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Primary Hyperoxaluria: A Comprehensive Review

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فرط أوكسالات البول الأولي: مراجعة شاملة

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Abstract:
Hyperoxaluria is characterized by excessive urinary oxalate excretion, which eventually leads to calcium oxalate kidney stone formation and severe complications. Primary hyperoxaluria (PH) is a rare genetic disorder with subtypes PH1, PH2, and PH3, each caused by specific enzyme deficiencies leading to oxalate overproduction. Globally, type 1 hyperoxaluria is the most prevalent type, as well as in Libya and North Africa. PH1 is common due to inbreeding, which leads to more mutations. Effective management depends on prompt genetic diagnosis. Management options, including changes in food intake, pharmacotherapy, and organ replacement in extreme cases, have proven their reliability. Developments such as enzyme replacement therapy and gene therapy might be promising options for PH treatment. The suggested measurements aimed to achieve a prompt prevention of kidney stone formation and renal failure, and all the mentioned treatment options have been discussed in this paper.

Keywords: Primary Hyperoxaluria; Low Oxalate Diet; Primary Hyperoxaluria in Libya; Kidney Stones; Oxalate Metabolism; Genetic Mutations; Consanguineous marriage.

الملخص
يتميز فرط أوكسالات البول بإفراز مفرط للأوكسالات في البول، مما يؤدي في النهاية إلى تكوين حصوات كلوية من أوكسالات الكالسيوم وبالتالي تحدث مضاعفات خطيرة للمريض. فرط أوكسالات البول (PH) هو اضطراب وراثي نادر له أنواع فرعية PH1 و PH2وPH3، كل منها ناتج عن نقص إنزيمي محدد يؤدي إلى فرط إنتاج الأوكسالات. يُعد فرط أوكسالات البول من النوع الأول الأكثر شيوعًا عالميًا، وكذلك في ليبيا وشمال إفريقيا. فرط أوكسالات البول من النوع الأول شائع بسبب زواج الأقارب، مما يؤدي إلى المزيد من الطفرات. يعتمد العلاج الفعال على التشخيص الجيني السريع. وقد أثبتت خيارات العلاج، بما في ذلك اتباع نظم غذائية محددة والعلاج الدوائي واستبدال الأعضاء في الحالات الشديدة، موثوقيتها. وقد تُمثل التطورات، مثل العلاج باستبدال الإنزيم والعلاج الجيني، خيارات واعدة لعلاج فرط أوكسالات البول. تهدف التدابير المقترحة في بعض الدراسات الموجودة في هذا البحث إلى تحقيق الوقاية السريعة من تكوّن حصوات الكلى والفشل الكلوي، وقد نوقشت جميع خيارات العلاج المذكورة في هذه الورقة. كما أعطت بعض النصائح العامة للوقاية من هذا المرض.

الكلمات المفتاحية: فرط أوكسالات البول الأولي، نظام غذائي منخفض الأكسالات، فرط أوكسالات البول الأولي في ليبيا، حصوات الكلى، أيض الأكسالات، الطفرات الجينية، زواج الأقارب.

Introduction

Oxalate is a result of specific metabolic activities in the body, is produced excessively in primary hyperoxaluria type 1 (PH1). It is classified as a significant genetic metabolic condition. Kidney stones

and gradual kidney damage can be caused by the production of extra oxalate, leading to oxalate calcium stones. Because of mutations in the AGXT genome, the alanine-glyoxylate aminotransferase (AGT) enzyme, which typically helps convert glyoxylate to glycine, is defective in PH1. The body then accumulates oxalate. In areas like Northern Africa, where consanguineous marriages are prevalent, the syndrome is more prevalent. Also, it is the most common type of hyperoxaluria in Libya, as one of the nation's diseases [1, 2, 3].

From early-onset kidney failure in babies to recurring kidney stones and permanent kidney damage in older kids and grown-ups. The symptoms of PH1 can vary greatly. The disease may affect more than renal function due to systemic oxalosis. Therefore, biochemical testing and genetic screening are crucial components of a prompt and accurate diagnosis to design the best treatment protocol, as action helps to handle the situation. By increasing fluid intake, changing the patient's diet, and taking medication, the current treatment aims to lower oxalate levels. Innovative treatment modalities, such as RNA interference therapy, offer promising substitutes [4, 5, 25]. This review highlights the genetic underpinnings, clinical spectrum, and treatment modalities of PH1.

Oxalate is a natural chemical found in certain foods and produced by the body. Dietary oxalate, absorbed by the intestine from external sources, accounts for 20% to 40% of the oxalate in the blood. The remaining 60% of endogenous oxalate accounts for approximately 80% of blood plasma, produced through the liver's metabolic processes. The primary characteristic of hyperoxaluria is elevated oxalate production in the urine, where high levels of oxalate can react with calcium to generate crystals of this substance, leading to stone formation and potentially dangerous kidney damage [4, 6].

Elevated urine oxalate levels, or hyperoxaluria, can be categorized into various types: Three distinct forms (PH1, PH3, and PH3) of primary hyperoxaluria, a rare genetic disorder that affects 1 to 3 individuals per million, are associated with different genetic abnormalities that impair the liver's ability to produce enzymes necessary for oxalate metabolism. Secondary hyperoxaluria (SH) can result from external factors such as high vitamin C intake or conditions like chronic renal disease and specific metabolic disorders that either enhance oxalate production or reduce its excretion. Another category includes intestinal disorders that increase the absorption of oxalate from food, such as Crohn's disease, inflammatory bowel disease, and certain types of gastric bypass surgery, which are significant causes of enteric hyperoxaluria [4, 5, 6, 7, 8]. The study by Mandrile et al., performed as part of the OxalEurope Consortium and ERKNet, identifies three primary hyperoxaluria types, each with a distinct genetic origin and implications for clinical management. It also emphasizes the significance of gene assessment in primary hyperoxaluria management programs, as it aids in early diagnosis and treatment enhancement. The study's findings indicate that genetic testing can effectively guide therapeutic strategies by identifying the specific type of hyperoxaluria [9, 25].

Hyperoxaluria types

- Primary hyperoxaluria type 1 (PH1) is brought on by a lack of the pyridoxal phosphate-dependent peroxisomal enzyme alanine glyoxylate aminotransferase (AGT), which is exclusive to the liver and coded by the AGXT gene. Because peroxisomal glyoxylate cannot be converted into glycine due to this deficit, it builds up in the cytosol. Glyoxylate is then transformed into either glycolate by the substance reductase/hydroxypyruvate reductase (GRHPR) or oxalate by lactate dehydrogenase (LDH) in the cytosol. The peroxisomal enzyme glycolate oxidase (GO) can reoxidize the newly generated glycolate back to glyoxylate and then to oxalate. Consequently, both oxalate and glycolate are overproduced. The four most prevalent mutations in the AGXT gene are c.731T>C, c.33_34insC, c.508G>A, and c.454T>A, which together account for over 100 disease-causing mutations that have been identified so far [10, 11]. With 80% of all primary hyperoxaluria patients occurring in northern Africa, PH1 is the most prevalent type and is distinguished by severe clinical symptoms. Kidney failure will eventually strike almost 70% of individuals. Early kidney dysfunction in newborns with systemic oxalate toxicity and late kidney failure, linked to frequent kidney stones or nephrocalcinosis, are among the clinical symptoms. Multiple organs are impacted by systemic oxalate poisoning; babies are especially susceptible to oxalate toxicity in the eyes, heart, and bones, while elderly individuals frequently experience problems with their hearts and bones.
- PH2 is more prevalent in Asia and less severe than PH1; it occurs due to a defect in the GRHPR gene that causes glyoxylate reductase/hydroxypyruvate reductase (GR/HPR) deficiency, leading to glyoxylate and hydroxypyruvate accumulation, which is converted by lactate dehydrogenase into L-glycerate and oxalate, that detected by urine test as a clinical feature. In PH2, CKD may develop in 25% of patients, while infantile oxalosis is rare [10, 11].
- PH3 is common in Europe and China; it's the least severe type that was recently discovered. It occurs due to a defect in the HOGA1 gene, leading to a deficiency in 4-hydroxy-2-oxoglutarate aldolase (HOGA), which causes oxalate accumulation in the end. Urolithiasis is the main clinical

feature, and CKD may develop in more than 20% of patients, in contrast to type 1 and type 2, hypocitraturia and hypercalciuria in PH3 are usually absent [11,12].

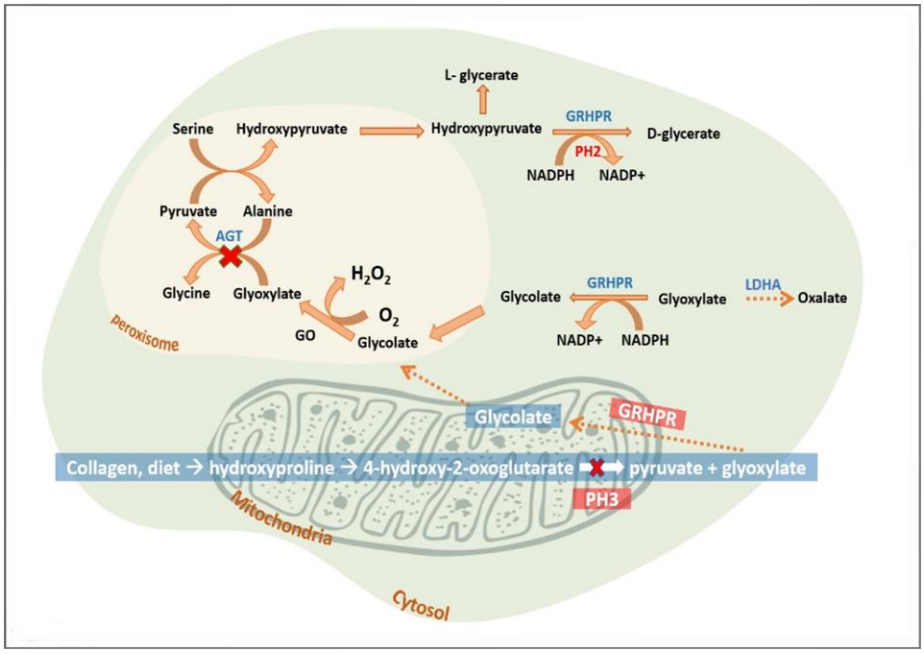

Figure 1. Glyoxylate metabolism pathways in the three types of Primary Hyperoxaluria.

PH1 Disease in Libya

In northern Africa, PH1 is highly prevalent [32]. Due to the widespread practice of consanguineous (blood-related) marriages, which raises the occurrence of autosomal recessive illnesses. locally, the prevalence of PH1 is noticeably high in Libya, and the study of Rhuma et al. [28] was conducted at Tripoli Children's Hospital to identify the precise genetic abnormalities causing PH1 among Libyan children. This study was a cohort study, where researchers performed an extensive genetic analysis, starting with an extraction of DNA from the participants' blood samples. They used polymerase chain reaction (PCR) to detect AGXT gene regions. Sequencing is used to detect and identify mutations. Also, the frequency and distribution of the mutations among the participants were systematically examined [1].

Numerous mutations in the AGXT gene, including both known and unknown variations, were found during the investigation. Interestingly, the most common variants found were c.33_34insC and I244T, which were found in 45% and 30% of the patients, respectively. In addition, 70% of the impacted infants were born to first-cousin parents. The significant connection between these mutations and consanguinity was proven. Participants' clinical presentations of PH1 varied; 60% showed early start of acute renal failure, whereas 40% had less severe symptoms. The study results emphasized the critical role of early genetic diagnosis by implementing genetic screening and counseling programs for families with a history of PH1. Furthermore, it highlights the need to improve awareness about consanguineous marriage and its associated genetic risks, to reduce the incidence of PH1 and improve public health outcomes in Libya [13].

Oxalate Metabolism and The Mechanism of Kidney Stone Formation in PH1

Oxalate is a metabolite or a product of the metabolism of various compounds, such as glyoxylate and ascorbate. The physiological pathway followed normally consists of ingested oxalate through dietary intake was also endogenously produced in the liver where AGXT gene responsible on producing Alanine-glyoxylate aminotransferase (AGT), that converses glyoxylate to glycine, an innocuous compound, in other hand, AGXT gene mutation results in AGT dysfunction, causing an accumulation of glyoxylate, which converts into oxalate, which transported to the kidneys via the bloodstream and excreted in the urine [2,11]. Excess oxalate in the urine results in supersaturation with oxalate and calcium, increasing the risk of crystal formation, which form in the renal tubules and then grow as oxalate and calcium ions precipitate from the supersaturated urine. This process is further exacerbated by low urine volume, which reduces solute dilution, and an acidic urine pH, which favors oxalate precipitation. Moreover, a lack of urinary inhibitors, such as citrate, which binds with calcium, thus preventing the nucleation or crystallization, allows the progression of crystallization and crystal growth. The crystals

grow bigger with time and become larger stones capable of obstructing the urinary passage, resulting in sharp pains, hematuria, increased risk of UTI, and chronic renal disease [11].

The Impact of PH1 through the Lifecycle

Clinical findings across different age groups include impaired kidney function or poor growth in infants under 12 months, often with nephrocalcinosis and the first kidney stone. In children and adolescents (ages 1-17), the first kidney stone, multiple or recurring calcium-containing stones, and nephrocalcinosis are common, with 30% showing nephrocalcinosis at the first imaging study. Adults (age 18 and older) frequently experience recurrent nephrolithiasis with multiple bilateral radiopaque calculi, nephrocalcinosis, and impaired kidney function. More than 10% were diagnosed post-kidney transplantation due to calcium oxalate crystals found on allograft biopsy [24].

Among children the Uncontrolled PH1 can lead to severe complications require dialysis or kidney transplantation as nephrocalcinosis, recurrent kidney stones, and end-stage renal disease (ESRD), even systemic oxalosis may occur, affecting many organs like eyes, bones, heart, and skin, leading to debilitating symptoms that include vision problems, pain in different body parts, fractures, cardiomyopathy, arrhythmias, in addition of skin lesions. Neurological and gastrointestinal problems may also impair the child's quality of life. Early diagnosis and intervention involve high fluid and pyridoxine intake, Ca-oxalate crystallization inhibitor medications, and liver-kidney transplantation, which are important in reducing these devastating complications and offering a better prognosis for the affected children [7, 18].

Multi-Organ Failure Due to Oxalate Deposits

PH1 in early life (> 1 year) may lead to Infantile oxalosis, which is characterized by the fifth stage of CKD, where multi-organ failure due to oxalate deposits occurs. According to 2022 registry data, 96% of these patients exhibit systemic oxalosis. Over half of infants diagnosed with PH1 develop stage 5 CKD, with common symptoms including poor feeding, failure to thrive, and seizures due to electrolyte imbalances. Managing these patients is challenging due to issues with dialysis access, tailored dietary needs, and frequent fractures. Therefore, dialysis with organ transplantation is a critical procedure, side by side with multidisciplinary care, in consideration of bone X-rays limited in fracture cases to avoid unnecessary radiation exposure [16].

Clinical evaluation and diagnosis of PH1

According to the Primary Hyperoxaluria clinical practice recommendations that were developed by the collaborative work of the European Society for Pediatric Nephrology (ESPN), ERKNet, OxalEurope, and the European Renal Association (ERA). Diagnosing involves evaluating symptoms such as nephrocalcinosis, hypercalcemia, kidney failure, or stones, along with considering any family history of kidney stones or renal disease [23]. Urine analysis to measure the oxalate excretion, where high levels (>0.5 mmol/L/1.73m² per day) of oxalate are a key indicator of PH1, and (0.5 - 0.7 mmol/1.73m²) per day need further investigation. Plasma oxalate levels measurement is needed in advanced renal disease; it is not useful for diagnosis in patients with normal renal function. Genetic testing, particularly sequencing the AGXT gene to identify mutations, is used to confirm the diagnosis. Additionally, carrier testing for family members and assessing alanine-glyoxylate aminotransferase (AGT) activity are part of the diagnostic process, in addition to DNA analysis, which is preferred for prenatal testing [16, 24].

Management of PH1

Management strategies for PH1, as outlined in the article, include ensuring high fluid intake to dilute urine and reduce kidney stone formation, and dietary modifications such as a low-oxalate diet and calcium supplementation to bind oxalate in the gut. Medications like pyridoxine (Vitamin B6) and alkalizing agents such as potassium citrate help reduce oxalate production and prevent stone formation. Emerging RNA interference (RNAi) therapies target the genetic causes of PH1 to significantly reduce oxalate production. Frequent kidney function observation and urine testing, along with multidisciplinary care involving nephrologists, dietitians, and genetic counselors, is a crucial procedure in mild and moderate cases, but if severity increases, then dialysis or transplantation of the liver and kidneys take place [15,24, 26].

Managing PH1 with Vitamins and minerals

- **Role of Vitamin B6 in PH1**

Vitamin B6 plays a significant role in preventing oxalate accumulation due to its ability to activate enzymes and its role as an AGT enzyme cofactor, which transforms glyoxylate to glycine. Moreover, Hoyer-Kuhn and his colleagues in 2014 assessed the impact of vitamin B6 on HP1 patients, after 40 years of clinical use. The results demonstrated that Vitamin B6 treatment had a positive effect on urinary oxalate reduction, contributing to improved symptoms and more effective management of this disease [14, 19].

The paper by Singh et al. [30] discussed the responsiveness of pyridoxine in a patient with PH1 and a rare AGXT gene mutation. This case proved that the patient with the rare AGXT mutation responded

very well to the treatment with pyridoxine. The results showed its effectiveness of oxalate diminution, and the clinical symptoms of the patient were ameliorating. Besides, the current study documented that even a rare mutation in the gene AGXT may be responsive to pyridoxine therapy, therefore, this kind of treatment should be considered in Primary Hyperoxaluria, even if rare mutations are identified [2]. As noted in the study by Hoppe and his colleagues in 2009, vitamin B6 (pyridoxine), ranging from 5 mg/kg to 20 mg/kg daily, is highly recommended to patients with confirmed PH1 to minimize the excretion of urine oxalate by less than 30% [18]. Absorption of pyridoxine may vary between patients depending on the type of mutation [1].

- **Role of Vitamin C and D in Primary Hyperoxaluria Type 1**

Canavese et al. [5] showed in their study that extended-duration intravenous administration of vitamin C can elevate calcium oxalate supersaturation, subsequently leading to the formation of kidney stones in individuals undergoing hemodialysis [19]. Based on the research by Ferarro et al. (2016), which aimed to examine the association between vitamin C intake and the risk of stone formation in kidneys, the findings revealed no association between total or supplemental vitamin C intake and stone formation in women. However, a significant association was observed in men. Also, Dietary vitamin C did not show any involvement with increased risk in any group. Therefore, only dietary vitamin C can be consumed safely for both genders [20, 27].

Vitamin D deficiency (18.9% to 59%) is a common sign among those struggling with recurrent kidney stones. Various studies have affirmed the link between vitamin D levels (25(OH)D) and hypercalciuria. A study by Sardari Masihi and his colleagues in 2023 indicated that although cholecalciferol supplements may change the 24-hour urine calcium levels, the saturation of calcium phosphate or calcium oxalate remained unaffected [21].

- **Role of calcium in PH1**

A study conducted by Borghi and his colleagues in 2002 included 120 men. Half of the participants followed a controlled diet reducing their daily intake of animal protein to 52g and salt to 50 mmol, while maintaining the recommended daily intake of calcium at 30 mmol, this group compared with the other half of participants who adhered to a common diet that provided only 10 mmol of calcium to examine the impact of calcium on idiopathic hypercalciuria and kidney stone formation. The results showed that the controlled diet of the first group had an impact on reducing hypercalciuria and stone recurrence compared to the uncontrolled diet of the second group [15].

- **Role of Potassium Citrate in Primary Hyperoxaluria Type 1**

For each kilogram of body weight, 0.10-0.15 grams of daily potassium citrate consumption (0.3-0.5 millimoles per kilogram) is sufficient to minimize the calcium crystallization due to its binding ability with it, restricting kidney stone formation in the end. Alternatively, sodium citrate can be administered orally, depending on the rate of glomerular filtration and serum potassium levels, as outlined in (Leumann, E. et. al. 1993) [15].

Dietary management of PH1

Various studies, including that of Courbebaisse in 2023 [24], demonstrate that efficient hydration and adequate fluid intake are critical prevention methods to minimize kidney stone formation and recurrence. As recommended, an individual should drink more than 3 L/m² of water daily, distributed throughout the 24 hours. This amount of fluid increases urine volume and delays kidney stone formation by minimizing oxalate and calcium concentration [24].

For infants and young children, the need for feeding tubes or a gastrostomy can be quite common. It's crucial to pay extra attention when they experience fluid loss due to diarrhea, vomiting, or fever, as well as when their oral hydration is insufficient, like after surgery. In such situations, administering intravenous (IV) fluids becomes essential [22, 30]. Dietary hyperoxaluria that causes chronic kidney disease can be effectively managed through a low-oxalate diet (Table 1, 2), which helps decrease oxalate excretion in urine, which may result in significant improvements in kidney deposits and a gradual enhancement of kidney function. The study by Sun et al. (2017) explores dietary hyperoxaluria's impact on chronic kidney disease, subsequently evaluating the impact of this dietary intervention on kidney function improvement. The researchers concentrated on the effectiveness of a low-oxalate diet in enhancing kidney function, and the positive findings, demonstrating that a low-oxalate dietary intervention, as in Table 2, can lead to substantial and sustainable improvements in kidney function [9].

Compared to the dietary restriction of oxalates in patients with PH1, such a diet has a very minimal effect on patients with pulmonary hypertension since most of the oxalates are internally produced in these cases [11]. Dill et al. [34] thus set out to improve diagnosis in hyperoxaluria by differentiating between PH and SH. In the study, participants were grouped according to their diet into (usual/low oxalate / high oxalate), followed by 3 sequential urine collections over 24 hours to analyze urinary oxalate, where the researchers identified a differential pattern that helped them to delineate PH from SH [34]. One investigation showed that on a typical diet, those with SH greatly reduced urinary oxalate

excretion when changing to a low oxalate diet by as much as 50%, whereas patients with PH always had high oxalate levels and thus represent genetically determined disease [10]. While a low-oxalate diet might not reduce the urinary oxalate sufficiently but it reduces the burden on the kidneys [28]. However, based on the principle of caution, some specialists propose consuming foods low in oxalates [14]. The majority of oxalate sources found in plants, particularly seeds and leafy greens such as spinach, rhubarb, Chocolate, grains and nuts. In contrast, animal-based foods contain only minimal amounts of oxalates [29].

Table 1. A list of some low-oxalate foods (32).

Food Items	Serving Size	Oxalate(mg)
Fruit		
Blueberries	½ cup	2
Pears	1 fruit	2
Apples	1 fruit	1
Apricots	1 fruit	0
Cantaloupe	¼ melon	1
Grapes	½ cup or 16 seedless grapes	1
Mango	1 fruit	1
Peaches	1 fruit	0
Watermelon	1 slice	1
Vegetables		
Cabbage	½ cup	1
Cauliflower	½ cup cooked	1
Chives	1 TSP	0
Corn	½ cup	1
Onions	1 small onion	0
Cucumber	¼ cucumber	1
Mushroons	1 mushroom	0
Peas	½ cup	1
Radish	10 counts	0
Zucchini	½ cup	1
Eggs and milk products		
Eggs	1 medium	0
Cheddar Cheese	1 slice	0
Mozzarella Cheese	1 oz	0
Low Fat Cheese	1 slice	0
Butter	1 pat	0
Whole Milk	1 cup	1
Cereals and Meats		
Barley Malt Flour	1 cup	0
Flaxseed	1 Tbs	0
Oat Bran, raw	1/3 cup	0
Ground Beef	3 oz	0
Sardines	1 can or 3.75oz	0

Table 2. A list of some high-oxalate foods (20).

Food Items	Serving Size	Oxalate (mg)
Fruit		
Dates	1date	24
Avocados	1fruit	19
Orange	1 fruit	29
Kiwi	1 fruit	16
Figs	1 medium fig	9
Pineapple	1 cup	4

Banana	1 fruit	3
Cherries	1 cup	3
Raisins	1 oz	3
Limes	½ fruit	3
Vegetables		
Yams	½ cup	40
Bamboo Shoots	1 cup	35
Turnip	½ cup mashed	30
Rutabaga	½ cup mashed	31
Fava Beans	½ cup	20
Olives	approx 10 olives	18
Red Kidney Beans	½ cup	15
Mashed Potatoes	1 cup	29
Refried Beans	½ cup	16
Tomato Sauce	½ cup	17
Milk		
Chocolate Milk	1 cup	7
Cereals and Meats		
Wheat Flour,Whole Grain	1 cup	29
Pistachios	1 oz	14
Pumpkin Seeds	1 cup	17
Tuna Salad	1 cup	6
Frozen Fish Sticks	2 sticks	3

Current and Upcoming Treatments for PH1

Existing treatment options are quite limited and mainly focused on symptom relief and delaying kidney failure. There's a single proven and effective method, which is a combined liver and kidney transplantation, which deals with metabolic issues but also implies the necessity of being on immunosuppressive therapy. The key strategy is to be the maintenance of kidney function by inhibiting calcium oxalate deposition [13, 25].

Currently, traditional treatments that used to lower oxalate levels in the urine is Nedosiran, while new treatments, including targeted therapies, are under investigation. Among these, one of the latest options is Lumasiran. In 2020, the American Food and Drug Administration (FDA) with the European Medicines Agency (EMA) approved Lumasiran use as treatment option, where it utilizes RNAi technology to lower oxalate levels by targeting the HAO1 gene, which reducing oxalate production by encodes the enzyme glycolate oxidase (GO) [3, 32]. According to a study conducted in 2020 involving several countries, Lumasiran reduced oxalate levels in urine by 53.5%, whereas the placebo-controlled group attained a mere 11.8%. Reported side effects were mild, and serious ones were absent in the study's focus group. Lumasiran has a subcutaneous mode of application, and its dose is determined by using the body weight of the patient. Currently, three phase 3 trials are in progress to assess Lumasiran's long-term efficacy and safety, with results anticipated in 2024 and 2025 [4, 11, 33]. Given that (PH1) is a genetic disorder frequently inherited through consanguineous marriages, it is vital to raise awareness about the condition. Genetic counseling is very critical for consanguineous couples in determining the gene carriers of PH1 and making a proper assessment of the risk they might pass on to their offspring. By being better informed, they would make a decision that agrees with their values, particular circumstances, and plans for the future. Increasing knowledge about this will help them when considering procreation and providing a substantial contribution to the alleviation and reduction of this genetic disorder [16, 23, 35].

Conclusion

Hyperoxaluria type 1 is a severe and widely recognized genetic disorder that has gained much attention in recent research due to its increasing prevalence and the lack of a definitive cure, except for liver and kidney transplantation. Studies are ongoing to discover alternative definitive treatments, however, no new therapies have been established. Therefore, the efficient management of hyperoxaluria type 1 should be pursued to decrease the workload of the kidneys, using dietary

management strategies as a diet high in fluids and low in oxalate. Besides, genetic counseling is highly recommended, especially in consanguineous marriages, to identify the carriers of the gene responsible for this condition. This will reduce the incidence of this disease, besides making people think well of their choices and reducing the risk of passing it to the next generation.

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