

Study on the Role of Diet in Gout Management and Its Mechanism

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Abstract. Gout is a metabolic disease caused by hyperuricemia, which is closely related to diet. With the increasing incidence of gout and hyperuricemia, more and more studies have begun to explore the role of diet in the management of gout. Current research suggests that a low-purine diet, as well as avoiding alcohol intake, can help lower uric acid levels and reduce gout attacks. However, there is a research gap regarding specific dietary factors and dietary patterns and their long-term effects on people with gout. This paper analyzes the latest research on dietary guidance for gout and discusses the effects of different dietary factors and patterns on uric acid metabolism. The results of the study showed that the Mediterranean diet, the DASH diet, was more helpful in reducing uric acid levels. In addition, this paper also put forward more detailed dietary suggestions on the influence and mechanism of different factors in diet on gout. This study provides a theoretical basis for future personalized diet programs for gout patients, but the metabolic differences among different individuals and the effects of long-term dietary intervention are still insufficient. Future studies should further explore the relationship between diet, genetic factors and metabolic mechanisms to better guide clinical practice.

Keywords: Gout, dietary factor, dietary pattern.

1. Introduction

Gout is a kind of crystalline arthritis caused by purine metabolism disorder and (or) reduced uric acid excretion. The clinical manifestations are hyperuricemia and characteristic acute arthritis caused by urate crystallization deposition, gouty stone formation, gouty stone chronic arthritis, and urate nephropathy, etc. In severe cases, joint disability and renal insufficiency may occur. Gout is a common disease that is relatively common around the world, especially in developed countries. According to The Lancet Rheumatology, 55.8 million people worldwide will have gout in 2020, an increase of 150.6% since 1990 [1]. The prevalence of gout in China is also rising rapidly. From 2018 to 2019, [2] the monitoring data of chronic diseases and risk factors in China show that the prevalence of hyperuricemia in adult residents in China is 14%, and the prevalence of gout is 0.86% ~ 2.20%, with males higher than females, urban higher than rural areas, and coastal higher than inland.

The prevalence rate of gout is increasing year by year, and the age of onset tends to be younger. This may be related to economic development, lifestyle and diet. Gout population is growing rapidly, but most patients' clinical symptoms are not typical, or even lifelong symptoms, so the disease is not paid attention to, [3] in addition to drug treatment in addition to diet treatment is almost unknown. The health education and dietary guidance of patients with gout and hyperuricemia can directly affect the diagnosis, treatment and rehabilitation of patients. Dietary management is the basis of the treatment of hyperuricemia and gout, which is complemented by drug therapy to improve the condition of hyperuricemia and gout. Good diet management can not only reduce the blood uric acid level, reduce the number of gout attacks, but also improve the overall health quality of patients. Therefore, the impact of dietary therapy on the treatment of gout needs to be further analyzed. In this paper, factors causing hyperuricemia and gout in diet will be combined. The effects of Mediterranean diet (MD), Dietary Approaches to Stop Hypertension (DASH) and low purine diet on gout were analyzed to highlight the application of rational diet in the treatment of gout.

2. Analysis of the Influence of Different Foods on the Pathogenesis of Hyperuricemia and Gout

Purines are components of a class of nucleotides, widely present in DNA and RNA. Purine metabolism is the process of producing uric acid through the breakdown of hypoxanthine and xanthine. Uric acid is the product of purine metabolism and is excreted primarily through the kidneys. If too much uric acid is produced or excreted, it will lead to elevated blood uric acid levels and the formation of hyperuricemia. The occurrence of hyperuricemia and gout is closely related to diet and lifestyle, especially long-term intake of high energy foods, large amounts of alcohol and/or high fructose beverages.

2.1. High Protein Diet

Protein intake affects uric acid metabolism, especially since different sources of protein have different effects on people with gout. Some foods that are high in protein in a high-protein diet, especially proteins from animal sources such as red meat, seafood and offal, are rich in purines. These foods are metabolized by the body to produce uric acid, which increases the level of uric acid in the blood and triggers gout. Purine is broken down in the body to produce hypoxanthine, which is then converted to uric acid by xanthine oxidase. Therefore, intake of high-protein foods rich in purines will accelerate uric acid production, which is an important trigger for gout attacks. However, not all high-protein diets have a negative effect on gout. Studies have shown that plant-derived proteins such as legumes and nuts, although they also contain purines, have less impact on uric acid levels and can even reduce the risk of gout attacks [4]. This is because plant purines have a more moderate metabolic pathway, and plant proteins are rich in beneficial components such as fiber and antioxidants, which may help reduce inflammation and uric acid deposition. However, there was no direct correlation between blood uric acid level and total protein intake.

2.2. High Fructose Intake

Fructose is a common simple sugar found in plants and a major component of sugar-sweetened beverages. Current studies suggest that an increase in the prevalence of hyperuricemia and gout is positively correlated with an increase in the consumption of total fructose and sugar-sweetened beverages. Unlike the monosaccharide glucose, the phosphate of fructose contributes to the consumption of adenosine triphosphate, leading to an increase in circulating blood uric acid levels. In two case analyses involving 125,299 participants and 1,533 cases of sudden gout disease, fructose intake was associated with an increased risk of gout (RR=1.62, 95% CI: 1.28-2.03, P<0.0001) [5]. In addition, fructose increases the risk of insulin resistance and affects the normal metabolism of uric acid [6]. Long-term hyperglycemia in patients may lead to decreased kidney function, resulting in renal tubule ischemia and hypoxia, competitive excretion of accumulated lactic acid and uric acid in the body, and decreased uric acid excretion capacity in renal tubules [7]. At the same time, hyperinsulinemia caused by diabetes can promote Na⁺-H⁺ exchange of renal proximal convoluted tubules. With the increase of Na⁺-H⁺ exchange, uric acid reabsorption is increased, and blood uric acid level is increased. Long-term hyperglycemia leads to the increase of free fatty acids in the portal system, the hyperfunction of liver synthesis of fatty acids, [8] and the increase of blood uric acid level.

2.3. Alcohol

Alcohol consumption increases the risk of hyperuricemia and gout attacks, but the effects are complicated by the type and amount of alcohol consumed. Beer is a drink that people with gout should avoid. Beer not only contains a high alcohol content, but also rich in guanosine nucleotides. Drinking beer increases the purine load in the body, resulting in a significant increase in uric acid production. In addition, alcohol metabolism produces a large amount of lactic acid, which competes with uric acid for renal excretion channels, thus inhibiting the excretion of uric acid. Epidemiological studies have shown that beer consumption is associated with a significantly increased risk of gout, higher

than that of other alcoholic beverages. Strong alcohol (such as vodka, whiskey, etc.), although it does not contain significant purines, can also exacerbate elevated blood uric acid levels by increasing purine metabolism and inhibiting uric acid excretion due to its high alcohol concentration. Wine, especially red wine, was once thought to have a possible protective effect on metabolic health due to its antioxidant properties such as resveratrol. However, scientific evidence suggests that excessive consumption (more than 1-2 cups per day) may still increase the risk of gout, especially in people with pre-existing hyperuricemia. In conclusion, no matter the type of alcohol, intake will have a negative impact on uric acid metabolism, and different alcohol has different effects on hyperuricemia and gout, but excessive intake is not recommended.

2.4. Fat

Fat affects the production and excretion of uric acid through various metabolic pathways. A high-fat diet (especially saturated fatty acids) can lead to insulin resistance, which is an important factor affecting uric acid metabolism. Insulin resistance inhibits uric acid excretion and increases the level of uric acid in the blood, which in turn promotes gout attacks. In addition, a high-fat diet also promotes the breakdown of purine nucleotides in the liver and increases the production of hypoxanthine and uric acid. During fat metabolism, especially when fat oxidation in the body increases, by-products of fatty acid metabolism (such as ketone bodies) competitively inhibit renal excretion of uric acid. This mechanism is like the inhibitory effect of alcohol on uric acid excretion, so a high-fat diet may promote elevated blood uric acid levels by reducing the excretion of uric acid. In addition, obesity itself is closely related to uric acid metabolism, and excessive body fat leads to increased uric acid production and inhibits its excretion, which is highly correlated with an increase in the frequency of gout attacks.

3. Food Principles and Recommendations

3.1. Diversified Diet with Limited Purine Intake

Make scientific dietary adjustments because of ensuring food diversity and nutritional balance. Every day should be consumed grains and potatoes, vegetables and fruits, livestock, poultry, fish, eggs and milk, soy and nuts and other foods, to ensure that the daily food types are not less than 12, not less than 25 per week [9]. At the same time, rationalize the proportion of energy provided by carbohydrates, proteins and fats in the diet. In addition, limiting the intake of high-purine foods can help control the blood uric acid level and reduce the attack of gout. High-purine foods such as animal organs (such as liver, kidney), some seafood (such as anchovies, sardines), and red meat should be strictly controlled. Moderate purine foods such as poultry, some fish (such as chicken, eel) can be eaten in moderation; Low-purine foods such as milk, eggs, vegetables and fruits should be a major part of the diet. Due to the difference in purine content and absorption rate of different foods, patients with hyperuricemia and gout should scientifically select food materials, mainly low purine food, and strictly control the purine content in the diet.

3.2. Limit Fructose Intake and Supplement with Adequate Protein and Fiber

Nutrients such as vitamins and phytochemicals help to promote the excretion of uric acid by the kidneys, thereby reducing the level of uric acid in the blood [10]. It is recommended to consume no less than 500 grams of fresh vegetables per day, which are rich in vitamins and antioxidants, can support the excretion of uric acid and play an anti-inflammatory role. These nutrients can help reduce inflammation in the body, improve uric acid metabolism, and aid in the management of gout. And limit fructose intake, as it can lead to metabolic abnormalities and insulin resistance, which can raise uric acid levels. Therefore, foods containing high fructose, such as certain sweetened beverages and processed foods, should be avoided as much as possible to maintain normal uric acid levels. Reasonable dietary adjustments to increase the intake of foods rich in vitamins and phytochemicals,

while limiting the intake of foods high in fructose, are essential to control hyperuricemia and prevent gout attacks.

3.3. Drink Enough Water and Limit Alcohol Consumption

Regular and regular drinking water has a significant effect on promoting uric acid excretion. Hyperuricemia and gout patients with normal cardiac and renal function should consume 2000 to 3000 ml of water per day, with preference for white water, while drinking lemon water, light tea, unsweetened coffee and soda, should avoid excessive drinking of strong tea and strong coffee, and try not to drink cold drinks. People with gout should limit alcohol consumption, especially those with acute gout attacks, poorly controlled medications, or chronic gouty arthritis, and should avoid alcohol altogether. Alcohol consumption significantly increases the risk of hyperuricemia and gout. Alcohol metabolism interferes with purine release, increases uric acid production, [11] and increases serum lactate levels, thereby reducing uric acid excretion.

3.4. Scientific Cooking, Less Raw and Cold Food

Proper food cooking and processing is essential for the management of hyperuricemia and gout. Adopting a diet low in salt, oil and light can effectively help control blood uric acid levels. It is recommended that the daily intake of salt be controlled within 5 grams, and the use of cooking oil should not exceed 25 to 30 grams. High-fat, high-purine cooking methods such as frying, frying and marinating should be reduced, it is recommended to blanch meat and avoid meat soups as much as possible. Cured and smoked foods often contain higher purines and salts, which tend to increase the burden of uric acid, so people with hyperuricemia and gout should avoid these foods. In addition, regular consumption of raw and cold food such as ice cream and raw and cold seafood may not only damage the spleen and stomach function, but also may promote the crystallization of urate, thereby increasing the risk of gout attack, so you should eat less raw and cold food.

4. Three Recommended Eating Patterns

4.1. MD

MD is a dietary pattern that emphasizes high intake of fruits, vegetables, whole grains, and legumes, along with moderate intake of fish and poultry, and moderate consumption of full-fat dairy products and red meat and their products. The dietary pattern uses olive oil as the main fat source, which is not only used as a cooking oil, but is also considered the core fat component of the diet. With its balanced nutrient composition and healthy fat sources, MD is considered one of the most effective dietary patterns to help prevent and treat primary hyperuricemia and gout. In a secondary analysis of a randomized controlled trial (RCT) published in Diabetes Care, the study included 235 obese patients who received dietary interventions [12]. One group followed an MD pattern of dietary modifications and limited total calorie intake. The results of the study showed that this weight loss diet not only effectively reduced serum uric acid levels, but also maintained this low level in the subsequent years without rebound. This suggests that MD has a lasting effect on controlling and lowering uric acid levels, further demonstrating its potential benefits in managing hyperuricemia and gout.

4.2. DASH

DASH was originally developed to treat high blood pressure. It is a plant-centric diet rich in whole grains, fruits, vegetables, and low-fat dairy products, with a high intake of plant protein from legumes and nuts, replacing animal protein. The model recommends that people consume less red meat, candy, sugary drinks, saturated fat, total fat and cholesterol [13]. Many patients with gout (74%) and hyperuricemia (50%) have combined hypertension, and the DASH diet has been consistently found in multiple studies to be beneficial in lowering uric acid [14]. The DASH dietary pattern is considered the most helpful dietary pattern for the prevention and treatment of primary hyperuricemia and gout.

4.3. Low Purine Diet

To date, the main treatment for hyperuricemia has been a low-purine diet [15]. At the heart of a low-purine dietary pattern is the restriction of purine-rich foods to reduce the production of uric acid, the product of purine metabolism. This dietary pattern reduces uric acid burden by reducing protein intake. However, when protein intake is reduced, the body needs to meet energy requirements by increasing the intake of carbohydrates or fats, which can lead to the intake of more food's rich in refined carbohydrates and saturated or trans fats. These components may negatively affect the control of uric acid levels [16]. Relevant studies have pointed out that low-purine diets can improve gout symptoms in the short term, but the long-term effect is not obvious, and the negative effects of diet adjustment may offset its positive effects.

5. Conclusion

Through the study of dietary guidance for gout patients, the effects of different dietary structures on uric acid metabolism were systematically analyzed to provide more effective dietary recommendations for gout management. Three recommended dietary patterns showed that plant-based protein intake significantly reduced uric acid levels, that high-fat foods and sugary drinks increased the risk of gout attacks, and that DASH and MD dietary patterns were better at long-term control of hyperuricemia than low-purine dietary patterns. In this paper, a dietary guidance scheme for gout patients is proposed, which provides theoretical support for the future dietary intervention of gout, and is helpful to formulate a personalized dietary treatment scheme. The study in this paper provides a new perspective for the dietary intervention of gout, especially in the optimization of dietary structure proposed detailed suggestions. However, there are some limitations in this paper. However, this study lacks a fully consideration of the metabolic differences of different individuals, especially the influence of genetic background and living habits. Future studies should further explore the interaction between diet and individual genetic and metabolic mechanisms, and analyze the practical effects of this in patients with gout. In addition, larger clinical studies and diverse population samples will help improve the universality of studies and provide more precise dietary management strategies for gout patients.

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