [85]. These studies suggest that other antibodies, such as ANCA and AECA, may be responsible for endothelial damage in AAV patients, which may be the precursor to thrombus formation [86].

Antiphospholipid antibodies in AAV: activation of the coagulation cascade can be detected in AAV patients even without thrombotic symptoms [9]. In one study, 20 patients with renal failure, 20 patients with renal failure but no AAV, and 21 patients with renal AAV were compared. Plasma prothrombin fragment and D-dimer levels are higher in AAV-positive patients than in AAV-negative patients [76]. AAV patients, even in the remission phase, had high levels of factor VIII, VWF antigen, and VWF activity. AAV had higher levels of plasma prothrombin fragments, D-dimer, fibrinogen, VWF antigen, and VWF activity compared to controls who had mild or severe nephropathy [87,88]. Patients with AAV had higher factor VIII activity than those with only mild kidney disease. In platelet-negative plasma, there was a higher endogenous thrombin-producing capacity in 27 AAV patients in remission compared to 36 healthy controls. AAV in remission also has prothrombotic potential, as evidenced by the same group's increased activity VIII level and tissues in comparison to uninfected controls [89]. Four members of this group experienced VTE during follow-up, but 3/4 of them were in remission at the time. In patients with AAV, fibrinolytic activity is also elevated [90]. In patients with AAV in remission, anti-plasminogen antibodies have also been found, and they are linked to a higher risk of VTE. While anti-protease 3 antibodies are well known in AAV, other antibodies found in these people are known as anti-cPR3 antibodies, and they are capable of recognizing proteins derived from the ribonucleic acid sequence encoding protease 3 [91].

A third of 116 AAV patients in a different cohort from the UK were identified as having lupus anticoagulant (LAC), anticardiolipin antibody (ACLA), or combined antiphospholipid antibody syndrome. When compared to other patients in this group, these patients had a higher amount of severe vessel damage [92]. Thirteen percent of 138 AAV patients in a different Korean cohort were found to have antiphospholipid antibody (APL). The rate of venous thrombotic events was 2.9 times higher in patients with a persistent diagnosis of APL. Additionally, APL has been noted in patients with cocaine/levamisole- or propylthiouracil-induced AAV or ANCA [93]. As a result, APL may play a significant role in AAV thrombosis. It is becoming more widely acknowledged that NETosis contributes significantly to the creation of antiphospholipid antibodies that can connect APL and AAV [94].

Thrombosis in drug-induced AAV: many drugs are known to cause ANCA and AAV inhibition. Levamisole (cocaine/levamisole) has necrotic lesions with vasculitis, reticulitis and vessel thrombosis, which is important in skin biopsies [73]. Nearly two-thirds of patients with drug- or levamisole-induced AAV received recommendations for lupus anticoagulants, and IgM ACLA was detected in the remaining patients [95]. In this case, the presence of APL may be one of the mechanisms causing vascular thrombosis. One more medication linked to AAV is a propylthiouracil. These patients have been reported to have vascular thrombosis, cerebral infarction, and skin necrosis due to DVT [96]. AAV caused by hydralazine has been linked to cutaneous vein thrombosis. The presence of large NETs in these thrombi may then suggest that NETosis is the root cause of vascular thrombosis [97].

Infections triggering thrombosis and AAV: AAV patients receiving antiviral therapy are more likely to develop a viral infection such as cytomegalovirus, which directly causes endothelial inflammation, and leads to vascular thrombosis [98]. ANCA may be linked to endocarditis and cause another sign of endothelial damage [99].

3.2.2. Pathogenesis of thrombosis in AAV

Immune system: neutrophils (produced by TNF and ANCA) and ECs may interact and cause oxidative stress that can result in atherosclerosis and thrombosis [100]. Endothelial dysfunction is a significant contributor to AAV.

Neutrophils release NETs with high levels of TF (tissue factor) expression when AAV is active, and NETs can also aid in the formation of thrombi by inhibiting TF pathway inhibitors and attracting platelets. A startling in vivo model that supports the involvement of NETs in AAV was recently presented [101]. In this model, NET-producing dendritic cells can trigger the production of ANCA in mice.

Coagulation system: studies have revealed that certain diseases are associated with elevated levels of soluble thrombomodulin and plasma endothelin C receptor in patients with GPA [88]. Patients with GPA did not illustrate an increase in thrombotic disorders (such as the V Leiden phenomenon) and mutations in the prothrombin gene, although they did show an increase in anticardiolipin (aCL), which was associated with thrombosis. The incident was not reported in relation to the incident.

The pathogenesis of AAV involves a complex interplay of immune dysregulation, genetic factors, and environmental triggers. In recent years, research has highlighted the significant role of the complement system in the development and progression of AAV [102]. The complement system is an essential component of the innate immune system, responsible for detecting and eliminating pathogens and damaged host cells. It consists of a cascade of proteins and receptors that can be activated through three main pathways: the classical, lectin, and alternative pathways [103]. Dysregulation of the complement system has been implicated in various autoimmune and inflammatory diseases, including AAV. One of the key players in AAV pathogenesis is the alternative complement pathway. In AAV, the alternative pathway is often activated excessively, leading to the generation of complement activation products, such as C3a and C5a, which can recruit inflammatory cells and trigger proinflammatory responses [103]. Additionally, complement activation can result in the formation of the membrane attack complex, which can directly damage blood vessel walls. The lectin pathway of the complement system has also been implicated in AAV [104]. Mannose-binding lectin (MBL), a pattern recognition molecule that activates the lectin pathway, has been found to be associated with AAV susceptibility. Elevated levels of MBL may contribute to the initiation of complement activation and inflammation in AAV. Furthermore, recent studies have highlighted the role of complement regulatory proteins, such as factor H and I, in controlling complement activation in AAV [105]. Genetic variations in these regulatory proteins may affect their ability to control complement activation, leading to increased disease susceptibility and severity [106].

3.2.3. Types of involvement

Arterial: AAV arterial involvement estimates range from 3 to 18 percent [107,108]. It was reported that cardiovascular events (CVE) increased in the group of 113 patients with AAV when compared to those with chronic kidney disease in a retrospective study. The three most powerful predictors of CVE were a history of heart disease, dialysis, and smoking [107].

Venous thrombosis: there is evidence that venous thrombotic events in AAV have become more frequent in recent years. Between 5 and 30 percent of AAV patients have venous thrombosis, depending on the case. Efficacy data from the WGET study (Wegener's Granulomatosis Etanercept Trial) were published in 2005. In this study, 180 GPA patients were followed for more than 2 years, and VTE was particularly noted during infection [109]. The prevalence of thrombotic events in patients with AAV, particularly in the early and active stages of the disease, has been confirmed by later studies. The incidence of VTE (typical and atypical sites) and pulmonary embolism was reported in a recent study of Australian patients with eosinophilic GPA [110]. In a recent retrospective study conducted at a tertiary referral center in Denmark, it was reported that patients with GPA have a high risk of VTE at both early and late follow-up (mean 7.2 years) as well as across multiple institutions embolism of the lungs and deep vein thrombosis [111].

3.2.4. Treatment

In vitro models have shown that simvastatin can inhibit ANCA-induced neutrophil degranulation, and has an important therapeutic role. There is currently no data on the use of antiplatelet drugs and/or anticoagulants in AAV [112,113]. Below, we will explore the latest advancements in the treatment of AAV.

Immunosuppressive therapy: historically, the cornerstone of AAV treatment has been immunosuppressive therapy. Drugs like cyclophosphamide and azathioprine were commonly used to dampen the immune system's hyperactivity, reducing inflammation and the risk of organ damage. Recent advances have led to the development of more targeted immunosuppressive agents, such as rituximab, which specifically targets B cells responsible for producing ANCA antibodies. Rituximab has demonstrated high efficacy for remission induction in AAV patients with less toxicity compared to traditional therapies [114,115].

Glucocorticoid minimization: glucocorticoids, like prednisone, were once a primary component of AAV treatment regimens. While effective at reducing inflammation, they can lead to a range of adverse effects, including weight gain, bone loss, and increased infection risk. Recent treatment strategies emphasize on early initiation of immunosuppressive agents like rituximab to minimize the use of glucocorticoids. This approach aims to reduce the long-term side effects [97,116].

Plasma exchange: in severe cases of AAV, plasma exchange (also known as plasmapheresis) can be employed for rapidly removing ANCA antibodies and inflammatory mediators from the bloodstream. Plasma exchange is often used in conjunction with immunosuppressive therapy to achieve disease control more rapidly [117,118].

Monoclonal antibodies: emerging monoclonal antibody therapies are showing promise in the treatment of AAV. Belimumab, for instance, is being investigated as a potential treatment option. This monoclonal antibody targets B-cell activating factor (BAFF), a molecule involved in B-cell survival and antibody production. By inhibiting BAFF, belimumab aims to reduce ANCA antibody production and disease activity [119,120].

Personalized *medicine:* researchers are exploring biomarkers and genetic factors that can predict disease progression and response to specific treatments. This tailored approach holds the potential to optimize treatment strategies and improve treatment outcomes for AAV patients [121,122].

3.3. Medium and large vessel vasculitis

Vasculitis is a type of vascular disease that is usually defined by the size of the vessels affected: small, medium, large, or abnormal. The 1994 and 2012 Chapel Hill International Consensus Conferences defined and coined the term vasculitis [123]. The term "great artery" refers to the aorta and its major branches; "middle" refers to the main arteries and veins and their branches; "small vessels" refers to veins, arteries, parenchymal vessels, venules, and fragments [124].

3.3.1. Pathogenesis of medium and large vessel vasculitis

Immune system: different problems of blood vessels due to inflammatory damages can result in aneurysm formation. In moderate and extensive vasculitis, repair of the vessel wall begins with the adventitia layer. Cell infiltration will be produced mainly by activated Th1/Th17 lymphocytes in dendritic cells and macrophages will produce proinflammatory cytokines (such as IL1β and IL6); the cause is intrinsic and layered macrophages for the creation of growth factors that cause intimal hyperplasia, such as platelet-activating factor and platelet-derived growth factor [125].

The coagulation system with thrombophilia does not appear to play a role in patients with GCA. There is no correlation between the number of antiphospholipid antibodies and the state of the blood vessels. Studies of patients with polymyalgia rheumatica (PMR) and GCA have reported elevated homocysteine levels that may be associated with corticosteroid treatment [126].

3.3.2. Types of involvement

Venous thrombosis: few studies evaluated left ventricular venous thrombosis. An extensive cohort of 909 GCA patients showed a high risk of VTE (DVT and PE), especially in the first year following diagnosis [127].

Arterial involvement: there is a large literature on LVV disease. According to a recent study involving about 3500 patients with GCA, there is a higher risk of SVO, especially in the first month following diagnosis [128]. However, this study only included data from several hospitals and lacked anatomical information [129]. The effect of DHA (docosahexaenoic acid) on cardiovascular diseases has not been determined, but a retrospective study from Spain reported several risk factors for atherosclerosis at diagnosis [130]. In another study of 287 DHA patients, it was discovered that 3 % of the LLV patients experienced a stroke, usually within a month of their diagnosis. The majority of these patients are men with high blood pressure, smoking histories, and DHA [131].

3.3.3. Treatment

A recent meta-analysis unequivocally establishes that corticosteroid therapy is superior to the use of antiplatelet/anticoagulant medications in primary prevention, without bleeding risks [132]. However, it was also reported that neither anticoagulants nor corticosteroids/immunosuppressants and antiplatelet medications prevent CVEs [132]. It's interesting to note that a recent academic study using data from the World Health Organization suggests a connection between statin use and the prevalence of PMR [133]. Some of the latest developments in the treatment of medium and large vessel vasculitis were noted briefly in the following.

Glucocorticoids and immunosuppressive agents: traditionally, glucocorticoids (steroids) have been the first line of treatment for medium and large-vessel vasculitis. They are effective at reducing inflammation and controlling symptoms. However, their long-term use can lead to severe side effects such as osteoporosis, diabetes, and hypertension. To mitigate these side effects, physicians are increasingly adopting a "steroid-sparing" approach. This involves combining glucocorticoids with immunosuppressive agents like methotrexate or mycophenolate mofetil. These medications help reduce the reliance on high-dose steroids and their associated risks [134,135].

Biologic therapies: monoclonal antibodies, such as tocilizumab and rituximab, have shown remarkable efficacy in reducing inflammation and maintaining remission in patients with GCA and Takayasu's Arteritis. Tocilizumab, an interleukin-6 receptor inhibitor, has demonstrated rapid and sustained remission in GCA patients, allowing for faster tapering of glucocorticoids. Rituximab, which targets B cells, has shown promising effects in refractory cases as a steroid-sparing option [136,137].

Targeted *therapies:* researchers are actively investigating new therapies that target specific pathways involved in medium and large-vessel vasculitis pathogenesis. For example, Janus Kinase inhibitors are being studied as potential treatment options. These drugs interfere with the signaling pathways that drive inflammation, offering a targeted approach to managing medium and large-vessel vasculitis [138,139].

Medium and large vessel vasculitis is a heterogeneous group of diseases, and patients can present with varying clinical features and disease activity. Tailoring treatment plans to each patient's unique needs is becoming increasingly important. This individualized approach considers factors like disease severity, organ involvement, and response to previous treatments [140,141].

3.4. Other systemic vasculitis

Takayasu arteritis is an idiopathic inflammatory condition that primarily affects the aorta and its major branches [142]. Men, women, and children can all be affected, but women under the age of 40 are most commonly affected. In the second or third year of life, this disease typically manifests. Takayasu arteritis in patients older than 40 has however continued to be reported [143].

The association of Takayasu arteritis with various populations' human leukocyte antigen (HLA) alleles raises the possibility that genetic factors contribute to pathogenesis [144]. HLA-B52 and B39 are linked to Takayasu arteritis in Japan, whereas patients from Mexico and Colombia are more likely to carry the HLA-DRB1*1301 and HLA-DRB1*1602 alleles. However, no link between HLA alleles and Takayasu arteritis was discovered in the United States [138].

Corticosteroids are the first-line therapy for Takayasu arteritis, and about 50 % of patients benefit from them. Prednisolone should

be started at 1 mg/kg/day for at least one month before being tapered off. Antibiotic therapy is typically required as the infection recurs. In patients with glucocorticoid resistance, methotrexate has been demonstrated to be a potent and effective medication for disease control [145]. The effects of azathioprine, cyclophosphamide, motimidate, leflunomide, and TNF inhibitors have also been reported [145]. Patients with refractory disease have been evaluated for tocilizumab and rituximab, with encouraging outcomes. In patients with Takayasu arteritis, antiplatelet therapy lowers the risk of ischemic events, especially cerebrovascular and cardiovascular events [146]. It has been established that in Takayasu arteritis, arterial bypass and reconstructive surgery are safer options than percutaneous transluminal coronary angioplasty [147,148].

Polyarteritis nodosa (PAN) is a vasculitis that affects small and medium-sized [149] vessels but not arteries [150]. PAN may be idiopathic or associated with an infectious disease (usually hepatitis B virus/HBV) [151]. Although the most common age is 40–60 years, it can be seen in all age groups, especially in children, after streptococcal disease [152]. The annual incidence of PAN is 6–9 cases per 1,000,000 individuals [153]. As a result of vaccination and appropriate antiretroviral therapy, HBV infection decreased and accordingly the incidence of PAN decreased. Other viruses associated with PAN include HIV, cytomegalovirus, parvovirus B19, human T-lymphotropic virus type I (HTLV-I), and HCV [154].

Kawasaki disease is a self-limiting chronic vasculitis that mostly affects the central nervous system in children under five years [155]. Kawasaki disease has three stages of progression: acute, subacute, and terminal. If left untreated, the pain from this disease can last up to 12 days. However, long-term complications such as coronary aneurysm, heart failure, myocardial infarction, and cardiac arrhythmias cause morbidity [156]. It is estimated that bacteria can enter the body through the respiratory or intestinal tract and are carried by lymphoid tissue in these organs [157]. Treatment of Kawasaki disease is important because up to 25 percent of untreated children develop permanent damage. Intravenous immune globulin (2 g/kg twice in a day) combined with ASA [80–100] reduces fever (i.e., severe disease stage). Despite advances in treatment, patients with Kawasaki disease should be followed for a long time to determine their risk of developing cardiovascular and vascular problems [158,159].

Cryoglobuilinemic vasculitis (CGV): Cryoglobulins released from the vessel wall result in CGV [160]. Only 7 %–15 % of people with cryoglobulin experience symptoms [160]. Three different types of cryoglobulin antibodies are recognized by cryoglobulinemia. When symptoms are present, Type I cryoglobulinemia frequently results in hyperviscosity and is linked to blood disorders like multiple myeloma and Waldstrom macroglobulinemia. Type II and type III cryoglobulinemias are referred to as mixed [161]. Up to 10 % of patients with mixed cryoglobulinemia have no underlying cause, which is referred to as primary cryoglobulinemia. The most frequent cause of cryoglobulinemia, however, is chronic hepatitis C virus (HCV) infection, as HCV RNA can be found in up to 95 % of patients with mixed cryoglobulinemia [162]. HIV and HBV are two other uncommon causes of cryoglobulinemia. Rarely do other diseases co-occur with cryoglobulinemia. The emergence of mixed cryoglobulinemia is also linked to autoimmune diseases, especially Sjögren's syndrome. Systemic lupus erythematosus, rheumatoid arthritis, and other autoimmune illnesses are uncommon [163]. The underlying illness or autoimmune disease, as well as the severity of the symptoms, determine the course of treatment for cryoglobulinemic vasculitis. In patients with acute glomerulonephritis, intestinal ischemia, central nervous system involvement, or alveolar hemorrhage, cryoglobulinemia should be taken into consideration [164–166].

4. Conclusion

A growing body of evidence suggests that the pathways of inflammation and hemostasis interact extensively. While the mechanisms underlying the hypercoagulable state seen in systemic vasculitis are still not fully understood, there are probably shared pathways. In BS, vascular thrombosis-particularly venous thrombosis-is frequent. Although there is debate over the function and duration of anticoagulation, there is strong evidence to support the use of systemic immunosuppression with drugs like glucocorticoids, azathioprine, cyclophosphamide, and cyclosporine A in the treatment and prevention of DVT in BS. Anticoagulation should be closely monitored, and screening for pulmonary artery aneurysms should be done because DVT in BS can be linked to pulmonary artery aneurysms. The anti-inflammatory treatments used for systemic vasculitis have a direct effect in limiting the rate of thrombosis. Both venous and arterial thrombosis seem to be highly correlated with disease activity in small vessel vasculitis.

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Data availability statement

There is no research related data stored in publicly available repositories, and the data will be made available on request.

CRediT authorship contribution statement

Kai Zhu: Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Conceptualization. **Feng Lv:** Writing – review & editing, Validation, Investigation, Conceptualization. **Xiangqian Hou:** Visualization, Supervision, Resources,

Investigation, Conceptualization. **Feng Wang:** Writing – original draft, Supervision, Project administration, Investigation, Formal analysis, Conceptualization. **Linbin Pang:** Visualization, Validation, Resources, Project administration, Investigation. **Miqian Zhong:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] A.A. Osman, W. Ju, D. Sun, B. Qi, Deep venous thrombosis: a literature review, Int. J. Clin. Exp. Med. 11 (3) (2018) 1551–1561.
[2] N.F. Ahamed, Deep Vein Thrombosis and Pulmonary Embolism, Available SSRN 1999673 [Internet], 2012 [cited 2023 Oct 31]; Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1999673.
[3] A.L. Gaffo, Thrombosis in vasculitis, Best Pract. Res. Clin. Rheumatol. 27 (1) (2013) 57–67.
[4] S.K. Galson, Prevention of deep vein thrombosis and pulmonary embolism, Publ. Health Rep. 123 (4) (2008 Jul) 420–421.
[5] C.C. Esenwa, M.S. Elkind, Inflammatory risk factors, biomarkers and associated therapy in ischaemic stroke, Nat. Rev. Neurol. 12 (10) (2016) 594–604.
[6] N. Toledo-Samaniego, C.M. Oblitas, E. Peñaloza-Martínez, J. del-Toro-Cervera, L.A. Alvarez-Sala-Walther, P. Demelo-Rodríguez, et al., Arterial and venous involvement in Behçet's syndrome: a narrative review, J. Thromb. Thrombolysis 54 (1) (2022 Jul) 162–171.
[7] G. Emmi, A. Bettiol, E. Silvestri, G. Di Scala, M. Becatti, C. Fiorillo, et al., Vascular Behçet's syndrome: an update, Intern Emerg Med 14 (5) (2019 Aug) 645–652.
[8] C. King, R. Patel, C. Mendoza, J.K. Walker, E.Y. Wu, P. Moss, et al., Cytomegalovirus infection is a risk factor for venous thromboembolism in ANCA-associated vasculitis, Arthritis Res. Ther. 24 (1) (2022 Aug 10) 192.
[9] D.P. Misra, K.N. Thomas, A.Y. Gasparyan, O. Zimba, Mechanisms of thrombosis in ANCA-associated vasculitis, Clin. Rheumatol. 40 (12) (2021 Dec) 4807–4815.
[10] M. Ralli, F. Campo, D. Angeletti, A. Minni, M. Artico, A. Greco, et al., Pathophysiology and therapy of systemic vasculitides, EXCLI J 19 (2020) 817.
[11] G. Emmi, E. Silvestri, D. Squatrito, A. Amedei, E. Niccolai, M.M. D'Elios, et al., Thrombosis in vasculitis: from pathogenesis to treatment, Thromb. J. 13 (1) (2015 Dec) 15.
[12] P.K. Henke, A.J. Comerota, An update on etiology, prevention, and therapy of postthrombotic syndrome, J. Vasc. Surg. 53 (2) (2011) 500–509.
[13] R.L. Bick, Disseminated intravascular coagulation: current concepts of etiology, pathophysiology, diagnosis, and treatment, Hematol Clin. 17 (1) (2003) 149–176.
[14] B.S. Gathof, S.M. Picker, J. Rojo, Epidemiology, etiology and diagnosis of venous thrombosis, Eur. J. Med. Res. 9 (3) (2004) 95–103.
[15] A. Bettiol, D. Prisco, G. Emmi, Behçet: the syndrome, Rheumatology 59 (Supplement_3) (2020) iii101–i107.
[16] H. Yazici, S. Ugurlu, E. Seyahi, Behçet syndrome: is it one condition? Clin. Rev. Allergy Immunol. 43 (3) (2012 Dec) 275–280.
[17] R. Lensen, R.M. Bertina, J.P. Vandenbroucke, F.R. Rosendaal, High factor VIII levels contribute to the thrombotic risk in families with factor V Leiden, Br. J. Haematol. 114 (2) (2001 Aug) 380–386.
[18] F. El Louali, A. Tamdy, A. Soufiani, L. Oukerraj, D. Omari, F. Bounjoum, et al., Cardiac thrombosis as a manifestation of Behçet syndrome [Internet], Tex. Heart Inst. J. 37 (5) (2010) [cited 2023 Oct 31], https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=15266702&AN=59970978&h=fLkReSxPXkJwxYTSjoSLDzP8sshmQ7AzrrejkSe8OoM2VH%2FapbsqYN7EFmex%2FKMHvnVJsFdIqHb%2F1j1jFiHuaw%3D%3D&crl=c.
[19] M. La Regina, A.Y. Gasparyan, F. Orlandini, D. Prisco, Behçet's disease as a model of venous thrombosis, Open Cardiovasc. Med. J. 4 (2010) 71.
[20] M. Leiba, U. Seligsohn, Y. Sidi, D. Harats, B.A. Sela, J.H. Griffin, et al., Thrombophilic factors are not the leading cause of thrombosis in Behçet's disease, Ann. Rheum. Dis. 63 (11) (2004) 1445–1449.
[21] I.M. Rietveld, W.M. Lijfering, S. Le Cessie, M.H.A. Bos, F.R. Rosendaal, P.H. Reitsma, et al., High levels of coagulation factors and venous thrombosis risk: strongest association for factor VIII and von Willebrand factor, J. Thromb. Haemostasis 17 (1) (2019 Jan) 99–109.
[22] M. Leiba, Y. Sidi, H. Gur, A. Leiba, M. Ehrenfeld, Behçet's disease and thrombophilia, Ann. Rheum. Dis. 60 (12) (2001) 1081–1085.
[23] S. Kiraz, İ. Ertenli, M.A. Öztürk, İ.C. Haznedaroğlu, İ. Çelik, M. Çalgüneri, Pathological haemostasis and 'prothrombotic state'in Behçet's disease, Thromb. Res. 105 (2) (2002) 125–133.
[24] H. Jeong, I kyung Yoo, S. Choi, Y. Lee, J. Ji, G. Song, et al., Thrombosis in Behçet's disease: a Behçet's disease patient with complete thrombotic obstruction of IVC and both iliac veins and decreased protein S activity, Rheumatol. Int. 33 (6) (2013 Jun) 1633–1635.
[25] M.C. Ar, G. Hatemi, S. Ekizoğlu, H. Bilgen, S. Saçlı, A.N. Buyru, et al., *JAK2* V617F mutation is not associated with thrombosis in behcet syndrome, Clin. Appl. Thromb. Hemost. 18 (4) (2012 Jul) 421–426.
[26] Y.J. Lee, S.W. Kang, J.I. Yang, Y.M. Choi, D. Sheen, E.B. Lee, et al., Coagulation parameters and plasma total homocysteine levels in Behcet's disease, Thromb. Res. 106 (1) (2002) 19–24.
[27] K. Aksu, N. Turgan, F. Oksel, G. Keser, D. Özmen, G. Kitapçıoğlu, et al., Hyperhomocysteinaemia in Behcet's disease, Rheumatology 40 (6) (2001) 687–690.
[28] M. Becatti, G. Emmi, A. Bettiol, E. Silvestri, G. Di Scala, N. Taddei, et al., Behçet's syndrome as a tool to dissect the mechanisms of thrombo-inflammation: clinical and pathogenetic aspects, Clin. Exp. Immunol. 195 (3) (2019) 322–333.
[29] G. Mazzoccoli, A. Matarangolo, R. Rubino, M. Inglese, A. De Cata, Behçet syndrome: from pathogenesis to novel therapies, Clin. Exp. Med. 16 (1) (2016 Feb) 1–12.
[30] S.F. Perazzio, E.J. Allenspach, K.K. Eklund, M. Varjosalo, M.M. Shinohara, T.R. Torgerson, et al., Behçet disease (BD) and BD-like clinical phenotypes: NF-κB pathway in mucosal ulcerating diseases, Scand. J. Immunol. 92 (5) (2020 Nov) e12973.
[31] J. Springer, A. Villa-Forte, Thrombosis in vasculitis, Curr. Opin. Rheumatol. 25 (1) (2013) 19–25.
[32] V. Hamuryudan, E. Seyahi, S. Ugurlu, M. Melikoglu, G. Hatemi, Y. Ozguler, et al., Pulmonary artery involvement in Behçet' s syndrome: effects of anti-Tnf treatment [Internet], in: Seminars in Arthritis and Rheumatism, Elsevier, 2015, pp. 369–373 [cited 2023 Oct 31], https://www.sciencedirect.com/science/article/pii/S0049017215001468.
[33] G. Geri, B. Wechsler, R. Isnard, J.C. Piette, Z. Amoura, M. Resche-Rigon, et al., Spectrum of cardiac lesions in Behçet disease: a series of 52 patients and review of the literature, Medicine (Baltim.) 91 (1) (2012) 25–34.
[34] J. Ayari, M.S. Mourali, A. Farhati, R. Mechmeche, Left main coronary artery thrombosis revealing angio-Behçet syndrome, Egypt J Intern Med. 26 (2) (2014 Jun) 88–90.

[35] E. Seyahi, O.S. Cakmak, B. Tutar, C. Arslan, A.S. Dikici, N. Sut, et al., Clinical and ultrasonographic evaluation of lower-extremity vein thrombosis in Behcet syndrome: an observational study [Internet], Medicine (Baltim.) 94 (44) (2015) [cited 2023 Oct 31], https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4915888/.
[36] H. Yazici, E. Seyahi, Behçet syndrome: the vascular cluster, Turk. J. Med. Sci. 46 (5) (2016) 1277–1280.
[37] B. Krupa, R. Cimaz, S. Ozen, M. Fischbach, P. Cochat, I. Koné-Paut, Pediatric Behcet's disease and thromboses, J. Rheumatol. 38 (2) (2011) 387–390.
[38] H. Ishibashi, What is vascular Behcet's disease? Ann Vasc Dis 11 (1) (2018) 52–56.
[39] F. Davatchi, F. Shahram, C. Chams-Davatchi, H. Shams, A. Nadji, M. Akhlaghi, et al., How to deal with Behcet's disease in daily practice, Int J Rheum Dis 13 (2) (2010 May) 105–116.
[40] A.C. Güngen, H. Çoban, Y. Aydemir, H. Düzenli, Consider Behcet's disease in young patients with deep vein thrombosis, Respir Med Case Rep 18 (2016) 41–44.
[41] F.Z. Sayeed, M. Nashit, S. Bhatty, B.Z. Sayeed, F. Asad, F. Sayeed, A case report of Behcet's disease with thromboses in the superior vena cava and external iliac vein [Internet], Cureus 14 (4) (2022) [cited 2023 Oct 31], https://www.cureus.com/articles/92600-a-case-report-of-behcets-disease-with-thromboses-in-the-superior-vena-cava-and-external-iliac-vein.pdf.
[42] A. Hamzaoui, F. Jaziri, T.B. Salem, F.S.I.B. Ghorbel, M. Lamloum, M.S. Khanfir, et al., Comparison of clinical features of Behcet disease according to age in a Tunisian cohort, Acta Med. Iran. (2014) 748–751.
[43] D.C. Valla, Budd–Chiari syndrome/hepatic venous outflow tract obstruction, Hepatol Int 12 (S1) (2018 Feb) 168–180.
[44] M.H. Sorgun, S. Rzayev, M.A. Kural, S. Erdoğan, C. Yücesan, Cerebral venous thrombosis in Behcet's disease patients compared to other causes of cerebral venous thrombosis: a retrospective study, Arch Rheumatol 31 (3) (2016) 248.
[45] E. Timer, S. Charsouei, N. Bebek, B. Baykan, B. Bilgiç, P.A. Sabancı, et al., Neurosurgical treatment of nonconvulsive status epilepticus due to focal cortical dysplasia, Epilepsy Behav Case Rep. 10 (2018) 4–7.
[46] O. Harmanci, T. Kav, B. Peynircioglu, Y. Buyukasik, C. Sokmensuer, Y. Bayraktar, Long-term follow-up study in Budd-Chiari syndrome: single-center experience in 22 years, J. Clin. Gastroenterol. 47 (8) (2013) 706–712.
[47] Y. Yang, Y. Yu, C. Sun, M. Jiang, J. Lin, Ischaemic heart disease in Behcet's syndrome: a systematic review and meta-analysis, Clin. Exp. Rheumatol. 40 (2022) 1497–1503.
[48] R. Yıldırım, M. Dinler, N.Ş.Y. Bilge, T. Kaşifoğlu, A rarely seen manifestation in Behcet's disease: intracardiac thrombosis, Clin. Rheumatol. 40 (10) (2021 Oct) 4355–4356.
[49] H. Wang, X. Guo, Z. Tian, Y. Liu, Q. Wang, M. Li, et al., Intracardiac thrombus in patients with Behcet's disease: clinical correlates, imaging features, and outcome: a retrospective, single-center experience, Clin. Rheumatol. 35 (10) (2016 Oct) 2501–2507.
[50] E. Seyahi, M. Melikoglu, C. Akman, V. Hamuryudan, H. Ozer, G. Hatemi, et al., Pulmonary artery involvement and associated lung disease in Behçet disease: a series of 47 patients, Medicine (Baltim.) 91 (1) (2012) 35–48.
[51] H. Tuzun, E. Seyahi, C. Arslan, V. Hamuryudan, K. Besirli, H. Yazici, Management and prognosis of nonpulmonary large arterial disease in patients with Behçet disease, J. Vasc. Surg. 55 (1) (2012) 157–163.
[52] M. Merashli, R. El Eid, I. Uthman, A review of current management of vasculo-Behcet's, Curr. Opin. Rheumatol. 30 (1) (2018) 50–56.
[53] F. Alibaz-Oner, H. Direskeneli, Management of vascular Behçet's disease, Int J Rheum Dis 22 (S1) (2019 Jan) 105–108.
[54] O. Karadag, E.C. Bolek, Management of Behcet's syndrome, Rheumatology 59 (Supplement_3) (2020) iii108–i117.
[55] Y. Yazici, G. Hatemi, Difficult-to-treat Behçet syndrome: a therapeutic approach, Clin Immunol 249 (2023) 109272.
[56] J. Rodríguez-Carrio, V. Nucera, I.F. Masala, F. Atzeni, Behçet disease: from pathogenesis to novel therapeutic options, Pharmacol. Res. 167 (2021) 105593.
[57] A. Borhani-Haghighi, B. Kardeh, S. Banerjee, G. Yadollahikhales, A. Safari, M.A. Sahraian, et al., Neuro-Behcet's disease: an update on diagnosis, differential diagnoses, and treatment, Mult Scler Relat Disord 39 (2020) 101906.
[58] S. Hirohata, H. Kikuchi, T. Sawada, M. Okada, M. Takeno, M. Kuwana, et al., Recommendations for the management of neuro-behçet's disease by the Japanese national research committee for behçet's disease, Intern. Med. 59 (19) (2020) 2359–2367.
[59] A. Boban, C. Lambert, C. Hermans, Successful treatment and secondary prevention of venous thrombosis secondary to Behçet disease with rivaroxaban [Internet], Case Rep Hematol (2016) 1–3. Article ID 2164329 [cited 2023 Oct 31];2016, https://www.hindawi.com/journals/crihem/2016/2164329/.
[60] Y. Yusuf, H. Gulen, B. Bahram, J.H. Cheon, S. Noburu, N. Ambrose, et al., Behçet syndrome (primer) [Internet], Nat. Rev. Dis. Prim. 7 (1) (2021) [cited 2023 Oct 31], https://search.proquest.com/openview/709576e611a280e07feffbe1b0f99e17/1?pq-origsite=gscholar&cbl=2069613.
[61] A.R. Kitching, H.J. Anders, N. Basu, E. Brouwer, J. Gordon, D.R. Jayne, et al., ANCA-associated vasculitis, Nat. Rev. Dis. Prim. 6 (1) (2020) 71.
[62] C. Pagnoux, Updates in ANCA-associated vasculitis, Eur J Rheumatol 3 (3) (2016) 122.
[63] R.W. Hunter, N. Welsh, T.E. Farrah, P.J. Gallacher, N. Dhaun, ANCA associated vasculitis [Internet], BMJ 369 (2020) 1–5, https://doi.org/10.1136/bmj.m1070 [cited 2023 Oct 31];369. Available from: https://www.bmj.com/content/369/bmj.m1070.abstract.
[64] D. Cornec, E.C.L. Gall, F.C. Fervenza, U. Specks, ANCA-associated vasculitis—clinical utility of using ANCA specificity to classify patients, Nat. Rev. Rheumatol. 12 (10) (2016) 570–579.
[65] D. Nakazawa, S. Masuda, U. Tomaru, A. Ishizu, Pathogenesis and therapeutic interventions for ANCA-associated vasculitis, Nat. Rev. Rheumatol. 15 (2) (2019) 91–101.
[66] A.J. Mohammad, An update on the epidemiology of ANCA-associated vasculitis, Rheumatology 59 (Supplement_3) (2020) iii42–50.
[67] H. Xiao, P. Hu, R.J. Falk, J.C. Jennette, Overview of the pathogenesis of ANCA-associated vasculitis, Kidney Dis. 1 (4) (2016) 205–215.
[68] M. Calatroni, E. Oliva, D. Gianfreda, G. Gregorini, M. Allinovi, G.A. Ramirez, et al., ANCA-associated vasculitis in childhood: recent advances, Ital. J. Pediatr. 43 (1) (2017 Dec) 46.
[69] F. Salvador, ANCA associated vasculitis, Eur. J. Intern. Med. 74 (2020) 18–28.
[70] M. Weiner, S.M. Goh, A.J. Mohammad, Z. Hruskova, A. Tanna, A. Bruchfeld, et al., Outcome and treatment of elderly patients with ANCA-associated vasculitis, Clin J Am Soc Nephrol CJASN 10 (7) (2015) 1128.
[71] T. Al-Hussain, M.H. Hussein, W. Conca, Mana H. Al, M. Akhtar, Pathophysiology of ANCA-associated vasculitis, Adv. Anat. Pathol. 24 (4) (2017) 226–234.
[72] A. Karras, C. Pagnoux, M. Haubitz, K. De Groot, X. Puechal, J.W.C. Tervaert, et al., Randomised controlled trial of prolonged treatment in the remission phase of ANCA-associated vasculitis, Ann. Rheum. Dis. 76 (10) (2017) 1662–1668.
[73] D. Söderberg, M. Segelmark, Neutrophil extracellular traps in ANCA-associated vasculitis, Front. Immunol. 7 (2016) 256.
[74] B.H. Rovin, S.G. Adler, J. Barratt, F. Bridoux, K.A. Burdge, T.M. Chan, et al., KDIGO 2021 clinical practice guideline for the management of glomerular diseases, Kidney Int. 100 (4) (2021) S1–S276.
[75] K. Gulati, H. Edwards, M. Prendecki, T.D. Cairns, M. Condon, J. Galliford, et al., Combination treatment with rituximab, low-dose cyclophosphamide and plasma exchange for severe antineutrophil cytoplasmic antibody-associated vasculitis, Kidney Int. 100 (6) (2021) 1316–1324.
[76] E. Frangou, D. Vassilopoulos, J. Boletis, D.T. Boumpas, An emerging role of neutrophils and NETosis in chronic inflammation and fibrosis in systemic lupus erythematosus (SLE) and ANCA-associated vasculitides (AAV): implications for the pathogenesis and treatment, Autoimmun. Rev. 18 (8) (2019) 751–760.
[77] C. Wang, D. Chang, M. Chen, M. Zhao, HMGB 1 contributes to glomerular endothelial cell injury in ANCA -associated vasculitis through enhancing endothelium–neutrophil interactions, J. Cell Mol. Med. 21 (7) (2017 Jul) 1351–1360.
[78] B. Wilde, A. Mertens, S.J. Arends, R.P. Rouhl, R. Bijleveld, J. Huitema, et al., Endothelial progenitor cells are differentially impaired in ANCA-associated vasculitis compared to healthy controls, Arthritis Res. Ther. 18 (1) (2016 Dec) 147.
[79] L.Y. Wang, R.X. Wang, C. Wang, S.F. Chen, X.J. Sun, Z.Y. Li, et al., Inhibitor of apoptosis proteins antagonist SM164 ameliorates experimental MPO-ANCA-associated vasculitis via enhancing fatty acid oxidation in neutrophils, Rheumatology 62 (7) (2023) 2563–2573.
[80] M. Manojlovic, A. Juto, A. Jonasdottir, J. Colic, J. Vojinovic, A. Nordin, et al., Microparticles expressing myeloperoxidase as potential biomarkers in anti-neutrophil cytoplasmic antibody (ANCA)-associated vasculitides (AAV), J. Mol. Med. 98 (9) (2020 Sep) 1279–1286.
[81] D. Chanouzas, M. Sagmeister, L. Dyall, P. Sharp, L. Powley, S. Johal, et al., The host cellular immune response to cytomegalovirus targets the endothelium and is associated with increased arterial stiffness in ANCA-associated vasculitis, Arthritis Res. Ther. 20 (1) (2018 Dec) 194.

[82] M. Chen, D.R. Jayne, M.H. Zhao, Complement in ANCA-associated vasculitis: mechanisms and implications for management, Nat. Rev. Nephrol. 13 (6) (2017) 359–367.
[83] A. Salmela, A. Ekstrand, L. Joutsi-Korhonen, A. Räisänen-Sokolowski, R. Lassila, Activation of endothelium, coagulation and fibrinolysis is enhanced and associates with renal anti-neutrophil cytoplasmic antibody-associated vasculitis, Nephrol. Dial. Transplant. 30 (suppl_1) (2015) i53–i59.
[84] M. Tedesco, M. Gallieni, F. Pellegata, M. Cozzolino, F. Alberici, Update on ANCA-associated vasculitis: from biomarkers to therapy, J. Nephrol. 32 (6) (2019 Dec) 871–882.
[85] S. Sciascia, C. Ponticelli, D. Roccatello, Pathogenesis-based new perspectives of management of ANCA-associated vasculitis, Autoimmun. Rev. 21 (3) (2022) 103030.
[86] K.A. Richard, H.J. Anders, N. Basu, E. Brouwer, J. Gordon, D.R. Jayne, et al., ANCA-associated vasculitis (Primer) [Internet], Nat. Rev. Dis. Prim. 6 (1) (2020) [cited 2023 Oct 31], https://search.proquest.com/openview/9aebd490f55857605aaaeaf87c750e07/1?pq-origsite=gscholar&cbl=2069613.
[87] J. Suzuki, S. Furuta, T. Sugiyama, T. Iwamoto, K. Ikeda, K. Suzuki, et al., Antiphospholipid antibody positivity and the thrombotic risk in Japanese patients with anti-neutrophil cytoplasmic antibody-associated vasculitis, Mod. Rheumatol. 33 (2) (2023) 346–351.
[88] J. Yoo, S.S. Ahn, S.M. Jung, J.J. Song, Y.B. Park, S.W. Lee, Persistent antiphospholipid antibodies are associated with thrombotic events in ANCA-associated vasculitis: a retrospective monocentric study, Nefrologia 39 (4) (2019) 395–401.
[89] S.L. Fernando, T. Boyle, Presence of dual anti-MPO and anti-PR3 antibodies in systemic lupus erythematosus/ANCA-associated vasculitis, J. Clin. Pathol. 73 (10) (2020) 687–688.
[90] S.K. Palleti, H. Larson, S. Avula, M.M. Picken, A. Wadhwa, Subarachnoid hemorrhage in autoimmune vasculitis: a rare presentation of systemic lupus erythematosus-antineutrophil cytoplasmic autoantibody-associated vasculitis overlap syndrome [Internet], Cureus 15 (5) (2023) [cited 2023 Oct 31], https://www.cureus.com/articles/154288-subarachnoid-hemorrhage-in-autoimmune-vasculitis-a-rare-presentation-of-systemic-lupus-erythematosus-antineutrophil-cytoplasmic-autoantibody-associated-vasculitis-overlap-syndrome.pdf.
[91] F. Bensiradj, M. Hignard, R. Nakkash, A. Proux, N. Massy, N. Kadri, et al., Benzylthiouracil-induced ANCA-associated vasculitis: a case report and literature review, Internet], Eur J Case Rep Intern Med 6 (12) (2019) [cited 2023 Oct 31], https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6936924/.
[92] Y. Harabuchi, K. Kishibe, K. Tateyama, Y. Morita, N. Yoshida, M. Okada, et al., Clinical characteristics, the diagnostic criteria and management recommendation of otitis media with antineutrophil cytoplasmic antibody (ANCA)-associated vasculitis (OMAAV) proposed by Japan Otological Society, Auris Nasus Larynx 48 (1) (2021) 2–14.
[93] B. Mashinchi, A. Aryannejad, M. Namazi, S. Moradi, Z. Masoumi, A. Parsaei, et al., A case of C-ANCA-positive systematic lupus erythematous and ANCA-associated vasculitis overlap syndrome superimposed by COVID-19: a fatal trio, Mod Rheumatol Case Rep 7 (1) (2023) 117–121.
[94] L. Lally, L.R. Sammaritano, Vasculitis in antiphospholipid syndrome, Rheum. Dis. Clin. 41 (1) (2015) 109–123.
[95] C. Lood, G.C. Hughes, Neutrophil extracellular traps as a potential source of autoantigen in cocaine-associated autoimmunity, Rheumatology 56 (4) (2017) 638–643.
[96] P. Bucur, M. Weber, R. Agrawal, A.I. Madera-Acosta, R.E. Elam, Pulmonary-renal syndrome from levamisole-adulterated cocaine-induced antineutrophil cytoplasmic antibody (ANCA)-Associated vasculitis: a systematic review, Pharmaceuticals 16 (6) (2023) 846.
[97] D. Geetha, J.A. Jefferson, ANCA-associated vasculitis: core curriculum 2020, Am. J. Kidney Dis. 75 (1) (2020) 124–137.
[98] K.N. Konstantinov, C.J. Ulff-Møller, A.H. Tzamaloukas, Infections and antineutrophil cytoplasmic antibodies: triggering mechanisms, Autoimmun. Rev. 14 (3) (2015) 201–203.
[99] J. Rathmann, P. Stamatis, G. Jönsson, M. Englund, M. Segelmark, D. Jayne, et al., Infection is associated with increased risk of MPO-but not PR3-ANCA-associated vasculitis, Rheumatology 61 (12) (2022) 4817–4826.
[100] M. Mazzariol, G. Camussi, M.F. Brizzi, Extracellular vesicles tune the immune system in renal disease: a focus on systemic lupus erythematosus, antiphospholipid syndrome, thrombotic microangiopathy and ANCA-Vasculitis, Int. J. Mol. Sci. 22 (8) (2021) 4194.
[101] P. Hansrivijit, A. Trongtorsak, K.P. Gadhiya, K. Lnu, C.T. Dimech, C. Thongprayoon, et al., Incidence and risk factors of venous thromboembolism in ANCA-associated vasculitis: a metaanalysis and metaregression, Clin. Rheumatol. 40 (7) (2021 Jul) 2843–2853.
[102] E. Tüzün, M. Kürtüncü, R. Türkoğlu, S. İçöz, M. Pehlivan, Ö. Birişik, et al., Enhanced complement consumption in neuromyelitis optica and Behcet's disease patients, J. Neuroimmunol. 233 (1–2) (2011) 211–215.
[103] S. Hou, J. Qi, D. Liao, Q. Zhang, J. Fang, Y. Zhou, et al., Copy number variations of complement component C4 are associated with behçet's disease but not with ankylosing spondylitis associated with acute anterior uveitis, Arthritis Rheum. 65 (11) (2013 Nov) 2963–2970.
[104] Y. Kimoto, T. Horiuchi, The complement system and ANCA associated vasculitis in the era of anti-complement drugs, Front. Immunol. 13 (2022) 926044.
[105] M.S. Chimenti, E. Ballanti, P. Triggianese, R. Perricone, Vasculitides and the complement system: a comprehensive review, Clin. Rev. Allergy Immunol. 49 (3) (2015 Dec) 333–346.
[106] M. Mazzariol, L. Manenti, A. Vaglio, The complement system in antineutrophil cytoplasmic antibody-associated vasculitis: pathogenic player and therapeutic target, Curr. Opin. Rheumatol. 35 (1) (2023) 31–36.
[107] M. Faurschou, L. Mellemkjaer, I.J. Sorensen, B. Svalgaard Thomsen, L. Dreyer, B. Baslund, Increased morbidity from ischemic heart disease in patients with Wegener's granulomatosis, Arthritis Rheum. 60 (4) (2009 Apr) 1187–1192.
[108] M.D. Morgan, J. Turnbull, U. Selamet, M. Kaur-Hayer, P. Nightingale, C.J. Ferro, et al., Increased incidence of cardiovascular events in patients with antineutrophil cytoplasmic antibody–associated vasculitides: a matched-pair cohort study, Arthritis Rheum. 60 (11) (2009 Nov) 3493–3500.
[109] Etanercept plus standard therapy for wegener's granulomatosis, N. Engl. J. Med. 352 (4) (2005 Jan 27) 351–361.
[110] Y. Vegting, L. Vogt, H.J. Anders, M.P. de Winther, F.J. Bemelman, M.L. Hilhorst, Monocytes and macrophages in ANCA-associated vasculitis, Autoimmun. Rev. 20 (10) (2021) 102911.
[111] M. Faurschou, N. Obel, B. Baslund, High risk of pulmonary embolism and deep venous thrombosis but not of stroke in granulomatosis with polyangiitis (Wegener's), Arthritis Care Res. 66 (12) (2014 Dec) 1910–1914.
[112] F. Kitamura, M. Yamaguchi, M. Nishimura, T. Katsuno, M. Ito, H. Sugiyama, et al., Anti-neutrophil cytoplasmic antibody-associated vasculitis complicated by thrombotic microangiopathy with posterior reversible encephalopathy syndrome successfully treated with eculizumab: A case report, Mod Rheumatol Case Rep 6 (2) (2022) 254–259.
[113] L. Nygaard, C. Polcwiartek, K.E. Nelveg-Kristensen, N. Carlson, S. Kristensen, C. Torp-Pedersen, et al., Long-term cardiovascular outcomes and temporal trends in patients diagnosed with ANCA-associated vasculitis: a Danish nationwide registry study, Rheumatology 62 (2) (2023) 735–746.
[114] S.T. Tseng, M.H. Tseng, J.L. Huang, Concurrent pulmonary hemorrhage and deep vein thrombosis in a child with ANCA-associated vasculitis: case report and review of literature, Pediatr. Rheumatol. 13 (1) (2015 Dec) 20.
[115] V. Tesar, Z. Hruskova, Limitations of standard immunosuppressive treatment in ANCA-associated vasculitis and lupus nephritis, Nephron Clin. Pract. 128 (3–4) (2015) 205–215.
[116] M. Walsh, P.A. Merkel, C.A. Peh, W. Szpirt, L. Guillevin, C.D. Pusey, et al., Plasma exchange and glucocorticoid dosing in the treatment of anti-neutrophil cytoplasm antibody associated vasculitis (PEXIVAS): protocol for a randomized controlled trial, Trials 14 (1) (2013) 73.
[117] M. Walsh, Plasma exchange in antineutrophil cytoplasm antibody-associated vasculitis, Curr. Opin. Nephrol. Hypertens. 23 (6) (2014) 555–559.
[118] S. Farshad, C. Kanaan, S. Savedchuk, D.S. Karmo, A. Halalau, A. Swami, Systemic lupus erythematosus (SLE) with acute nephritis, antineutrophil cytoplasmic antibody-(ANCA-) associated vasculitis, and thrombotic thrombocytopenic purpura (TTP): a rare case report with literature review [Internet], Case Rep Rheumatol (2019) 1–5. Article ID 8750306 [cited 2023 Nov 1];2019, https://www.hindawi.com/journals/crirh/2019/8750306/abs/.
[119] Z. Zhang, W. Huang, F. Ren, L. Luo, J. Zhou, M. Tian, et al., Analysis of Risk Factors and the Establishment of a Predictive Model for Thrombosis in Patients with Antineutrophil Cytoplasmic Antibody-Associated Vasculitis, Int. J. Gen. Med. 15 (2022 Nov) 8071–8079.
[120] S. Moiseev, A. Kronbichler, E. Makarov, N. Bulanov, M. Crnogorac, H. Direskeneli, et al., Association of venous thromboembolic events with skin, pulmonary and kidney involvement in ANCA-associated vasculitis: a multinational study, Rheumatology 60 (10) (2021) 4654–4661.

[121] E. Baier, D. Tampe, I.A. Kluge, S. Hakroush, B. Tampe, Implication of platelets and complement C3 as link between innate immunity and tubulointerstitial injury in renal vasculitis with MPO-ANCA seropositivity, Front. Immunol. 13 (2022) 1054457.
[122] B.J.M. Yap, A.S. Lai-Foenander, B.H. Goh, Y.S. Ong, A. Duangjai, S. Saokaew, et al., Unraveling the immunopathogenesis and genetic variants in vasculitis toward development of personalized medicine, Front Cardiovasc Med 8 (2021) 732369.
[123] D. Saadoun, M. Vautier, P. Cacoub, Medium- and Large-Vessel Vasculitis, Circulation 143 (3) (2021 Jan 19) 267–282.
[124] D. Pugh, M. Karabayas, N. Basu, M.C. Cid, R. Goel, C.S. Goodyear, et al., Large-vessel vasculitis, Nat. Rev. Dis. Prim. 7 (1) (2021) 93.
[125] C.M. Weyand, J.J. Goronzy, Immune mechanisms in medium and large-vessel vasculitis, Nat. Rev. Rheumatol. 9 (12) (2013) 731–740.
[126] M.D. Nasimuzzaman, P. Malik, Role of the coagulation system in the pathogenesis of sickle cell disease, Blood Adv 3 (20) (2019) 3170–3180.
[127] S. Shenavandeh, H.G. Johari, E. Aflaki, Association of Large Vessel Aneurysm/Pseudo-Aneurysm/Aortitis and Deep Vein Thrombosis in Patients with Behçet's Disease: A Case Report, Curr. Rheumatol. Rev. 18 (1) (2022) 83–87.
[128] D. Nonaka, H. Takase, M. Machii, K. Ohno, Colchicine therapy for deep vein thrombosis in a patient with vascular-type Behçet disease: a case report [Internet], Medicine (Baltim.) 99 (16) (2020) [cited 2023 Nov 1], https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7220338/.
[129] M. Pelletier-Galarneau, T.D. Ruddy, PET/CT for Diagnosis and Management of Large-Vessel Vasculitis, Curr. Cardiol. Rep. 21 (5) (2019 May) 34.
[130] K.B. Gribbons, C. Ponte, S. Carette, A. Craven, D. Cuthbertson, G.S. Hoffman, et al., Patterns of Arterial Disease in Takayasu Arteritis and Giant Cell Arteritis, Arthritis Care Res. 72 (11) (2020 Nov) 1615–1624.
[131] M.A. Gonzalez-Gay, T.R. Vazquez-Rodriguez, I. Gomez-Acebo, R. Pego-Reigosa, M.J. Lopez-Diaz, M.C. Vazquez-Triñanes, et al., Strokes at time of disease diagnosis in a series of 287 patients with biopsy-proven giant cell arteritis, Medicine (Baltim.) 88 (4) (2009) 227–235.
[132] M. Banach, M. Rizzo, P.P. Toth, M. Farnier, M.H. Davidson, K. Al-Rasadi, et al., Statin intolerance – an attempt at a unified definition, Expert Opin Drug Saf 14 (6) (2015 Jun 3) 935–955. Position paper from an International Lipid Expert Panel: This paper is also published in parallel in Archives of Medical Science [Banach M, Rizzo M, Toth PP, et al. Statin intolerance – an attempt at a unified definition. Position paper from an International Lipid Expert Panel. Arch Med Sci 2015; 11(1): 1–23].
[133] H.J. de Jong, S.R. Saldi, O.H. Klungel, R.J. Vandebriel, P.C. Souverein, R.H. Meyboom, et al., Statin-associated polymyalgia rheumatica. An analysis using WHO global individual case safety database: a case/non-case approach, PLoS One 7 (7) (2012) e41289.
[134] H. Ohigashi, N. Tamura, Y. Ebana, M. Harigai, Y. Maejima, T. Ashikaga, et al., Effects of immunosuppressive and biological agents on refractory Takayasu arteritis patients unresponsive to glucocorticoid treatment, J. Cardiol. 69 (5) (2017) 774–778.
[135] B.D. Nielsen, L.C. Gormsen, I.T. Hansen, K.K. Keller, P. Therkildsen, E.M. Hauge, Three days of high-dose glucocorticoid treatment attenuates large-vessel 18F-FDG uptake in large-vessel giant cell arteritis but with a limited impact on diagnostic accuracy, Eur J Nucl Med Mol Imaging 45 (7) (2018 Jul) 1119–1128.
[136] V.S. Schäfer, J. Zwerina, Biologic treatment of large-vessel vasculitides, Curr. Opin. Rheumatol. 24 (1) (2012) 31–37.
[137] F. Muratore, N. Pipitone, C. Salvarani, Standard and biological treatment in large vessel vasculitis: guidelines and current approaches, Expet Rev. Clin. Immunol. 13 (4) (2017 Apr 3) 345–360.
[138] N. Terrades-Garcia, M.C. Cid, Pathogenesis of giant-cell arteritis: how targeted therapies are influencing our understanding of the mechanisms involved, Rheumatology 57 (suppl_2) (2018) ii51–62.
[139] H. Zhang, R. Watanabe, G.J. Berry, L. Tian, J.J. Goronzy, C.M. Weyand, Inhibition of JAK-STAT Signaling Suppresses Pathogenic Immune Responses in Medium and Large Vessel Vasculitis, Circulation 137 (18) (2018 May) 1934–1948.
[140] E.M. Isselbacher, O. Preventza, J. Hamilton Black Iii, J.G. Augoustides, A.W. Beck, M.A. Bolen, et al., 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease, J. Am. Coll. Cardiol. 80 (24) (2022 Dec) e223–e393.
[141] S.L. Mackie, C. Dejaco, S. Appenzeller, D. Camellino, C. Duftner, S. Gonzalez-Chiappe, et al., British Society for Rheumatology guideline on diagnosis and treatment of giant cell arteritis, Rheumatology 59 (3) (2020) e1–e23.
[142] J. Hwang, S.J. Kim, O.Y. Bang, C.S. Chung, K.H. Lee, D.K. Kim, et al., Ischemic stroke in Takayasu's arteritis: lesion patterns and possible mechanisms, J. Clin. Neurol. 8 (2) (2012) 109–115.
[143] E. Seyahi, Takayasu arteritis: an update, Curr. Opin. Rheumatol. 29 (1) (2017) 51–56.
[144] M.L.F. Zaldivar Villon, J.A.L. De La Rocha, L.R. Espinoza, Takayasu Arteritis: Recent Developments, Curr. Rheumatol. Rep. 21 (9) (2019 Sep) 45.
[145] M. Samson, G. Espígol-Frigolé, N. Terrades-García, S. Prieto-González, M. Corbera-Bellalta, R. Alba-Rovira, et al., Biological treatments in giant cell arteritis & Takayasu arteritis, Eur. J. Intern. Med. 50 (2018) 12–19.
[146] B. Hellmich, A.F. Águeda, S. Monti, R. Luqmani, Treatment of Giant Cell Arteritis and Takayasu Arteritis—Current and Future, Curr. Rheumatol. Rep. 22 (12) (2020 Dec) 84.
[147] A. Mekinian, C. Comarmond, M. Resche-Rigon, T. Mirault, J.E. Kahn, M. Lambert, et al., Efficacy of Biological-Targeted Treatments in Takayasu Arteritis: Multicenter, Retrospective Study of 49 Patients, Circulation 132 (18) (2015 Nov 3) 1693–1700.
[148] S. Aslanabadi, R. Azhough, P.S. Motlagh, S. Hadidchi, A.D. Tabrizi, K.K. Zonouzy, Intramedullary spinal cord ganglioglioma presenting with abnormal abdominal wall movement: case report, Neurosurg. Focus 17 (4) (2004) 1–2.
[149] A. De Virgilio, A. Greco, G. Magliulo, A. Gallo, G. Ruoppolo, M. Conte, et al., Polyarteritis nodosa: a contemporary overview, Autoimmun. Rev. 15 (6) (2016) 564–570.
[150] H.E. Sönmez, B. Armağan, G. Ayan, K. Barut, E.D. Batu, A. Erden, et al., Polyarteritis nodosa: lessons from 25 years of experience, Clin. Exp. Rheumatol. 37 (Suppl 117) (2019) 52–56.
[151] P.R. Criado, G.F. Marques, T.C.A.B. Morita, J.F. de Carvalho, Epidemiological, clinical and laboratory profiles of cutaneous polyarteritis nodosa patients: report of 22 cases and literature review, Autoimmun. Rev. 15 (6) (2016) 558–563.
[152] O. Karadag, D.J. Jayne, Polyarteritis nodosa revisited: a review of historical approaches, subphenotypes and a research agenda, Clin. Exp. Rheumatol. 36 (Suppl 111) (2018) 135–142.
[153] S. Ginsberg, I. Rosner, G. Slobodin, M. Rozenbaum, L. Kaly, N. Jiries, et al., Infliximab for the treatment of refractory polyarteritis nodosa, Clin. Rheumatol. 38 (10) (2019 Oct) 2825–2833.
[154] T. Bettuzzi, M. Jachiet, E. Sbidian, L. Frumholtz, F. Cordoliani, L. Mouthon, et al., Efficacy and safety of treatments in cutaneous polyarteritis nodosa: A French observational retrospective study, J. Am. Acad. Dermatol. 86 (5) (2022) 1035–1041.
[155] J.W. Newburger, M. Takahashi, J.C. Burns, Kawasaki Disease, J. Am. Coll. Cardiol. 67 (14) (2016 Apr) 1738–1749.
[156] E. Rife, A. Gedalia, Kawasaki Disease: an Update, Curr. Rheumatol. Rep. 22 (10) (2020 Oct) 75.
[157] C.M. Hedrich, A. Schnabel, T. Hospach, Kawasaki disease, Front Pediatr 6 (2018) 198.
[158] R. Ae, N. Makino, K. Kosami, M. Kuwabara, Y. Matsubara, Y. Nakamura, Epidemiology, treatments, and cardiac complications in patients with Kawasaki disease: the nationwide survey in Japan, 2017-2018, J. Pediatr. 225 (2020) 23–29.
[159] S. Agarwal, D.K. Agrawal, Kawasaki disease: etiopathogenesis and novel treatment strategies, Expet Rev. Clin. Immunol. 13 (3) (2017 Mar 4) 247–258.
[160] P. Cacoub, C. Comarmond, F. Domont, L. Savey, D. Saadoun, Cryoglobulinemia vasculitis, Am. J. Med. 128 (9) (2015) 950–955.
[161] M.N. Kolopp-Sarda, P. Miossec, Cryoglobulinemic vasculitis: pathophysiological mechanisms and diagnosis, Curr. Opin. Rheumatol. 33 (1) (2021) 1–7.
[162] F. Dammacco, G. Lauletta, S. Russi, P. Leone, M. Tucci, C. Manno, et al., Clinical practice: hepatitis C virus infection, cryoglobulinemia and cryoglobulinemic vasculitis, Clin. Exp. Med. 19 (1) (2019 Feb) 1–21.
[163] B. Terrier, I. Marie, A. Lacraz, P. Belenotti, F. Bonnet, L. Chiche, et al., Non HCV-related infectious cryoglobulinemia vasculitis: Results from the French nationwide CryoVas survey and systematic review of the literature, J. Autoimmun. 65 (2015) 74–81.

[164] M.B. Binazir, M. Alizadeh, H.J. Bayrami, R. Azhough, R. Movassaghi, P. Nikasa, The effect of a modified world health organization surgical safety checklist on postoperative complications in a tertiary hospital in iran, Iran. J. Public Health 44 (2) (2015) 292.
[165] P. Marson, G. Monti, F. Montani, A. Riva, M.T. Mascia, L. Castelnovo, et al., Apheresis treatment of cryoglobulinemic vasculitis: a multicentre cohort study of 159 patients, Transfus. Apher. Sci. 57 (5) (2018) 639–645.
[166] C. Comarmond, P. Cacoub, D. Saadoun, Treatment of chronic hepatitis C-associated cryoglobulinemia vasculitis at the era of direct-acting antivirals, Ther Adv Gastroenterol 13 (2020 Jan) 175628482094261.