The ‘Fast’ and ‘Slow’ Protein Concept

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Several factors are known to regulate postprandial protein deposition. Some depend on nutrients other than proteins (energy intake, for example), others depend on the pathophysiological condition (aging, stress, and so on), and some depend on the dietary protein itself. With respect to the latter, there have been various studies dealing with the effects of the amount of protein given, its amino acid composition (the ‘quality’ of a protein), and its physicochemical structure and environment (which can affect its digestibility). However, it is also possible that the time course of absorption of dietary amino acids might be an important – and so far underestimated – factor affecting protein deposition. In this chapter we briefly summarize our current knowledge of the postprandial modifications of whole body protein kinetics and report the studies that led to the concept of ‘slow’ and ‘fast’ dietary proteins.

Mechanisms of Nitrogen Gain During Feeding

In adults, body protein mass is kept constant day by day despite diurnal fluctuations. This protein homeostasis arises from losses that occur in the absence of exogenous substrates (that is, in the postabsorptive state), and from compensations during the absorption of nutrients through the gut (the fed state). Modifications in nitrogen balance occur to ensure that an equilibrium is maintained between whole body protein synthesis and breakdown. These kinetic variables are measured by isotopic dilution methods, the most commonly used being the so-called precursor method, based on the dilution of a labeled essential amino acid (which is usually leucine). To make calculations easier, studies are normally performed under steady-state conditions, although this is not compatible with normal meals. Various kinds of feeding are used to obtain a steady state; thus
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A liquid meal may be given by continuous nasogastric infusion [1–3] or small meals are given at 15- to 60-min intervals [4–6]. The experimental conditions used are also very variable with respect to nitrogen and energy intake (0.8–1.5 g of protein/kg-day, representing 5–20% of the energy intake). The molecular form of the nitrogen substrates (from free amino acids to whole proteins) and the duration of feeding (from 4 to 12 h) are additional factors to be taken into account.

When making a collective analysis of studies on protein metabolism, the changes observed in the postprandial periods are as follows:

- Leucine balance becomes positive with feeding, and increases with dietary leucine intake.
- Leucine oxidation also increases when the intake is above the requirement. This concept has been used for the estimation of amino acid requirements in humans.
- Whole body protein breakdown, as assessed by the endogenous leucine production, is depressed by at least 30–50% with feeding. In some studies, corrected endogenous leucine production is obtained by subtracting the dietary leucine flux, corrected for first-pass splanchnic extraction, from total leucine flux. This calculation compensates for the fact that not all the dietary amino acids reach the systemic pool; however, it requires an oral tracer as well as the intravenous tracer. The extent of the correction is moderate for leucine in adults, as splanchnic extraction is around 10–25% [1, 4, 7]. It may become important in neonates [8] or in the elderly [7]. Splanchnic extraction is of course greater for amino acids which are predominantly oxidized in the liver, such as phenylalanine [4]. Correction for splanchnic extraction results in a higher – and probably more accurate – estimate of protein breakdown. Inhibition of protein breakdown is generally attributed primarily to insulin, with a synergistic effect of hyperaminoacidemia.
- Whole body protein synthesis, classically assessed by the nonoxidative disposal of an amino acid, has been shown to increase in some studies [2, 5, 9], but to remain unchanged in others [3, 6, 7]. These apparently discrepant results are primarily explained by the protein content of the meal. By giving isocaloric meals with a protein content ranging from 0.4 to 2.1 g/kg-day, Pacy et al. [9] showed that protein synthesis increases only for intakes of >1.5 g/kg-day. Also, when multiple studies are evaluated [10], the postprandial increase in plasma leucine concentrations correlates fairly well with stimulation of protein synthesis.

What Factors Affect Postprandial Protein Gain?

Several factors are well known to modulate protein ‘efficiency’. Apart from protein quality (that is, its essential amino acid composition), the effect of protein intake has been the most widely studied variable. It has been known for decades
that nitrogen balance increases with nitrogen intake [11]. However, this relation is not linear and is only valid until a given protein intake is reached. This effect is mostly achieved through modifications in the postprandial response of protein kinetics. Two factors – substrate availability and insulin – are the main regulators of protein metabolism. For amino acid oxidation, the primary determinant is substrate availability (that is, intracellular amino acid concentration). For proteolysis, insulin and to a lesser extent amino acids exert separate and additive inhibitory effects [12]. Finally, as stated above, protein synthesis is regulated by intracellular amino acid levels. However, postprandial stimulation by an increase in amino acid levels is not necessarily helpful because the stimulation of protein synthesis is counterbalanced by a parallel increase in amino acid oxidation. The influence of insulin on protein synthesis is still controversial [13].

It is worth mentioning that for these variables (amino acid oxidation, protein breakdown and synthesis) there is a dose-response relation with amino acid concentrations, as was recently shown using stepwise intravenous amino acid infusions [14]. Finally, it is likely that the habitual protein intake regulates the level of the postabsorptive protein loss (the higher the intake, the greater the loss) [15].

Thus postprandial hyperaminoacidemia is an important variable. Not unexpectedly, postprandial amino acid levels differ substantially depending on the mode of administration of the dietary protein: a single protein meal results in an acute but transient peak of amino acids [16–18]; by contrast, the same amount of the same protein given continuously induces a smaller but more prolonged increase [18]. The difference is particularly striking for branched chain amino acids, owing to their low splanchnic extraction. It was therefore logical to examine the effect of the pattern of protein feeding (the number of daily meals) on nitrogen retention. These studies gave conflicting results. In young women, nitrogen balance was more positive when the daily protein intake was spread fairly evenly over three meals than when it was spread over two meals, with one meal containing no protein [19]. In young men, the same conditions resulted in no significant change in nitrogen balance [20]. In another study in young men, whole body leucine balance – an index of protein deposition – was more positive with a diet given over 24 h than with three discrete meals [21]. More recently, it was shown that protein retention in elderly women was better when the protein was given in a pulse-feeding pattern than in a spread feeding pattern [22]. Comparisons between continuous and bolus infusions of nutrients have also been performed in the setting of total parenteral nutrition, with differing results according to the level of stress [23, 24]. There are numerous differences between all these studies, such as the sex and age of the subjects, the daily protein and nonprotein energy intake, and the methods used. However, collectively, these results support the hypothesis that the pattern of protein feeds can modulate nitrogen retention and that amino acid availability is one of the main regulatory mechanisms for this effect. Apart from amino acids, insulin is also likely to play a role. During a single meal, plasma insulin
concentrations are higher than during prolonged feeding, but the duration of hyperinsulinemia is limited.

It is also known that the time course of absorption of dietary amino acids is very variable and depends on the rate of digestion of the ingested protein. This depends in turn on gastric and intestinal motility, on luminal digestion, and finally on the rate of mucosal absorption of the amino acids. For example, the time course of digestion of two major milk protein fractions – casein and whey proteins – is quite different. Whey proteins are much more rapidly emptied from the stomach than casein, because the latter clots at acidic pH. However, further digestion by the hydrolases is in general slower for the major protein fraction of whey proteins (β-lactoglobulin) than for the caseins [25, 26], as has been shown using 15N-labeled proteins. Such differences should result in variable postprandial amino acid levels, and therefore could influence the postprandial protein gain and kinetics. By analogy, it is well known that the structure of dietary carbohydrates affects their rate of absorption, which has a major impact on the metabolic and hormonal response to a meal; this led to the common classification of carbohydrates as ‘slow’ and ‘fast’. Therefore, our hypothesis was that the rate of absorption by the gut of amino acids derived from dietary proteins might affect whole body protein kinetics and protein deposition.

**How Can the Effect of the Time Course of Absorption be Studied?**

As mentioned above, postprandial protein kinetics have been almost exclusively studied during continuous feeding. Measurements are done 2–4 h after initiation of feeding, once isotopic and substrate steady state is achieved. Under these conditions, any difference related to the time course of dietary amino acid absorption is blunted. Therefore, we needed to study protein kinetics after a single meal (bolus).

We needed to use an oral tracer together with the intravenous tracer to assess the time course of the peripheral appearance of dietary amino acids. During a single meal, the time course of absorption of a free tracer and a protein-bound amino acid are certainly different: gastric emptying of a free amino acid is rapid and there is no need for hydrolysis before absorption (although this is probably partially compensated for by the more rapid absorption of di- and tripeptides compared with free amino acids). It is thus likely that a free labeled amino acid added to a protein meal does not reflect the behavior of the same amino acid when protein bound. Therefore, we had to use an intrinsically labeled protein, which involves inserting a labeled amino acid in the peptide chain. Furthermore, the enrichment had to be sufficient for use in human studies.

Among the existing labeled proteins, none met the criteria required for our study. We therefore undertook to produce [1-13C]-leucine-enriched milk proteins by infusing lactating cows with large amounts of [1-13C]-leucine. This tracer and these proteins were selected because (i) [1-13C]-leucine is a widely used tracer
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and is quite cheap; (ii) large amounts of milk, and consequently milk proteins, can be obtained in a single experiment, and (iii) cow’s milk is a common source of proteins of high biological value. Furthermore, numerous technological processes have been developed for cow’s milk, thus allowing various protein fractions of different physicochemical properties to be obtained.

The procedure has been described in detail [27]. Briefly, lactating cows were infused for 24 h or more with 80–90 g of [1-13C]-leucine. From the milk collected for 48 h, two protein fractions – micellar native casein and whey protein concentrate – were separated by microfiltration and ultrafiltration membrane techniques. In these two fractions, leucine enrichments ranged from 3 to 19.4 mol% excess, and the bacteriological quality was excellent. The final yield of the process (that is, tracer recovered as protein divided by tracer infused) was 22–27%, which makes this tracer expensive but still affordable. Other similarly labeled proteins were then obtained by Evenepoel et al. [28] by feeding hens with 13C-leucine and collecting the eggs [28], and by Metges et al. [29] using goat’s milk.

In our first study using this new tracer [17], we aimed to determine whether or not a labeled protein was more appropriate than a free oral tracer for assessing whole body protein kinetics during a single meal. To do this, we compared leucine kinetics following a single whey protein meal, using either a [1-13C]-leucine-labeled protein or an unlabeled protein with added free [1-13C]-leucine. Leucine kinetics were calculated using Steele’s equations and transposition according to Proietto et al. [30]. The protocol and results have been described in detail [17]. The main conclusion was that a free oral tracer is inappropriate for this kind of study. Its peak appearance in the plasma was 40 min earlier than the peak appearance of the same labeled amino acid incorporated in the protein. At this peak, the enrichment in the plasma was higher than in the meal, which is impossible; it simply reflects the fact that the tracer was absorbed very rapidly, while absorption of the tracee (that is, the protein-bound unlabeled amino acid) was delayed. Also, protein breakdown calculated from the free tracer transiently decreased to zero, which is highly unlikely (it was actually negative in some subjects).

**Does the Rate of Absorption of Dietary Protein Affect Whole Body Protein Kinetics?**

Our next study was intended to compare leucine kinetics after ingestion of a single meal containing either whey protein or caseins, taken as paradigms for ‘fast’ and ‘slow’ proteins, respectively [31]. Whey protein is actually a mixture of soluble proteins which do not precipitate at low pH. In contrast, caseins coagulate in the stomach and are known to delay gastric emptying. Sixteen young healthy subjects participated in the various studies. As it was not possible to have two meals of identical nitrogen and leucine content (owing to the different amino acid composition of the proteins), we elected to provide the same
amount of leucine (that is, 380 \( \mu \text{mol/kg leucine} \)). For this reason, the two groups received either 30 g of labeled whey protein or 43 g of labeled casein. \([5,5,5-^{2}\text{H}_3]\)-Leucine was infused intravenously. In a second set of experiments, the \([1-^{13}\text{C}]\)-leucine was given intravenously for calculations of total leucine oxidation. Leucine fluxes were determined from the time-dependent evolution of plasma leucine and ketoisocaprate enrichments and concentrations in the non-steady state. Briefly, the rate of total leucine appearance in the peripheral circulation is the sum of the entry rate of endogenous leucine (Endo Leu Ra), an index of protein breakdown, and of exogenous (dietary) leucine (Exo Leu Ra). The latter is calculated from the appearance of the oral tracer. Similarly, the total rate of leucine disappearance from the plasma is the sum of the leucine used for protein synthesis (total nonoxidative leucine disposal or Total NOLD) and of the leucine oxidized (Total Leu Ox). The latter is measured from the production of \(^{13}\text{C}\)-labeled CO\(_2\) in the expired breath. Postprandial leucine balance was calculated over 7 h following the meal by subtracting the integrated area under the curve of Total Leu Ox from the leucine intake. In this calculation, it was assumed that all the leucine administered was absorbed, as milk proteins are highly digestible.

The increases in postprandial plasma amino acids over baseline were different between casein and whey proteins. Despite a higher amino acid intake with casein, concentrations increased less than with whey protein 2 h after the meal. By contrast, after 3–4 h, most amino acids remained at higher concentrations after the casein meal, whereas they had returned to basal levels with the whey protein meal. These two plasma amino acid profiles are illustrated by the leucine concentrations shown in Figure 1A. Plasma insulin levels increased to a similar extent after both meals. The time courses of absorption of the dietary amino acids, calculated from the oral tracer, were clearly different, and followed the same pattern as the plasma amino acid concentrations: there was a smaller but much more prolonged influx of dietary leucine (Exo Leu Ra) from the casein meal compared with the whey protein meal (Fig. 1B).

Protein breakdown (Endo Leu Ra) did not significantly change after the whey protein meal while it was progressively and persistently inhibited after the casein meal (Fig. 1C). Total NOLD (that is, total protein synthesis) was stimulated by 68 and 31% with whey protein and caseins, respectively, the difference between the two diets being nonsignificant (Fig. 2A). Total Leu Ox increased with both proteins; however, the magnitude of the increase was much larger with whey protein than with caseins (Fig. 2B). Finally, postprandial leucine balance over 7 h was positive with the casein meal (+141 \( \pm \) 96 \( \mu \text{mol/kg} \)), but not different from zero with the whey protein meal (+11 \( \pm \) 36 \( \mu \text{mol/kg} \); \( p < 0.05 \), casein vs. whey protein).

However, as stated above, leucine content is higher in whey protein (11% wt/wt) than in casein (8% wt/wt). Therefore, the two ‘isoleucine’ meals provided two different nitrogen loads. As nitrogen content \( \text{per se} \) could affect postprandial balance, we performed an additional study during which nitrogen content was the same (that is, 30 g) for whey protein and casein: by definition, the leucine
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Fig. 1. Plasma leucine concentrations (A), exogenous leucine rate of appearance (Exo Leu Ra) (B), and endogenous leucine rate of appearance (Endo Leu Ra) (C) after a single oral load of caseins (○; 43 g of protein, 380 µmol/kg of leucine), or whey proteins (△; 30 g of protein, 380 µmol/kg of leucine) intrinsically labeled with [1-13C]-leucine in young healthy humans. Exogenous leucine rate of appearance measures the appearance in the plasma of the ingested amino acids. Endogenous leucine rate of appearance is an indicator of whole body protein breakdown. *p < 0.05 between casein and whey protein. This figure is reproduced from Boirie et al. [31] with permission. Copyright 1997, National Academy of Sciences, USA.

intake from the casein was then lower than in whey protein. Even under these conditions, leucine balance was still better with casein than with whey protein.

In a more general sense, the amino acid composition (other than the leucine content) of the meal could affect postprandial protein metabolism: it could act either directly, if an essential amino acid becomes rate limiting for protein
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Fig. 2. Total nonoxidative leucine disposal (NOLD) (A) and total leucine oxidation (B) after a single oral load of caseins (●; 43 g of protein, 380 µmol/kg of leucine), or whey proteins (△; 30 g of protein, 380 µmol/kg of leucine) intrinsically labeled with [1-13C]-leucine in young healthy humans. Total nonoxidative leucine disposal is an indicator of whole body protein synthesis. Total leucine oxidation measures whole body leucine oxidation and is an indicator of the irreversible losses of amino acids. *p < 0.05 between casein and whey protein. This figure is reproduced from Boirie et al. [31] with permission. Copyright 1997, National Academy of Sciences, USA.

synthesis, or indirectly by means of hormonal modifications reflecting a particular amino acid profile specific for a protein. Therefore, a further study was performed to assess the potential effect of the different amino acid compositions of the two proteins. Using the same methodology, we first compared a casein meal with an amino acid mixture meal mimicking the composition of the casein. We also compared a single whey protein meal with continuous feeding of repeated small whey protein meals. Therefore in both cases the two meals were isonitrogenous and of identical amino acid composition. They differed only in the time course of absorption: this was ‘fast’ with whey protein and with the amino acids, and ‘slow’ with the casein or with continuous feeding. As expected, total postprandial leucine oxidation was always lower (and leucine balance higher) when the meal contained slow protein than when it was composed of fast protein or amino acid [32].
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We therefore demonstrated that the time course of amino acid absorption after protein ingestion has a major impact on the postprandial metabolic response to a single protein meal. Slowly absorbed protein promotes postprandial protein deposition, in contrast to rapidly absorbed protein—at least under our experimental conditions.

**How Could the Effect of the Rate of Absorption of Dietary Protein on Protein Deposition be Explained?**

The methodology we used did not allow us to identify the rate limiting step(s) that explain the slower digestion of caseins. It is, however, very likely that slower gastric emptying was mostly responsible for the slower appearance of amino acids in the plasma. Interestingly, the rate of absorption could be assessed simply by monitoring the branched chain amino acid concentrations, which correlated closely with the appearance of the tracer.

After whey protein ingestion, large amounts of dietary amino acid (~25 mmol of leucine) flood the relatively small body pool (~5 mmol) in a short time, resulting in a dramatic increase in concentration. This is probably responsible for the stimulation of leucine oxidation and, to a lesser extent, protein synthesis. With casein, on the other hand, plasma amino acid concentrations were lower, resulting in less oxidation and a smaller increase in protein synthesis. The inhibition of protein breakdown observed with casein is more difficult to explain: protein breakdown is classically inhibited by insulin, but plasma insulin concentrations did not differ between the two meals. However, the insulin to glucagon ratio might be more important than the absolute concentration of either, and glucagon was not measured. Finally, it is possible that a sufficiently prolonged period of hyperaminoacidemia is needed to obtain a significant inhibition of protein breakdown.

**Conclusions and Perspectives Raised by the ‘Slow’ and ‘Fast’ Protein Concept**

While the impact of the rate of absorption of dietary proteins on protein metabolism holds true when proteins are given on their own, the effect might be blunted in more complex meals, which could affect the rate of gastric emptying (lipids) or substrate and hormone response (carbohydrates). Thus further studies are urgently needed to confirm the reproducibility of this effect under more physiological conditions. It would also be of interest to use methodological approaches other than leucine balance to assess the effects of ‘slow’ and ‘fast’ meals. Finally, it is currently unclear whether the apparently greater efficacy of ‘slow’ proteins is a general phenomenon that is present regardless of the age [22] and pathophysiological conditions [23, 24] of the subjects studied.
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If confirmed, this concept offers a number of therapeutic possibilities, for example in old age or in patients with wasting disorders (protein-energy malnutrition, critically ill patients, and so on). It could also be applied to circumstances where excessive amino acid concentrations need to be avoided, while preserving the anabolic action of dietary protein (renal disease, hepatic encephalopathy).

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**Discussion**

*Dr. Silk:* The growth rates appear to be rather poor with the DH30. My question is whether these young rats weighing 100 g have normal pancreatic function or whether exocrine pancreatic function is underdeveloped.

*Dr. Finot:* I cannot answer your question directly because we did not test pancreatic function on this occasion. But we did study pancreatic function 15 years ago in rats.
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fed with unhydrolyzed whey protein, or with whey protein hydrolyzed using trypsin, chymotrypsin and pancreatin, or with free amino acids. We found that the animals fed on hydrolyzed whey had evidence of pancreatic stimulation compared with the group fed intact protein [1].

Dr. Fürst: A short comment to Dr. Finot concerning available products. When I synthesized dipeptides, I did it for intravenous use. That means that it needed to be about 99.5% pure. That is very expensive. If you want dipeptides for enteral use, much cheaper methods can be used. In that case over-reaction products are allowed and you can use a 95% pure preparation which costs a fraction of the amount of dipeptides. What I’d like to say is that when you are working with a new indication you must adapt your need to the technique. I was involved with a new method for glutamine determination in proteins which we published in 1996 – an old development of hydrolysis. While doing this, I discovered how the industry had previously fractionated gluten down to a product with a completely worthless structure, having extremely poor bioavailability and biological value, and then they simply diluted this fractionated product with casein. My question is, why doesn’t the industry think about how to do it properly: take a good milk protein, for instance, and use a reverse phase enzyme catalyzed method to enrich it with glutamine or arginine? Why use expensive products that are not suited for the purpose?

Dr. Finot: I think you are right. I explained that we have the technology to fortify protein hydrolysate with cysteine and also with glutamine. We achieved a level of 15% glutamine. But the problem is what is the optimum level of glutamine that should be provided in a product? Is 15% enough?

Dr. Boza: I’d like to ask Dr. Fürst whether it is technically possible to make a dipeptide of cysteine and glutamine.

Dr. Fürst: Certainly it’s possible.

Dr. Millward: I’d like to make a point about the potential biological significance of the fast and slow protein concept in relation to appetite regulation. Those of us who are interested in aminostatic appetite-related mechanisms are intrigued by the effect of differential rates of amino acid absorption on satiety, and I think these have a great deal of potential clinical significance. We’ve done some studies comparing whey and casein on satiety, which I’d like to summarize. We did a single blind crossover study looking at a group of young students given a meal of casein with some carbohydrate or whey, and we followed them for 90 min after the meal, measuring subjective measures of satiety and hunger. We then we offered them a buffet meal and measured their energy intake. The hypothesis was that whey, as a fast protein, would be more satiating than casein, and therefore we predicted that energy intake at this buffet meal would be lower after whey than after casein. This prediction was confirmed and the effect was significant. We also got a significant subjective effect in terms of ratings for hunger for the 90-min period after the meal. We don’t yet know what the mechanisms are, but it is a potentially important finding in relation to the concept of fast and slow proteins, and it has obvious clinical relevance in terms of patients for whom appetite is a problem.

Dr. Young: That is an interesting observation, but I’ve learned over past years that single meal short-term studies of this kind have serious limitations in terms of the consequences for long-term energy intake. So I would hope that you will follow this up with more elaborate studies that will allow you to overcome the limitations of single meal studies.

I’d like to go back to Dr. Beauprère’s interesting physiological exposition on slow and fast proteins. You did indicate that slow proteins lead to a better leucine balance, based on your relatively short-term elegant kinetic studies, but we know of course that whey protein is an excellent source of protein and is capable of maintaining body nitrogen and amino acid homeostasis just as well as casein, which is your slow protein. So I just wonder whether you’d like to comment on the extent to which your short-term studies can be extrapolated to the longer periods of time in which the clinician is more interested.
Dr. Beaufrère: I accept that I’m a labeled leucine addict. But I do think that we still need nitrogen balance and body composition studies over the longer term. The two main drawbacks that I see in our own studies are first that they were short-term and second the fact that only protein meals were tested. We need to do tests with mixed meals.

Dr. Lundholm: Are slow and fast proteins a kinetic concept or a biochemical concept?

Dr. Beaufrère: Obviously it has to do with the physical chemical properties of the protein itself. We’re not dealing with a single protein but with a mixture. Whey, for example, is a mixture of dozens of proteins. But the fact is that this mixture of proteins does not clot. I think that is the rate-limiting factor. As it does not clot in the stomach it passes much faster into the jejunum. Afterwards it’s a matter of standard metabolic regulation which has to do with amino acid availability and possibly hormone levels.

Dr. Tessari: Do you have an explanation for the different behavior in young and elderly people with respect to pulse feeding versus continuous feeding?

Dr. Beaufrère: There are data in old rats and also in old human subjects suggesting that postprandial stimulation of protein synthesis, particularly in muscle, may be deficient. Thus the idea would be that an increased availability of amino acids in elderly people would be useful for stimulating protein synthesis, particularly in muscle, while in younger subjects the only thing it would do would be to increase oxidation because of stimulation of decarboxylase.

Dr. Tessari: Is there any difference in the rate of gastric emptying between younger and older people? Did you account for that?

Dr. Beaufrère: In healthy elderly people we have not found any difference, at least for amino acids.

Dr. Reeds: You’ve got the full kinetic data on concentrations and isotopic enrichment. Presumably you calculated the area under the curve. Was there a difference in splanchnic extraction between slow and fast proteins?

Dr. Beaufrère: It looks as though the slower the protein, the higher the splanchnic extraction.

Dr. Grimble: Would you like to speculate on whether you should use a slow or a fast or a super-fast protein in the patient immediately after surgery if you want to give enteral nutrition?

Dr. Beaufrère: I just cannot answer that. The only thing I can say is that we compared short-chain peptides versus whole casein in postoperative patients and found no differences – the final balance was absolutely the same. These were seriously stressed postoperative patients, but we found absolutely no difference in terms of final leucine balance between short peptides and casein.

Dr. Young: I’m confused. You showed us the results of your study on pulse versus spread feeding, and you found that nitrogen balance was better with pulse feeding. I assume you equate pulse feeding to a fast protein condition and spread feeding to a slow, but then your kinetic data appear to show that slow proteins give a better balance than pulsed or fast protein conditions. So, which experiment am I to believe?

Dr. Beaufrère: I think the difference has to do with age. Pulsed feeding, which I agree equates to fast protein, seems to be more efficient only in elderly people, not in young people. All these studies were done in young people and obviously it would be of interest to repeat the studies in elderly people.

Reference