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Clinical Significance of Cholesterol Estimation in Animal Serum

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Introduction

Cholesterol is the main sterol in animal tissues. Cholesterol plays has a role in membrane fluidity but its most important function is in reducing the permeability ofthe cell membrane. Cholesterol helps to restrict the passage of molecules by increasing the packing of phospholipids.Dietary intake is the major source of cholesterol, but it can also be synthesized endogenously by the liver and other tissues. It plays a fundamental role in central metabolic pathways, such as bile acid metabolism and steroid hormone and vitamin D synthesis. Lipids are water-insoluble molecules, they cannot be transported in aqueous solutions, such as plasma. For that reason, lipids are transported in plasma as macromolecular complexes known as lipoproteins.

Canine lipoproteins can be divided based on their hydrated density into four major classes:

1. **Chylomicrons**
2. **Very Low-Density Lipoproteins (VLDL)**
3. **Low-Density Lipoproteins (LDL)**
4. **High-Density Lipoproteins (HDL)**

Clinical Significance

Cholesterol is an unsaturated alcohol of the steroid family of compounds; it is essential for the normal function of all animal cells and is a fundamental element of their cell membranes. It is also a precursor of various critical substances such as adrenal and gonadal steroid hormones and bile acids. They are responsible for transporting cholesterol to peripheral tissues, by binding to LDL receptors on these tissues, e.g., adrenal glands, ovary and testes. HDLs are synthesized in the liver and gastrointestinal tract and transport cholesterol from tissues to the liver (so-called “reverse” cholesterol transport, which is

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thought to be minimal in dogs due to the lack of some transferase enzymes). Once in the liver, cholesterol can be incorporated into VLDLs, synthesized into bile acids, esterified to long chain fatty acids or excreted into the bile. Bile is the main route of excretion of cholesterol.

Dogs with hyperlipidemia may have no clinical signs, especially with mild to moderate elevations. White lipid deposits in the corneas of the eyes can be a common mild symptom. Some dogs, however, will experience abdominal discomfort, vomiting and diarrhoea. Prolonged elevations can lead to pancreatitis, which can be life threatening. If triglyceride levels are quite high, central nervous system signs, including seizures, are possible.

Most dogs with pancreatitis having more cholesterol concentrations which lead to hypercholesterolemia, Dogs with pancreatitis had higher low-density lipoprotein fractions and lower triglyceride-rich lipoprotein and high-density lipoprotein fractions than healthy dogs(Panagiotis G. et., al in 2020).

Increased concentration(hypercholesterolemia)

High cholesterol is usually due to increased numbers of cholesterol-rich lipoproteins, i.e., HDL and LDL. Because VLDL does contain some cholesterol (12%), high cholesterol can also be seen with very high VLDL concentrations. Chylomicrons have very little cholesterol, so high cholesterol concentrations are not usually seen post-prandially. Common causes of high cholesterol without triglycerides in dogs are nephrotic syndrome, hypothyroidism and cholestasis. Increases of cholesterol and triglycerides in dogs are seen in metabolic conditions such as diabetes mellitus, hyperadrenocorticism, pancreatitis etc (due to high VLDL). High cholesterol in cats is usually due to cholestasis (not all cholestatic dogs and cats will have high cholesterol). Cholesterol is not routinely measured in large animals; therefore, we know less about cholesterol concentrations in these species.Cholesterol is a waxy substance found in blood. Body needs cholesterol to build healthy cells, but high levels of cholesterol can increase risk of heart disease.

With high cholesterol, animal can develop fatty deposits in your blood vessels. Eventually, these deposits grow, making it difficult for enough blood to flow through your arteries. Sometimes, those deposits can break suddenly and form a clot that causes a heart attack or stroke.

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High cholesterol can be inherited, but it's often the result of unhealthy lifestyle choices, which make it preventable and treatable. A healthy diet, regular exercise and sometimes medication can help reduce high cholesterol.

High cholesterol can cause a dangerous accumulation of cholesterol and other deposits on the walls of your arteries (atherosclerosis). These deposits (plaques) can reduce blood flow through your arteries, which can cause complications, such as:

Symptoms

Symptoms in dogs may be absent or may correlate with the underlying cause of the hyperlipidemia. Symptoms of hyperlipidemia can include:

- Decreased appetite
- Vomiting
- Diarrhea
- Abdominal pain
- Bloated abdomen
- Cloudy eyes
- Fatty deposits under the skin
- Hair loss
- Itching
- Seizures
- **Chest pain.** If the arteries that supply your heart with blood (coronary arteries) are affected, you might have chest pain (angina) and other symptoms of coronary artery disease.
- **Heart attack.** If plaques tear or rupture, a blood clot can form at the plaque-rupture site -blocking the flow of blood or breaking free and plugging an artery downstream. If blood flow to part of your heart stops, you'll have a heart attack.
- **Stroke.** Similar to a heart attack, a stroke occurs when a blood clot blocks blood flow to part of your brain.

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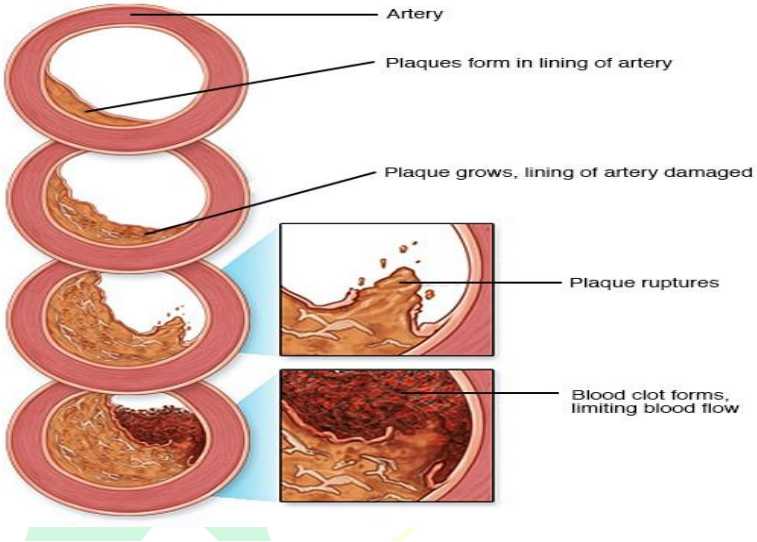

Fig 1. Development of atherosclerosis in artery

Development of atherosclerosis

Causes

Cholesterol is carried through blood, attached to proteins. This combination of proteins and cholesterol is called a lipoprotein. There are different types of cholesterol, based on what the lipoprotein carries. They are:

- **Low-density lipoprotein (LDL).** LDL, or "bad" cholesterol, transports cholesterol particles throughout your body. LDL cholesterol builds up in the walls of arteries, making them hard and narrow.
- **High-density lipoprotein (HDL).** HDL, or "good" cholesterol, picks up excess cholesterol and takes it back toliver.

A lipid profile also typically measures triglycerides, a type of fat in the blood. Having a high triglyceride level can also increase risk of heart disease.

Factors that can control such as inactivity, obesity and an unhealthy diet contribute to high cholesterol and low HDL cholesterol. Factors beyond your control might play a role, too. For example, animal genetic makeup might keep cells from removing LDL cholesterol fromblood efficiently or cause your liver to produce too much cholesterol.Common causes of high cholesterol without triglycerides in dogs are nephrotic syndrome, hypothyroidism and cholestasis. Increases of cholesterol and triglycerides in dogs are seen in metabolic conditions such as diabetes mellitus, hyperadrenocorticism,

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pancreatitis etc (due to high VLDL.Most hyperlipidaemia in dogs is secondary to other diseases, and testing to find these is important. The most common causes are:

- Hypothyroidism, meaning low thyroid production
- Hyperadrenocorticism, an overactive adrenal gland
- Pancreatitis, inflammation of the pancreas
- Diabetes

Occasionally dogs may have gall bladder or kidney problems. If untreated, these disorders can make your pet quite ill. Sometimes hyperlipidaemia is the first symptom that leads to early detection of these diseases.

Decreased concentration (hypocholesterolaemia)

Low cholesterol can be due to decreased numbers of cholesterol-containing lipoproteins (LDL, HDL, VLDL) or a decreased cholesterol content of these lipoproteins. The most common causes of low cholesterol are protein-losing enteropathy in dogs and cancer in dogs and cats.

- Genetic defect in apoprotein production
- Decreased absorption
- Decreased production
- Altered metabolism
- Increased uptake of lipoproteins

Risk factors

Factors that can increase your risk of bad cholesterol include:

- **Poor diet.** Eating saturated fat, found in animal products, and trans fats, found in some commercially baked cookies and crackers and microwave popcorn, can raise cholesterol level. Foods that are high in cholesterol, such as red meat and full-fat dairy products, will also increase your cholesterol.
- **Obesity.** Having a body mass index (BMI) of 30 or greater puts you at risk of high cholesterol.
- **Lack of exercise.** Exercise helps boost your body's HDL, or "good," cholesterol while increasing the size of the particles that make up your LDL, or "bad," cholesterol, which makes it less harmful.

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Fig. 2. Routine exercise for pet animal

- **Age.** Because your body's chemistry changes as you age, your risk of high cholesterol climbs. For instance, as you age, your liver becomes less able to remove LDL cholesterol.
- **Diabetes.** High blood sugar contributes to higher levels of a dangerous cholesterol called very-low-density lipoprotein (VLDL) and lower HDL cholesterol. High blood sugar also damages the lining of your arteries.

Prevention

The same heart-healthy lifestyle changes that can lower cholesterol can help prevent from having high cholesterol in the first place. To help prevent high cholesterol, animal can:

- A low-fat, high-fiber diet can help reduce blood lipids. Proper portion sizes and daily exercise can prevent obesity, also a contributing factor to hyperlipidemia. Homemade diets are not recommended as they often lack in daily vitamin and mineral requirements for dogs.
- Limit the amount of animal fats and use good fats in moderation
- Lose extra pounds and maintain a healthy weight
- Exercise on most days of the week for at least 30 minutes