Phosphatidylcholine

A versatile medicine

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Part I: What is Phosphatidylcholine?

Phosphatidylcholine is a versatile medicine with a little-known but impressive range of functions in human health. By serving as an essential phospholipid and an important component of the cell membrane lipid bilayer, as well as being a major source of choline, representing about 95% of choline tissue stores, phosphatidylcholine has a number of critical functions, including serving as a precursor for brain-signaling molecules such as acetylcholine (ACh), assisting with liver metabolism of cholesterol, and being involved in methylation reactions such as those converting homocysteine, a predictor of cardiovascular disease, to methionine.

In brief, this means that choline and/or phosphatidylcholine may have an important role in the maintenance of healthy liver function and normal cholesterol metabolism, reduction of cardiovascular risk, maintenance of intestinal health, and brain function including memory and mental health.

The human body can synthesize choline by converting the phospholipid phosphatidylethanolamine to phosphatidylcholine. However, the conversion of phosphatidylethanolamine to phosphatidylcholine in humans is very inefficient, and humans cannot adequately meet physiological requirements without intake from food.

As a nutrient, choline occurs in food as phosphatidylcholine, which is 13% choline. Choline is found in foods such as liver, wheat germ, milk, peanuts, fish, and beef, with eggs being the richest source, providing 680 mg per 100 g. In addition, soy lecithin
is synonymous with phosphatidylcholine, and may be an easy way to supplement food sources. The Institute of Medicine has established Adequate Intake (AI) levels for choline: 425 mg per day for adult women, and 550 mg per day for adult men aged 19 and over. For children under three years, AIs are in the range of 100–200 mg, while for older children AIs are in the range of 200–400 mg per day. In addition, human requirements for choline are interdependent with the status of other nutrients such as folate, such that if one is deficient in folate, the body requires higher amounts of choline. Hormones also influence choline status, with estrogen driving increased choline synthesis in the body. Since choline tends to occur in higher amounts in animal foods, vegetarians are at especially high risk of deficiency.

Stay tuned for subsequent sections of this article discussing the applications of phosphatidylcholine in liver health, intestinal health, and brain function.

References

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Part II: PhosphatidylCholine and Liver Health

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In Part I, we saw that choline is an essential nutrient with a role in liver metabolism of cholesterol. Humans consuming a choline-deficient diet have been shown to develop fatty liver and liver damage. On the other hand, supplementation with choline has been shown to reduce liver damage due to fatty liver and reduce fat accumulation within cells.

Choline plays an essential role in cholesterol transportation. When fat and
cholesterol are consumed, they are absorbed from the intestine and sent to the liver for “packaging” on transporter proteins in order to be sent out to the rest of the body. Choline functions as part of the very low density lipoprotein (VLDL) that transports cholesterol from the liver to the rest of the body.[2] Therefore, when the body is deficient in choline, fat and cholesterol accumulate in the liver, resulting in fatty liver and damage. Choline also increases the solubility of cholesterol in the bile, increasing excretion through this route.[1] As an offshoot of this effect on bile solubility, choline may also have benefits on prevention of gallstones.[1]

Low dietary intake of choline has been associated with increased liver fibrosis (permanent damage) among women with non alcoholic fatty liver disease (NAFLD).[3] In trials, choline supplementation has also been shown to improve hepatocyte (liver cell) integrity in patients with NAFLD.[4] Another study assessing the effects of milk thistle bound to choline found that supplementation resulted in improvements in liver enzyme levels, blood sugar control, and liver cell characteristics on microscopic examination.[5] In patients receiving choline-deficient nutrition, daily supplementation of choline has been shown to reverse associated fatty liver.[6]

Betaine is a special derivative of choline that acts as a methyl donor in the metabolism of homocysteine, and may also have a therapeutic role in fatty liver. One pilot study in patients with nonalcoholic steatohepatitis (NASH) (the second stage of fatty liver) found that supplementation with betaine for one year resulted a marked improvement in liver enzyme levels, the degree of fat deposition, inflammatory grade, and stage of fibrosis.[7] Other studies have shown that supplementation with 2.6 g phosphatidylcholine can lower homocysteine levels,[8] an important predictor of risk of stroke and other types of cardiovascular disease.

Finally, in patients with liver cirrhosis and in liver failure, one study found that supplementation with 350 mg phosphatidylcholine three times per day for 6–8 weeks was associated with better recovery from complications (encephalopathy and ascites) and a lower mortality rate.[9]

In part III, we will discuss the evidence for phosphatidylcholine’s role in the maintenance of healthy intestinal function.

References

As reviewed in part I, phosphatidylcholine serves an important function as a component of the cell membrane, maintaining membrane integrity and functioning in cell-to-cell communication. In the digestive tract, maintenance of barrier function and cell membrane integrity is of particular importance. A number of studies have examined use of phosphatidylcholine as a treatment for ulcerative colitis[1–3] and in stomach ulcers.[4, 5] In both these conditions, the integrity of the cells lining the digestive tract is seriously damaged, resulting in severe pain, and in ulcerative colitis, cramping, diarrhea, and bleeding.

One study of 60 patients with ulcerative colitis not responding to steroid therapy found that supplementation with 500 mg phosphatidylcholine four times daily (total 2 g per day) for 12 weeks was able to decrease disease activity by 50% or more in 50% of the patients receiving the treatment.[1] This was compared to such improvement in only 10% in the placebo group. In addition, 80% of the phosphatidylcholine group were able to discontinue use of steroids without exacerbation of their disease, compared to only 10% of the control group.
A second study examined 60 patients with non-steroid dependent ulcerative colitis.[2] Supplementation with phosphatidylcholine resulted in significant improvements in disease remission rates, endoscopic findings (scope & imaging of the inside of the intestine), and quality of life scores, compared to placebo.

Finally, a third study was conducted in 40 non-steroid dependent patients with chronically active ulcerative colitis.[3] This study found that supplementation with 1 g, 3 g, or 4 g per day phosphatidylcholine resulted in significant improvements in disease activity after 12 weeks. This was accompanied by improvements in endoscopic findings, and improved healing of the intestinal mucosa. Of note, the 3 g and 4 g doses were more effective in inducing remission compared to the 1 g dose. Side effects were mild to moderate bloating and nausea.

In addition to ulcerative colitis, protective effects have been shown for phosphatidylcholine on the stomach. In animals, supplementation with a pectin-lecithin complex was able to successfully treat gastric ulcers.[4] In humans, the gastrointestinal toxicity of aspirin, which can result in ulcers or intestinal bleeding, was offset by formulating the aspirin in a complex with phosphatidylcholine.[5] This was accompanied by a decrease in markers of inflammation, and a decrease in the number of gastric erosions to almost one third of that seen with the regular aspirin formulation.

Part IV will discuss the role of choline in healthy brain function including memory and the prevention of mental illness.

References

In the brain, choline functions as part of the neural cell membrane, as well as a precursor for signaling molecules. Perhaps the most important of these is acetylcholine (ACh), a neurotransmitter that cells use to signal to each other. ACh has an important role in the transmission of nerve impulses, muscle control, and memory. Psychiatrists from Harvard have investigated the relationship between choline in the brain and the development of neurodegenerative conditions such as Alzheimer’s and dementia.

In a key study, a group of young (20–40 years old) and older (60–85 years old) participants were given choline as an oral supplement. Researchers then measured blood levels of choline as well as the incorporation of the choline into the brain through an advanced technique called proton magnetic resonance spectroscopy (pMRS). Blood levels of young and older participants were similar; however, for incorporation into the brain, the young participants experienced a large increase (60%), while older participants had only a very small increase (16%). This suggests that not only may decreased choline levels be implicated as a factor in memory decline and dementia related to aging, yet there may be a window of time when supplementation with choline is likely to be particularly beneficial — earlier in life.

Supplementation with a slightly different form of choline, CDP-choline, also known as citicoline, has been shown to preferentially increase synthesis of phosphatidylcholine in the brains of older adults. As a result this form, citicoline, has been further researched for its effects on memory and cognitive impairment. Citicoline supplementation has been shown to improve memory, including verbal memory, in patients with age-related cognitive impairment, as well as improve cognitive function in elderly patients with vascular-related mild cognitive impairment.
Finally, because of the findings that choline is differentially incorporated in the brain at different points in development, the role of choline supplementation in pregnancy has received attention. Choline supplementation during pregnancy may reduce risk of psychiatric or neurological disease in the offspring. Although this question is still under investigation, an early study has been conducted, supplementing pregnant women from the second trimester onward with twice the recommended amount (see part I) of choline. The study found that choline supplementation resulted in a brain development pattern that is associated with decreased risk of schizophrenia.[7]

In summary, choline/phosphatidylcholine has a variety of important roles in human health, including liver health, gut health, and neurological health. Choline is an essential nutrient, and adequate intake levels are currently defined as approximately 500 mg per day in adults.

References