Intestinal Cholesterol Conversion in Adults and Elderly from Four Different European Countries

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Key Words

Microbes • Metabolism • Cholesterol • Intestine

Abstract

The growing healthy aging population in Europe is a heterogeneous group with varying nutritional needs, especially in association with problems like decreased sense of smell and taste, saliva production, chewing and swallowing problems besides all disease problems that put specific demands on the dietary intake and the role of the intestinal metabolism. To investigate this, one must clarify which functions are related to the host itself and which actions are related to the microflora. In short, the host's side of the ecosystem can be defined as milieu interieur (MI), the non-host side as milieu exterieur (ME) and MI plus ME together as milieu total (MT). We have investigated the role of the intestinal flora and its functions in adults and elderly from different European countries and this publication is concentrated on the microbial conversion of intestinal cholesterol to coprostanol, aiming to investigate the hepatic-intestinal flora co-cross-talk.

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The growing healthy aging population in Europe is a heterogeneous group with varying nutritional needs, especially in association with problems like decreased sense of smell and taste, decreased saliva production, chewing and swallowing problems besides all diseases and other

problems that put specific demands on their dietary intake. Some of the most modifiable lifestyle factors in these ages are the intake of diet and physical activity. Poor nutrition, once thought to be part of the normal aging process is, in fact, identifiable, preventable, and reversible, and should be handled before diseases manifest.

Our group studies microbial intestinal functions in health and disease. We evaluate what the intestinal flora has done, as many microbes associated with intestinal functions are difficult to isolate or otherwise detect – many processes have occurred in the upper colon or cecum, and most often these microbes are impossible to isolate – but you can identify the microbial metabolites and thereby claim presence of functionally active microbes, but so far unknown. In this way, we have the chance to evaluate the role of endogenous and exogenous substances – the cross-talks – between the host and the flora.

To investigate this, one must clarify which functions are related to the host and which are related to the microflora itself. In short, the host's side of the ecosystem can be defined as milieu interieur (MI), the non-host side as milieu exterieur (ME) and MI plus ME together as milieu total (MT). When baselines in MI are established, the normal functions of the flora as well as alterations in these functions can be worked out by applying the so-called MAC/GAC concept. A microflora-associated characteristic (MAC) has been defined as the recording of any anatomical structure, physiological, biochemical, or im-

Table 1. Mean value of the percentage of conversion of cholesterol into coprostanol in healthy adults and elderly volunteers from France, Germany, Italy, and Sweden

	Adults		Elderly	
	male	female	male	female
France	66% (n = 19, both sexes)		71% (n = 24, both sexes)	
Germany	76% (n = 8)	60% (n = 13)	74% (n = 14)	65% (n = 23)
Italy	57% (n = 4)	40% (n = 13)	69% (n = 24)	72% (n = 14)
Sweden	55% (n = 5)	63% (n = 13)	61% (n = 23)	68% (n = 15)

Thirteen volunteers were zero converters – not included in the table.

munological function that has been influenced by the microflora, e.g. the ME [1]. When active microbes that actually influence the parameter under study are absent – as in germ-free animals and healthy newborns (MI) and sometimes following antimicrobial therapy – the particular recording is termed germ-free animal characteristic (GAC). In this chapter, I will concentrate on the microbial conversion of intestinal cholesterol to coprostanol, aiming to investigate the hepatic-intestinal flora co-cross-talk – and how this pool is affected by the intestinal flora.

Microbial conversion of cholesterol to coprostanol is one route for the body to reduce the host cholesterol pool – cholesterol deriving from both endogenous and exogenous sources. Endogenous cholesterol is synthesized mainly in the liver and the small intestine, and the exogenous source is mainly of dietary origin. Cholesterol in the intestine can be reabsorbed, but there are also some microbes that are able to convert cholesterol to coprostanol, unabsorbable, and thus reducing the intestinal cholesterol pool [2]. Some studies have shown an association between high excretion of coprostanol and plasma cholesterol-lowering effects after feeding *Eubacterium coprostanoligenes* to rabbits and mice [3, 4]. However, when the same strain was given to hens, no plasma cholesterol-lowering effect was seen [5]. However, none of the 18 probiotic strains tested in our laboratory as mono-contaminants on germ-free mice were able to convert cholesterol to coprostanol. Therefore, we suggest that one function of some probiotics could be that probiotics are able to de-conjugate bile acids, and in that way reduce the intestinal cholesterol pool [2].

In humans, we have found that most often this microbial function is established before the age of 2 years [6], and that the conversion in many cases is disturbed during ordinary antimicrobial therapy [7]. Breastfed children were found to establish this flora function somewhat later than formula-fed ones. We have also investigated a

large group of adult North Europeans with regard to conversion of cholesterol to coprostanol. In that study, we arbitrarily divided 633 healthy volunteers into three age groups: <36, 36–50, and >50 years, males and females, with a conversion capacity of cholesterol to coprostanol of none, low, and high. In males, we found that there was a higher percentage of nonconverters in the younger group, compared to the two other groups, and the percentage of high converters was increased slightly in the oldest male group. In females, similar differences were not detected in any age group [8]. In the comparison between the adults and elderly in another study – the EU project Crownalife [9], where we investigated the microbial conversion of cholesterol to coprostanol in 83 adults (age 25–45) and 142 elderly (>65 years) from France, Germany, Italy, and Sweden, we found that the number of zero converters were 1, 3, 5 and 4, respectively. Of these, 10% of the adult volunteers and 4% of the older participants were zero converters [to be published]. However, we did not find any significant differences between northern and southern Europe, due to too few volunteers, either with regard to zero converters or those that converted cholesterol to coprostanol (table 1). Similarly as before, we can see a reduction here with age of the number of nonconverting healthy volunteers. Our supposition is that a lower capacity to convert intestinal cholesterol to coprostanol in elderly could be a disease or a morbidity factor, as most of these volunteers have left the healthy fraction of the population.

Disclosure Statement

The author declares that no financial or other conflict of interest exists in relation to the content of the article.

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