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Mini Review

Is Autoimmune Disease a Misnomer, and Dysbiosis of the Gut is the Cause of Psoriatic and Rheumatoid Arthritis?

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Abstract

The definition of an autoimmune disorder is a condition in which the body's immune system mistakenly attacks its own healthy tissues and cells. The assumption is that something is wrong with the immune system's targeting. The theory is that the immune system is overactive and targeting healthy cells. This paper will demonstrate that there is nothing inherently wrong with the immune system, and the body is fighting a chronic infection due to dysbiosis. The term "Autoimmune Disease" is a misnomer; the immune system is just fighting an infection caused by dysbiosis. Metabolic syndrome is the underlying disease. A poor diet, which leads to dysbiosis and elevated levels of triglycerides and glucose, allowing bacteria and fungi to thrive. Dysbiosis causes a leaky gut, allowing bacteria and fungi to leak into the bloodstream and relocate to undesirable sites, such as the synovial fluid in the case of Arthritis. Under viral attack, the immune system reallocates resources and energy to focus on the immediate threat posed by the virus. The constant leak eventually causes the bacteria to become entrenched, forming biofilms and other strategies to evade the immune system. Macrophages and neutrophils release cytokines that trigger inflammation and joint pain. When the immune system clears the infection, inflammation is reduced. This paper will show how this occurs, explain common arthritis symptoms, and advance the theory that common commensal and pathogenic bacteria, viruses, and fungi can enter the bloodstream through a leaky gut, bleeding gums, or ulceration of the stomach or esophagus. Bacteria can be commensal in one area and pathogenic in another. The blood and synovial fluid are not sterile. Each has its biosphere. People living with Arthritis typically have dysbiosis. *H. pylori* is found in the synovial fluid of arthritic patients. Perhaps Arthritis is a case of the wrong bacteria entering the synovial fluid, causing dysbiosis of the synovial fluid. During the immune response, the cartilage matrix is destroyed by the actions of Natural Killer Cells, Killer T Cells, and the Complement System, which attempt to rid the body of bacteria and fungi. Neutrophils deploy their Neutrophil Extracellular Traps (NETs). This kills bacteria and fungi, and also damages the cartilage, creating more crevices and hiding places for other bacteria. As more DNA is detected, more inflammation occurs, causing the symptoms of Arthritis. A diet that focuses on whole foods and plant-based sources of protein has been reported to be beneficial for the maintenance of Arthritis and for achieving remission. For example, a controlled case series of 22 patients with Arthritis demonstrated a remission rate of 92% when placed on a plant-based diet.

Keywords: Dysbiosis; Arthritis; Psoriasis; Inflammation; Bacteria; *H pylori*; Synovial fluid

Summary

The definition of an autoimmune disorder is a condition in which the body's immune system mistakenly attacks its own healthy tissues and cells. The assumption is that something is wrong with the immune systems targeting. The theory is that the immune system is overactive and targeting healthy cells. This paper will demonstrate that there is nothing inherently wrong with the immune system, and the body is fighting a chronic infection due to dysbiosis. During an infection, the body's immune system will kill healthy cells. Perhaps the term "Autoimmune Disease" is a misnomer, and the immune system is just fighting an infection caused by dysbiosis.

Bacteria, fungi, and viruses are found in the mouth, esophagus, stomach, and intestinal tract. Most bacteria are commensal. Bacteria is found in the blood, and the synovial fluid. Arthritis sufferers typically have dysbiosis. H Pylori is found in arthritic

patients in the synovial fluid. When the gut is leaky, or there is an ulcer or bleeding gums, bacteria escape into the body, seeking food and a place to hide. When the body is under attack from a pathogenic virus, the immune system reallocates resources and energy to focus on the immediate threat posed by the virus. Fewer resources are allocated to treating bacterial infections. During a viral attack, the bacteria may enter the synovial fluid and hide in the cracks in the cartilage, which have developed due to wear and tear, triggering an inflammatory response from the immune system. During the immune response, the cartilage matrix is destroyed due to the actions of Nutrifilles, Natural Killer Cells, Killer T Cells, and the Complement System, which attempt to rid the body of bacteria and fungi.

Psoriatic and rheumatoid arthritis may be a normal immune response to the dysbiosis of the synovial fluid. In healthy individuals, bacteria are present throughout the body, including in the bloodstream and synovial fluid. Perhaps arthritis is a case of the wrong bacteria entering the synovial fluid, causing dysbiosis in the synovial fluid. The infiltration of bacteria causes an immune response, and the macrophages are drawn to the area, releasing cytokines. Cytokines trigger inflammation, and neutrophils and dendritic cells are drawn to the area, thereby exacerbating the inflammation. As the improper bacteria bury through the cartilage, the macrophages and neutrophils follow them deeper and deeper. Bacteria and fungi are seeking microcracks to hide in. Neutrophils deploy their Neutrophil Extracellular Traps (NETs). The NETs kill bacteria and fungi, and also damage the cartilage, creating more crevices and hiding places for other bacteria. The blood and the synovial fluid are not in a sterile environment. Each has its biosphere.

Intestinal tract infections, gum infections such as gingivitis, and acid reflux disease can all contribute to the potential for a leak into the bloodstream. During a viral infection, cytokines are released drawing macrophages and neutrophils to the area of viral infection and away from a small bacteria infection in the synovial fluid. Further neutrophils will apoptosis after 24 hours further diminishing the bacterial infection fight. In their brilliant paper, Berthelo et al. details that DNA from gut microbiota can be found in the synovium of osteoarthritis and rheumatoid arthritis sufferers. Furthermore, they point out that bacterial DNA is found in the blood, and bacteria are also found in the crevices of the cartilage [3]. Berthelot et al [22] summarize the microbiome that exists and opens the door to the diversity that exists from the shoulder to the knee. Here I propose that Metabolic syndrome is the underlying disease. Its contributing factor is a poor diet, which results in dysbiosis and elevated levels of triglycerides and glucose in the blood, allowing bacteria and fungi to thrive. We should treat the gut biome along with the arthritis. A diet that focuses on whole foods and plant-based sources of protein has also been reported to be beneficial in the maintenance of arthritis and remission. For example, one controlled case series of 22 arthritis patients demonstrated a remission rate of 92% when placed on the plant-based diet [34].

How Can Bacteria Enter the Body?

Periodontal Disease

A high percentage of people with (RA) Rheumatoid Arthritis have periodontal disease, often cause by the bacterium *Porphyromonas gingivalis* [1]. Inflamed and bleeding gums create a constant entry point for these bacteria to leak into the bloodstream.

Acid Reflux in The Esophagus (GERD)

Many bacteria can cause Gastroesophageal Reflux Disease (GERD), particularly *Helicobacter pylori* (*H. pylori*). Additionally, changes in the gut microbiome, including shifts in specific bacterial populations, have also been linked to the development and exacerbation of (GERD) [16]. The resulting acid reflux can damage the esophagus, allowing the bacteria in that region to enter the bloodstream [26].

Ulcers in the Stomach

Damage to the stomach lining can cause bacteria to enter the bloodstream. *Helicobacter pylori* (*H. pylori*) is particularly common [17]. *H. pylori*-infected patients with RA exhibited notably higher levels of the anti-Cit-K1 antibody both in serum and synovial fluid than uninfected patients with RA. Additionally, the serum anti-Cit-K1 antibodies whereas positively correlated with Cit-K1 expression. In short, people with high levels of *Helicobacter pylori* had a higher incidence of arthritis [18].

Leaky Gut

Inflammation of the intestinal tract can cause gaps to form, allowing commensal bacteria to penetrate the intestinal wall. Moreover, evidence for microbial maternal transmission is increasingly widespread across animals. An imbalance in gut bacteria, called dysbiosis, can occur when different foods, chemicals, toxins, or poorly digested foods can cause an imbalance of microbes. The result of dysbiosis is inflammation and a leaky gut, which allows microbes to enter the bloodstream. Peyers patch in the intestine are the early warning cells for the intestine. These cells monitor the types of bacteria in the gut [24]. Cytokines damage tight junctions in the epithelial cells in the gut [38]. Everyone has experienced eating food that causes gas and bloating. This is a bloom of different types of bacteria. The intestinal microbiota is far more complex than currently imagined. An unhealthy diet and stress can impact the biome. Several researchers suggest that there may be over 1,000 species of bacteria, as well as an unknown number of viruses and fungi. With a leaky gut even, fungi can penetrate the

bloodstream. To controld fungi mycoviruses are diverse and can infect a wide range of fungal species, including both pathogenic and non-pathogenic fungi. They can cause a variety of effects in their fungal hosts, ranging from asymptomatic infections to severe disease [15].

The Intestinal Biome

The innermost first layer is the mucus layer, which allows friendly microbes to adhere and nourish themselves. These beneficial bacteria communicate with our immune system, triggering an immune response when pathogenic bacteria and viruses are present. Beneath the mucus layer, Intestinal Epithelial Cells (IECs) form a physical barrier through tight junctions, which is essential for a healthy person. The intestinal flora can downregulate and upregulate regulatory T cells (T_{reg} cells) to modulate the immune response. Peyer's patches continuously sample gut bacteria [24]. Cytokines are released by many of the immune cells like toll receptors, macrophages, neutrophils, dendritic cells will loosen tight junctions [38]. The intestinal flora can cause food cravings and mood changes. It does invite the question of who is working for whom; are we just legs and arms for the bacteria?

Diet and a Healthy Intestine Biome

Foods such as fermented foods (yogurt, kimchi, sauerkraut), whole grains, beans, leafy greens, and onions can promote a healthy gut microbiome, which is crucial for digestion, nutrient absorption, and overall well-being. These foods provide food for beneficial bacteria and fiber that nourish the gut microbiome. High-Fiber foods: Beans, lentils, leafy greens, asparagus, onions, and legumes are excellent sources of fiber and provide prebiotics that support a healthy gut microbiome. Bone broth provides collagen, which helps repair the gut lining. Garlic and onions act as prebiotics, while berries and other fruits contain polyphenols that protect the gut microbiome.

The Blood is not Sterile

In Castillo's paper, it is illustrated that even in healthy individuals, a bacterial biome exists. They point out that blood microbiome exists in domesticated animals. They assert "that the presence of foreign microorganisms in human blood does not necessarily equate with infection or a diseased state [4]. In 1969, Tedeschi reported the presence of active bacteria in the blood of healthy individuals [2]. Bacteria from the skin and oral cavities can enter the bloodstream when the barriers between these environments are compromised. There are commensal bacteria that both occupy space and provide essential nutrition. Moreover, the microbiome can also self-regulate to some degree, some bacteria kill pathogenic bacteria, and certain viruses (bacteriophages) are excellent way to infect and kill pathogenic bacteria in a very target specific way [35]. Diet can also regulate the microbiome when the body has too much sugar or other nutrients, bacteria and fungi can bloom. Similar to an algae bloom in a lake that receives excessive runoff of fertilizer [27].

Synovial Fluid is Not Sterile it has its own Biome

The common understanding was that synovial fluid was sterile. New research shows that this is not the case. The paper by Hammad, et al.'s paper [6], showed that "Bacterial 16S rRNA genes were detected in 87.5% RA patients and all healthy control subjects" and "Utilising PCR bacterial 16S DNA was detected in synovial fluid of 14 of 16 patients with RA (87.5%) and 9 out of 9 healthy control subjects. The presence of fungi was detected in 12 of 16 (75%) RA samples and 8 out of 9 (89%) healthy control samples." The author proposes that bacteria from the oral cavity or gut have found their way to the synovial fluid via the bloodstream [6]. The immune system views most bacteria and viruses as hostile beyond the skin barrier. Some bacteria are commensal in other areas of the body, such as the synovial fluid. Betaproteobacteria dominated Osteo-arthritis, and the control group had Actinobacteria and Clostridia. There are commensal bacteria everywhere, and the immune system is working diligently to distinguish between those that belong and those that do not. The biom is very complex and a common bacterium in one location might be more pathogenic in another. For example, the common bacteria in the mouth can be pathogenic in other parts of the body. Further viruses can be commensal. For example: specific viruses like bacteriophages can target specific pathogenic bacteria, acting as a very potent antibiotic that does not harm commensal bacteria. It is estimated that 40% of the bacteria in the ocean are infected with a virus [24]. Before the age of antibiotics, phages were used for the antibiotic properties [35].

How does Bacteria and Fungi get into the Synovial Fluid?

Bacteria, viruses, and fungi are always with us. Many species are commensal in one location, such as the intestine, and can be pathogenic in a different location, such as the synovial fluid. The Bacteria enter the synovial fluid through the bloodstream. The pore size of the cartilage is 6nm, the size of most bacteria is 100 to 4000nm, and the bacteria spores are 100nm. The only way bacteria can get into the synovial fluid is through the bloodstream. Microcracks can occur in the articular cartilage due to loading and extensive use. These micro-cracks can become filled with the wrong type of bacteria, which activates the dendritic cells as part of the innate immune system [3] [13]. Cytokines released from the immune cells destroy the tight junctions of epithelial cells, which is a characteristic of the classic leaky gut [38]. The immune system releases cytokines to activate macrophages and neutrophils, enabling them to deal with the infection. When sufficient bacteria are present in the synovial fluid, the macrophages are activated, releasing cytokines that induce inflammation and recruit dendritic

cells to sample the area. As the bacteria become more entrenched, larger quantities of cytokines are released, attracting additional neutrophils and exacerbating the inflammation. The neutrophils will kill the bacteria and surrounding somatic cells; the resulting DNA release from dying bacteria and somatic cells causes further inflammation and the release of additional cytokines. When attacked, bacteria become stressed and enter a mutation mode, signaling internal and external species to mutate. Many bacteria form biofilms, making it hard on the immune system. Next, the adaptive immune system is engaged. With the adaptive immune system engaged, the helper T-cells are active and activate the killer T-cells. A battle occurs between the immune system and mutating bacteria. If there is a wave after wave of bacteria from the leaky area, the bacteria and fungi will gain the upper hand, especially during a Cold and Flu Event. Most arthritis sufferers report an uptick in joint pain during a cold and flu episode [20]. The bacteria can mutate to evade and fend off the immune system because not enough resources are allocated to the attack. Since the synovial fluid has poor blood flow, there are few macrophages present, allowing bacteria to burrow deep into the cartilage. At some point, the immune system detects this through dendritic cells [13]. Pathogenic bacteria induce the natural killer cells to produce proinflammatory cytokines (IFNγ) from human lamina propria ILC3s, whereas commensal bacteria primarily elicit the production of protective cytokines (IL-22). This means the immune response is greater for pathogenic bacteria [37]. The ILC3s may also contribute to the relocation of intestinal bacteria from the intestine to the synovial fluid, as commensal bacteria are not typically viewed as pathogenic (Chart 1).

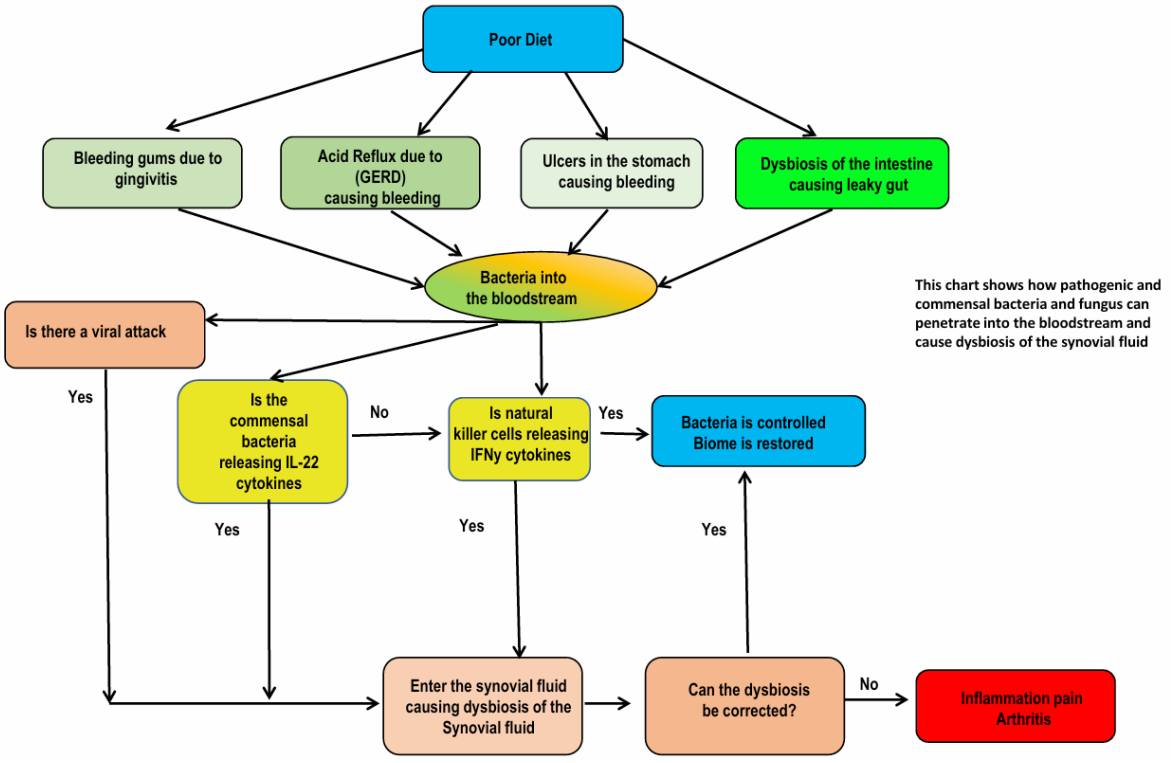

Chart 1: Dysbiosis Flowchart.

Rheumatoid Arthritis and the Immune Response

Macrophages are drawn to the synovial fluid because a noncommensal bacteria is present. They show clear signs of activation, such as overexpression of major histocompatibility complex class II (MHC-2) molecules, proinflammatory or regulatory cytokines, and growth factors. Synovial macrophages differentiate into stimulatory or inhibitory subpopulations, which in turn influence T-cell activity [10]. At the site of tissue destruction, macrophages express significant amounts of the inflammatory cytokines IL-1, TNF-α, and GM-CSF. The potential of macrophages to directly degrade cartilage matrix components is limited [10].

The lymphokine IL-17, produced in approximately 90% of RA synovial cultures but only in 16% of osteoarthritis cultures, strongly

stimulates macrophages to produce IL-1 and TNF-α. The recent discovery of the gut microbiome in human cartilage, which differed between individuals with osteoarthritis and control groups, suggests that live bacteria from the gut microbiota may migrate between the gut and epiphyseal bone marrow. Subchondral microbiota could enhance cartilage healing and transform components of deep cartilage matrix into metabolites with immunosuppressive properties [8]. As the improper bacteria bury through the cartilage, the macrophages and neutrophils follow them deeper and deeper. Bacteria and fungi are seeking microcracks to hide in. Neutrophils deploy their Neutrophil extracellular traps (NETs). This kills bacteria and fungi, and also damages the cartilage, creating more crevices and hiding places for other bacteria. The release of bacteria DNA stimulates macrophages to release more cytokines, thus creating more inflammation. If a leaky gut is present, with an increase in bacteria and fungi, this process repeats itself, causing further cartilage damage and inflammation [33].

Psoriasis and Psoriatic Arthritis PsA

Diabetes and psoriasis are prevalent conditions with a spectrum of serious adverse outcomes. Both diseases are common comorbidities, and diabetes is considered a risk factor for psoriasis. It is characterized by underlying inflammatory processes, including regulatory immune cells, cytokines, and adipokines [3]. An increase in the thin Staphylococcus aureus bacterium has been linked to dermatitis and psoriasis. Streptococcus pyrogenes (Group a streptococcus) is found in the upper respiratory tract and can exacerbate psoriasis flares. Studies suggest an association between psoriatic arthritis (PsA) and certain gut microbiota dysbioses. Specifically, decreased diversity in the gut microbiome, characterized by lower levels of beneficial bacteria such as Akkermansia, Ruminococcus, and Coprococcus, has been observed in patients with psoriatic arthritis (PsA). Dysbiosis of the intestinal tract is the leading cause of psoriasis. If psoriasis develops into a rash and leaks to the outside, then any opportunistic bacteria have a chance to infect the body [23]. Macrophages are drawn to the synovial fluid because noncommensal bacteria are present. They are numerous in the inflamed synovial membrane and the cartilage-pannus junction [29].

The Body Has a Finite Amount of Energy

Producing macrophages, neutrophils, T-cells, and other cells is energy demanding. The immune system uses between 5% and 10% of the body's energy budget at rest and 10-20% when fighting an infection, such as a cold. That means the immune system can consume a significant amount of energy when fully engaged. A one-degree temperature rise can utilize the energy of a 10% increase in metabolism [7]. Being sick is very expensive.

The energy consumption of organs varies, but collectively, our major organs account for the majority of the body's energy use.

- Brain: About 20% of energy.
- Liver: Around 20-25%,
- Muscles (at rest): Roughly 20%, but this increases significantly during activity.
- Heart: About 8-10%,
- Kidneys: Around 5-10%,
- Lungs about 5% at rest
- Digestive Tract uses about 10%

The above is 88% at rest and 100% with movement or more [7,30]. People with allergies tend to get more colds because their immune system is fighting the allergy antigen. The immune system can only provide a limited number of resources [32]. The body's management system must allocate resources depending on the task and threat it faces. When the body is under attack from a virus, cytokines are released into the bloodstream to invoke an immune response. One of the responses is the release of interferon, which dampens the activity of nonimmune cells. Furthermore, appetite is suppressed, and the immune system is activated. Let us look at this from a systems perspective. Energy is required for the immune system. So, the nonimmune cells are powered down for two reasons: 1. To conserve energy for the immune system and 2. To limit cellular activity, which hinders the virus's ability to replicate. Further, appetite is suppressed to conserve energy. Furthermore, other systems are downregulated, resulting in a general feeling of fatigue throughout the body. The purpose is to re-distribute the energy to the immune system and shut down nonessential functions to focus on the viral attack.

Hypothesis

This Paper is Advancing the Following Concepts

Autoimmune disease is a misnomer, and the immune system is not broken. It is targeting a real threat. The threat is bacteria and fungi in the wrong area, such as the synovial fluid. The leak can originate from the mouth, esophagus, sinuses, stomach, and gut. The leak is caused by dysbiosis. Cytokines loosen bonds in epithelial cells. The body has a limited power budget thus during a viral infection, resources are allocated to fight the virus and taken away from the chronic infections and organs. Neutrophils are drawn to the area with the highest concentration of cytokines. So, new neutrophils will be directed toward the viral infection site, and fewer will be directed to the chronic infection site. Additionally, neutrophils have a lifespan of approximately 24 hours and are produced in the bone marrow. So, neutrophils at the site of chronic infection will be diminished. At this time, bacteria and fungi can enter the

bloodstream and establish a new home. All the bacteria referenced in the paper can form biofilms, making it difficult for the immune system to combat them. Only the Neutrophils have some ability to overcome the biofilm. Neutrophils are dangerous to the body and can damage normal cells, which is why they are on a 24-hour timer. The ILC3s may also contribute to the relocation of intestinal bacteria from the intestine to the synovial fluid, as the commensal bacteria are not considered pathogenic. The suggestion of possible treatment with IgG antibodies for localized treatment is proposed below. Why do women get arthritis more than men? During a woman's cycle, the immune system is suppressed. This gives an opportunity for the bacteria to expand [21]. Why does alcohol make arthritis worse? It increases blood glucose levels and triglycerides. This is fuel for bacteria and fungi, causing a bloom. Alcohol can change the intestinal biome and cause changes in the stomach biome. In addition, alcohol is a depressant and can slow down the immune response. Beyond the scope of this paper is the potential role of dysbiosis in many human ailments such as Alzheimer's, Heart disease, Amyotrophic Lateral Sclerosis, and Multiple Sclerosis. All have a dysbiosis as a contributing factor with the wrong bacteria in the wrong place. Perhaps we should recite Hippocrates most prophetic phrase "Let food be thy medicine".

Immune Suppressive Drugs

It is an interesting paradox to take an immunosuppressive drug to counteract the effects of Neutrophils and Killer T cells. On one hand, it would reduce inflammation and pain; on the other hand, it would inhibit the body's ability to clear the infection. Along with immune-suppressive drugs, closing the leaky parts of the body, from the gums to the intestinal tract, would be critical, followed by providing IgG antibodies to the localized area [31].

Suggested Study

Provide the two test groups: One with immune suppression drugs only.

Provide the second group with 12 weeks of detailed and comprehensive repair of the mouth, esophagus, and intestinal biome, along with a probiotic diet that limits sugars and processed foods. The diet is rich in organic vegetables and fruits. Then, slowly reduce the immune-suppressive drugs over the next 12 weeks while giving IgG antibodies. After 6 months, compare the two groups.

Conclusion

The term "Autoimmune Disease" is a misnomer, and the immune system is just fighting a chronic infection caused by dysbiosis. During an infection, the body's immune system will kill healthy cells, which causes inflammation.

This paper advances the theory that common commensal and pathogenic bacteria, viruses, and fungi can penetrate the bloodstream due to a leaky gut, bleeding gums, or ulceration of the stomach or esophagus. Most of the time, macrophages, neutrophils, and the complement system kill them. When metabolic syndrome occurs, lipids, glucose, and triglycerides are freely circulating, providing nutrients for bacteria and fungi. During stress or a viral infection, the immune system must fight on multiple fronts with a finite amount of resources. The immune resources are spent to attack the most pressing threat: viral infection. When this occurs, bacteria and fungi can enter undesirable parts of the body, such as the synovial fluid, through the bloodstream. They burrow into the cartilage after entering and mutating to evade the macrophage. Neutrophils only last 24 hours and are drawn to the location with the highest concentration of cytokines. The macrophages and neutrophils attack the bacteria, releasing cytokines and chemokines, causing inflammation and pain. As the improper bacteria burrow through the cartilage, the macrophages and neutrophils follow them deeper and deeper. Neutrophils deploy their Neutrophil extracellular traps (NETs). This kills bacteria and fungi, and also damages the cartilage, creating more crevices and hiding places for other bacteria. As more DNA is detected, more inflammation occurs, causing the symptoms of arthritis. Bacteria and fungi are mutating, and the Bacteria can deploy biofilms that are effective against the immune system. This is why people living with arthritis often experience flare-ups during cold weather. The body needs energy for thermogenesis taking away resources from the immune system.

Stress releases cortisol, which dampens the immune system, creating an opportunity for these bacteria to escape. The complement system is also engaged and damages the cartilage.

As the infection progresses, natural killer cells and killer T cells are drawn to the area, along with B cells and antibodies. All are causing increasing inflammation and damage. In summary, the immune system is not broken "Autoimmunity," but the immune system is targeting and fighting entrenched bacteria and fungi that are populating the synovial fluid in osteoarthritis caused by dysbiosis. To counter the inflammation, the invation of bacteria needs to be stopped by the "closing" of the leaky gut, gums, or any other areas that allow bacteria access.

Bacteria Associated with Different Conditions

Each of the bacteria listed below is found in the human body, and some are associated with dermatitis and psoriasis. Further, each bacterium on the list forms a biofilm to protect it from the immune system and or to have the ability to move.

Porphyromonas gingivalis is associated with rheumatoid arthritis and can form a biofilm to evade the immune system.

***Helicobacter Pylori*:** Rosaces Related signs and symptoms- can form a biofilm to evade the immune system. It does have the ability to move on its own with a flagella.

***Staphylococcus aureus*:** An increase in this bacterium has been linked to dermatitis and psoriasis. It lives on healthy skin and can form a biofilm to evade the immune system.

Commensal Bacteria: *Faecalibacterium prausnitzii*, a decrease in the bacteria, has been linked to atopic dermatitis. -- can form a biofilm to evade the immune system.

Bacteroidetes: A decrease in these bacteria has been linked to atopic dermatitis, as they can form a biofilm to evade the immune system. Bacteroidetes species possess the ability to move independently, utilizing several different mechanisms. Some Bacteroidetes are moble through flagella.

Clostridia: An increase in this bacterium has been linked to atopic dermatitis -- can form a biofilm to evade the immune system. Clostridia can move on their own, although they are generally not considered to be highly moble.

Streptococcus pyrogenes (Group a streptococcus) is found in the upper respiratory tract and can exacerbate psoriasis flares. - can form a biofilm to evade the immune system.

Corynebacterium species: These bacteria are part of the normal skin microbiome and may play a role in regulating inflammation. - can form a biofilm to evade the immune system.

Healthy Synovial Bacteria Our Relationships are Complex

Actinobacteria: "production of different enzymes and enzyme inhibitors, as well as antibiotics such as aureomycin and streptomycin. Actinobacteria play important roles in the degradation or decomposition of organic substances, including polysaccharides, cellulose, starch, chitin, organic acids, proteins, and fats [11].

Clostridia, specifically Clostridium species, a predominant cluster of commensal bacteria in the gut, exerts numerous beneficial effects on intestinal homeostasis. To date, Clostridium species have been reported to effectively attenuate inflammation and allergic diseases due to their distinctive biological activities. Of the anaerobes that infect humans, clostridia is the most widely studied. They are involved in a variety of human diseases, the most important of which are gas gangrene, tetanus, botulism, pseudomembranous colitis, and food poisoning. In most cases, clostridia are opportunistic pathogens; that is, one or more species establish a nidus of infection in a particular site in a compromised host. All pathogenic clostridial species produce protein exotoxins (such as botulinum and tetanus toxins) that play an important role in pathogenesis [12].

Synovial Fluid and Cartilage Repair

- Mesenchymal Stem cells (MSCs) are found in synovial fluid and can differentiate into cartilage-forming cells, potentially contributing to cartilage repair.

- Hyaluronan (HA): Hyaluronan, also known as hyaluronic acid (HA), is a naturally occurring, complex carbohydrate molecule that plays a crucial role in various bodily functions. HA, which is found in synovial fluid, may play a role in cartilage repair by promoting MSC attachment to cartilage. Hyaluronan is a linear polysaccharide composed of repeating disaccharide units (glucuronic acid and N-acetylglucosamine).

Author Contributions

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