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REVIEW

## GASTRIC BANDING and the Fine Art of Eating

by PAUL O'BRIEN, MD



**INTRODUCTION**

Laparoscopic adjustable gastric banding (LAGB) has been shown to enable patients with obesity to achieve substantial, durable, and safe weight loss,<sup>1,2</sup> which can help reduce or resolve multiple diseases,<sup>3</sup> improve quality of life, and prolong survival in patients with obesity.<sup>4</sup> LAGB is a weight loss surgical procedure performed solely for the purpose of affecting a key physiological function in weight loss, appetite control. In 2005, we conducted a randomized, blinded, crossover trial that showed that the LAGB controls the appetite.<sup>5</sup> However, if the LAGB is not placed properly or if the patient does not eat properly, it will not perform at an optimal level. For example, if the band is placed too loosely, then it will not provide the proper level of reduced satiety and appetite, and likely will have little effect on the patient's weight and health. If the band is placed too tightly or if patient eats too fast or takes large

bites of food, slips and enlargements can occur, leading to reflux, heartburn, vomiting, and sometimes the need for revision. Optimally, the band should be adjusted so that it squeezes the stomach at just the right pressure. If the patient eats correctly and the band is placed correctly, the LAGB should adequately control the patient's appetite, resulting in optimal weight loss.

**THE PHYSIOLOGY OF LAGB**

Dr. Paul Burton, a bariatric surgeon at the Centre for Obesity Research and Education, Melbourne Australia, has studied the physiology and the pathophysiology of the LAGB closely. He used high-resolution video manometry, isotope transit studies, endoscopy, and contrast imaging to understand what happens during eating in normal controls, eating in patients who are doing well after LAGB, and eating in patients who have symptoms of reflux, heartburn,

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CASE SERIES



## Early Complications of 120 Laparoscopic Greater Curvature Plication Procedures

by YOUSSEF ANDRAOS, MD; DANY ZIADE, MD; RANA ACHCOUTY, MD; and MARIETTE AWAD, PhD

**INTRODUCTION**

A number of bariatric surgical procedures achieve weight loss in patients by multiple mechanisms, including restriction of food intake. Adjustable gastric banding (AGB) and vertical sleeve gastrectomy (VSG) are restrictive procedures that reduce the volume of ingested food in a patient. Roux-en-Y gastric bypass (RYGB) and duodenal switch (DS) work by diminishing the quantity of and the absorption of ingested food.<sup>1,2,5,6,15</sup> AGB, VSG, RYGB, and DS can all be highly effective in achieving weight loss; however, they are not without significant complications, such as perforation, slippage, and gastric erosions for bands. Moreover, VSG, DS, and RYGB are irreversible procedures and are associated with high rates of perforation, bleeding, infection due to foreign material in the body, and gastric leaks.<sup>3,4,7,13-15</sup> Leaks in a patient who has undergone VSG are dangerous and can lead to morbidity and mortality. Leaks after VSG are difficult to manage, especially at the level of Angle of His.

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ASK THE EXPERTS

This Month's Featured Expert



**ALEX GANDSAS, MD, FACS**

THIS MONTH'S DILEMMA  
 Management of Large Left Upper Quadrant Air-fluid Collection after Laparoscopic Sleeve Gastrectomy

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**TOTAL BARIATRIC CARE**

by ERIC J. DEMARIA, MD



THIS MONTH:  
 Part 1  
**A PROPOSAL: Why We Need a New Aftercare Plan**

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# GASTRIC BANDING

## and the Fine Art of Eating

by PAUL O'BRIEN, MD

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### ABSTRACT

The author reviews the physiology of eating and what the adjustable gastric band does to the function of the distal esophagus and upper stomach of the patient. The author also provides the "Eight Golden Rules" on proper eating habits for patients of laparoscopic adjustable gastric banding, including what, when, and how they should eat, in order to achieve optimal weight loss results.

### KEY WORDS

Laparoscopic adjustable gastric band, LAGB, gastric banding, eating and gastric band

### Continued from page 1

and/or vomiting after LAGB.<sup>7-15</sup> In Burton's series of articles, he concluded that in LAGB, it is not the band that fails, but rather the patients who receive the band and, more importantly, the doctors who care for them.

Many years ago at the Centre for Obesity Research and Education (CORE), my colleagues and I developed the Green Zone chart, a conceptual way of identifying the optimal level of band restriction (Figure 1). When a patient is in the yellow zone, it is an indication that the band is too loose. When in the yellow zone, a patient may be eating too easily, feeling hungry, and not losing weight. When a patient is in the green zone, he or she does not feel hungry, is satisfied with small amounts of food, and is achieving weight loss or maintaining a satisfactory level of reduced weight. When a patient is in the red zone, it is an indication that the band is too tight. The patient experiences reflux, heartburn, and vomiting. The range of food the patient in the red zone can eat after undergoing LAGB is limited and he or she may start to eat abnormally (so-called maladaptive eating), favoring softer, smoother foods like ice cream and chocolate. While in the red zone, patients will not lose weight as effectively and they may even gain weight.

Burton measured the pressure within the upper stomach beneath the band in numerous patients when they were in the green zone. He found the optimal pressure was typically 25 to 30mmHg. The art of adjustment is to find the level of fluid in the band that achieves that pressure range. That level of pressure generates a background sense of satiety that

persists throughout the day. The patient, when correctly adjusted, normally will not feel hungry upon waking in the morning, and throughout the day should feel much less hungry than he or she did before band placement. In my experience, it is common for LAGB patients to have no feeling of hunger in the morning. Then, during the day, a modest level of hunger will develop, which a small meal should satisfy.

One of the key lessons learned from Burton's studies was that each bite of food should pass across the band completely before another bite is swallowed. There is no pouch or small stomach above the band and there should never be food sitting there waiting.

The esophagus is a powerful muscular organ that typically generates pressures of 100 to 150mmHg, but it is capable of generating pressures above 200mmHg. Esophageal peristalsis squeezes the bite of food down toward the band and then progressively squeezes that bite across the band. Each bite must be squeezed across the band before the next bite starts to arrive. Figure 2 shows a bite in transit across the band.

A single bite of food, chewed well until it is mush, will move down the esophagus by peristalsis. At the level of the band, the esophageal peristalsis will squeeze that bolus of food across the band. It takes multiple squeezes (usually 2-6 squeezes or peristaltic waves) to get that bite of food across in a patient with a well-adjusted band (Figure 2). Those squeezes generate a feeling of not being hungry and stimulate a message that passes to the hypothalamus to indicate that no more food is needed. If a single bite of food is able to generate between two and six waves of signal, a meal of 20 bites

may generate 100 or more signals. This is enough to satisfy a person and is enough to signal him or her to stop eating.

We recognize two terms for appetite control, *satiety* and *satiation*. *Satiety* refers to the background control of hunger that is present throughout the day regardless of eating. In the LAGB patient, satiety is generated by the band exerting a constant compression on the cardia. *Satiation* is the early control of hunger that comes with eating. In the LAGB patient, satiation is generated by the squeezing of the bolus of food across the band during a meal. Each squeeze adds to the satiation signal.

There are sensors in the cardia of the stomach that detect this squeezing. The exact nature of these sensors is still to be confirmed but they must be either hormonal or neural. We know that satiety and satiation are not mediated by one of the hormones currently known to arise from the upper stomach.<sup>16</sup> Ghrelin is a hormone that stimulates appetite. A number of hormones that can be derived from the cardia of the stomach are known to reduce appetite. None of these hormones are found to be raised in the basal state after gastric banding and none can be shown to rise significantly after each meal.<sup>16</sup>

Vagal afferents are plentiful in the cardia, and one group of afferents has a particular structure that lends itself to recognizing the compression of the gastric wall associated with squeezing of the bite of food across the band. In

my opinion, the intraganglionic laminar endings, better known as IGLEs, are the most likely candidate as mediator of the background of satiety throughout the day and the early satiation after a meal. The IGLEs lie attached to the sheath of the myenteric ganglia and are known to detect tension within the wall of the stomach. They are low-threshold and slowly adapting sensors and therefore are optimal for detecting continued compression of cardia of the stomach over a 24-hour period. The several squeezes that go with the transit of each bite stimulate the IGLEs further. The signal passes to the arcuate nucleus of the hypothalamus and the drive to eat is reduced.

**The lower esophageal contractile segment.** Burton developed the concept of the lower esophageal contractile segment (LECS). It is made up of four parts: the esophagus, the lower esophageal sphincter, the proximal stomach (including the 1cm or so above the band and the 2cm of stomach behind the band), and the band itself (Figure 3).

As the esophagus squeezes the bolus of food down toward the band, the lower esophageal sphincter relaxes as this peristaltic wave approaches. It then generates an after-contraction, which can maintain some of the pressure of the peristaltic wave as a part of the food bolus is squeezed into that small segment of upper stomach. The upper stomach, including the area under the band, is sensitive to these pressures. It

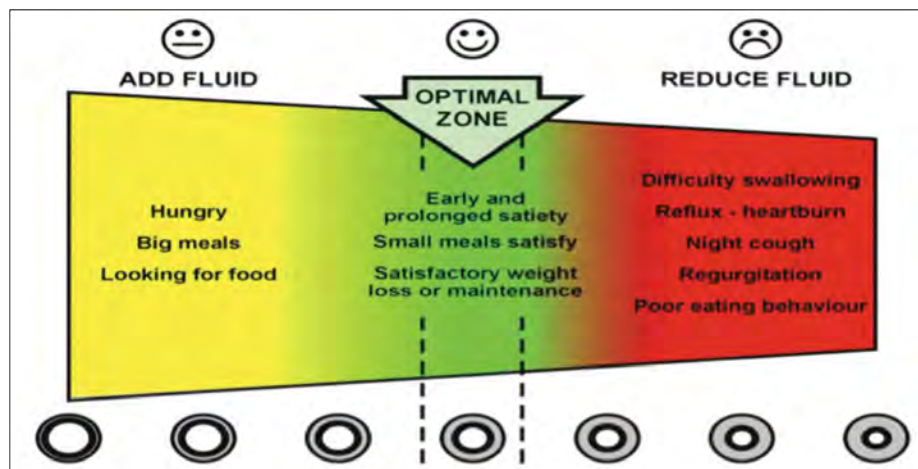
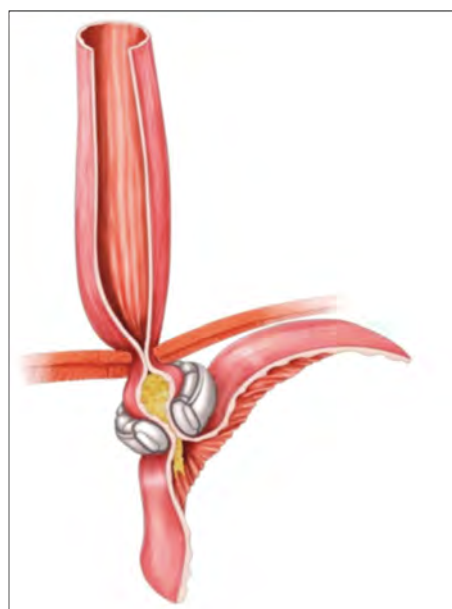


FIGURE 1. The Green Zone chart. Copyright © CORE



**FIGURE 2.** Normal transit of a single bite across the lower esophageal contractile segment. Copyright © CORE

generates signals to the hypothalamus. These signals may be hormonal but are more likely to be neural. A correctly adjusted band will generate a basal intraluminal pressure of 25 to 30mmHg, providing a resistance to flow. The segment of the bolus that is squeezed through generates more signals from that area. Keeping the LECS intact is a key requirement for success with the gastric band. Bad eating habits (e.g., insufficient chewing, eating too quickly, taking bites that are too large) hurt the LECS. If those bad habits go on for long enough, stretching occurs and the power of peristalsis is lost, leading to the return of hunger (Figure 4).<sup>11,12</sup>

### THE FINE ART OF EATING

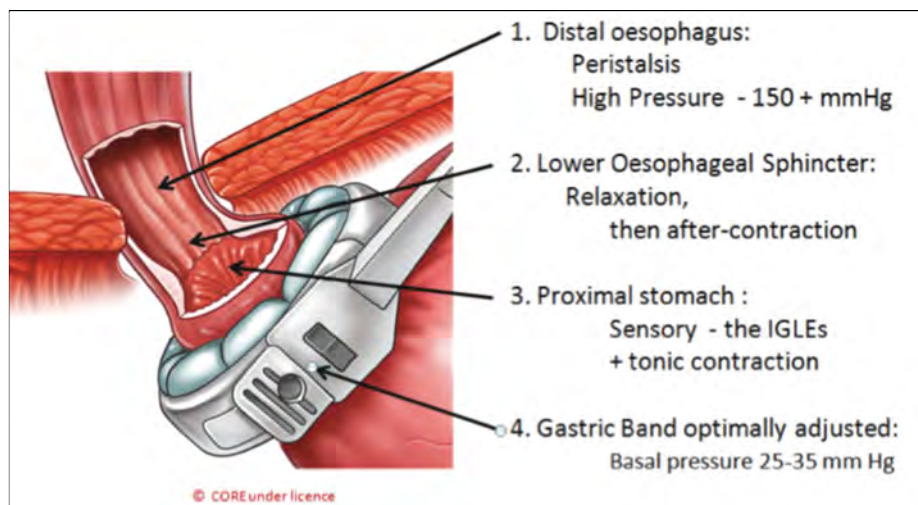
A quality aftercare program is essential to successful weight loss in patients after LAGB. Before making the decision to proceed with LAGB in patients, I promise my patients three things: 1) to place the band in the optimal position safely and securely, 2) that they will have permanent access to a skilled aftercare program, and 3) that I will give them the information they need to obtain the best possible weight loss from the band. In return, I ask for three commitments from my patients: 1) that they follow the rules regarding eating after undergoing the procedure, 2) that they follow the rules regarding exercise and activity, and 3) that they always come back for follow up no matter how many years have passed.<sup>9</sup>

**The “Eight Golden Rules.”** At my facility, we summarized guidelines for eating after LAGB into what we call the “Eight Golden Rules” (Table 1). These rules are included in a book and DVD given to every patient who undergoes LAGB at the facility.<sup>6</sup> The rules are also posted on [www.lapbandaustralia.com.au](http://www.lapbandaustralia.com.au) and are reinforced at most aftercare visits.

These eight golden rules must become part of each patient’s life. The effect of the LAGB procedure on

hunger facilitates a patient’s adherence to the rules, making it more likely that he or she will follow them. However, achieving positive results with LAGB requires a working partnership between the physician and patient. Adhering to these rules is the patient’s part of the partnership, and he or she ultimately is responsible for the success or failure of weight loss following LAGB.

**What to eat.** After undergoing LAGB, patients should eat small amounts of “good food,” meaning food that is protein rich, of high quality, and in solid form. Each meal should consist of 125mL or 125g (i.e., about half of a cup of food). This measure of “half a cup” is a concept rather than a real measure of food, as some foods, such as vegetables and fruit, are composed largely of water and this has to be allowed for in some way. Thus, I allow exceeding the “half a cup” limit a little for vegetables and fruit.



**FIGURE 3.** The four components of the lower esophageal contractile segment: the esophagus, the lower esophageal sphincter, the proximal stomach, and the band. Copyright © CORE

We instruct patients to put each meal on a small plate and to use a small fork or spoon. The patient should not expect to finish all of the food on the plate, but rather he or she should plan to stop when he or she is no longer hungry. Any food left on the plate should be discarded.

**Protein-rich foods.** Protein is the most important macronutrient in the food a LAGB patient eats. At our clinic, we recommend that our patients consume approximately 50g of protein per day. We have measured protein intake of our patients (Table 2) and have monitored their blood levels. We have not seen any protein malnutrition after LAGB, indicating that a daily intake of about 50g a day is sufficient. Table 2 shows the energy and macronutrient intake of 129 consecutive patients measured before and at one year after LAGB. Note the mean energy intake is reduced by approximately 1500kcal.<sup>17</sup>

The best source of protein is meat; however, red meats, such as beef and lamb, tend to be difficult to break up with chewing in order to be

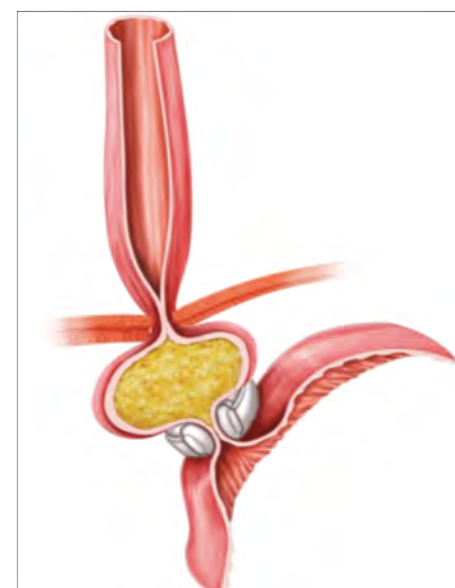
sufficiently turned into mush. It is much easier to break up fish with chewing, and many fish are high in protein, including shellfish. Chicken, duck, quail, and other birds can also be cooked to be easily chewed to mush before being swallowed. Eggs and dairy, including cheese and yogurt, are also excellent protein sources. For nonanimal sources of protein, a patient should consider lentils, chickpeas, and beans. Half of the “half a cup” allotment per meal should comprise protein-rich food. The other half should be made up of vegetables and/or fruits. I recommend to my patients that they eat more vegetables than fruit because vegetables have less sugar. Any space left in the “half a cup” can be used for the starches, (e.g., bread, pasta, rice, cereals, potatoes), though I recommend to my patients that they eat a minimal amount from this group of foods as they tend to provide no important nutritional benefit.

is adjusted correctly, there should be no need for him or her to eat between meals. In fact, even three meals a day may be more than needed for satiety. In my experience, patients have little interest in eating in the morning. By late morning or early afternoon, patients may start to notice some hunger, which indicates that it is time to have a first small meal. In the evening, patients may have another meal. Most importantly, patients should be instructed that a meal missed is not to be replaced later on. The typical human body is satisfied with a maximum of three meals per day but often is happy to accept two or even one meal per day.

Patients should be reminded that there should be no snacking between meals. If a patient finds that he or she is hungry by late afternoon, encourage him or her to eat something small and of high quality, such as a piece of fruit or some vegetables, just to tide him or her over until the evening meal. The patient should then visit the clinic to check whether or not he or she is in the Green Zone. It is important that the patient adhere to the aftercare program to monitor whether or not he or she is in the green zone. If not in the green zone, the patient will need to have fluid in the band increased or decreased.

**How to eat.** Take a small bite and chew well. The “half a cup” of food should be placed on a small plate. The patient should use a small fork or a small spoon to eat. A single bite of food should be chewed carefully for 20 seconds. This provides the opportunity to reduce that bite of food to mush. It also provides the important opportunity for the patient to actually enjoy the taste, the texture, and the flavor of the food. Encourage your patients to enjoy eating more than they ever have. After chewing the food until it is mush, the patient should swallow that bite.

*Swallow, then wait a minute.* The patient must wait for that bite to



**FIGURE 4.** The destruction of the lower esophageal contractile segment by distending the area above the band. Copyright © CORE

**High-quality foods.** High-quality food are foods that are minimally processed, natural, and whole. We encourage our patients to look for quality over quantity—for example, they might try sashimi-grade tuna, smoked salmon, duck breast, lobster, or even a simple poached egg. It is also important to remind your patients that there is no limit to the amount of herbs and spices that can be used to enhance the flavors of their foods.

**Solid foods.** The patient should choose solid foods over liquids whenever possible. Liquids pass too quickly across the palate and, more importantly, too quickly across the band. There is no need for the esophagus to squeeze liquid, and without the squeeze, there is no stimulation of the IGLEs and no induction of satiety; therefore, eating calorie-containing liquids may negatively impact a patient’s weight loss.

**When to eat.** After undergoing LAGB, a patient should eat three or less times per day. If the patient is in the green zone, meaning that the band

**TABLE 1.** “Eight Golden Rules” for laparoscopic adjustable gastric band patients

1. Eat three meals or less per day.
2. Do not eat anything between meals.
3. Eat slowly and stop when no longer hungry.
4. Focus on nutritious foods.
5. Avoid calorie-containing liquids.
6. Exercise for at least 30 minutes each day.
7. Be active throughout each day.
8. Always keep in contact with us.

From *The Lap-Band Solution: A Partnership for Weight Loss*<sup>8</sup>

**TABLE 2.** Food intake and appetite at baseline and at 12 months after gastric banding<sup>17</sup>

COMPONENTS OF FOOD	BASELINE	12 MONTHS AFTER GASTRIC BANDING
Total energy (kcal)	2,497kcal	1,020kcal
Protein	114g	52.2g
Fat	98.5g	34.6g
Carbohydrate	233g	98.5g
Hunger Score	9	2

go completely across the band before swallowing another bite. Normally, it will take between two and six peristaltic waves passing down the esophagus, which can take up to one minute. This is probably the biggest challenge of educating the patient who has undergone LAGB. You must instruct the patient to eat slowly—chew well, swallow, and then wait one minute.

A meal should not go on for more than 20 minutes. At one bite per minute, that is just 20 small bites. The patient probably will not finish the “half a cup” of food in this time. In this case, the patient should throw away the rest of the food. After undergoing LAGB, the patient should always expect to throw away food and to never eat everything on the plate. If it takes between two and six squeezes to get a single bite of food across the band and each squeeze generates satiety signals, then 20 bites should be generating 40 to 120 signals. The actual number will depend on the consistency of the food, the tightness of the band, and the power of the esophagus. With good eating practices and optimal band adjustments, the patient should not be hungry after 20 bites or less. As soon as the patient is no longer hungry, he or she should stop eating. After undergoing LAGB, the patient should never expect to feel full. Feeling full means stasis of food above the band and distension of that important part of the LECS above the band. This destroys the LECS, the mechanism that enables optimal eating behavior and appetite control. A patient should always keep this process in mind.

If the patient finds that after eating the “half a cup” of food he or she is still hungry, he or she should review his or her eating practices, correct the errors, and consider the need for further adjustment of the band. If this is occurring, it is usually an indication that the patient is not in the green zone.

*Eat a small amount of good food slowly.* These eight words are the key to success. *Small amount* refers to small bites, the small fork (e.g., oyster fork), and a total meal size of half a cup. *Good food* refers to protein-rich, high-quality, and solid food. *Slowly* refers to chewing well, swallowing, and waiting a minute.

Try to repeat these eight words to every patient every time you see them. Get them to repeat it at every meal. The failure of the gastric band can almost always be traced to failure of this process.

#### ADDRESSING THE CHALLENGES

The two principal challenges after LAGB are weight loss failure and the need for revisional surgery due to proximal enlargements above the band. Weight loss failure will occur if the band is not placed or adjusted

correctly or if the patient does not adhere to the guidelines of proper eating and exercise. When a patient is not achieving results after his or her LAGB operation, the doctor should check to ensure that the band is correctly and safely placed.

The most common reason for weight loss failure is poor eating behavior, which leads to enlargement above the band. There are three common eating errors:

1. The patient is not chewing the food adequately. Food must be reduced to mush before swallowing. If it cannot be reduced to mush, it is better for the patient to spit it out (discreetly) than to swallow it.
2. The patient is eating too quickly. Each bite of food should be completely squeezed across the band before the second bite arrives.
3. The patient is taking bites that are too big to pass through the band.

Each of these errors leads to a build up of food above the band where there is no existing space to accommodate it (Figure 4). Space is then created by enlargement of the small section of stomach or by enlargement of the distal esophagus, both of which can compromise the elegant structure of the LECS. If the LECS is stretched, it cannot squeeze. Without the squeezing, satiation is not induced. When satiation is not induced, hunger persists, more eating occurs, and stretching continues. If our patient continues this each day for a year, it is inevitable that chronic enlargement will occur, the physiological basis for satiety and satiation is harmed, and stasis, reflux, heartburn, and vomiting supervene.

The doctor should continually review the Eight Golden Rules for proper eating and exercise with each patient. For optimal weight loss following LAGB, the patient should have access to a comprehensive long-term aftercare program for clinical support and optimal band adjustments and he or she must follow the guidelines regarding eating and exercising for the rest of his or her life. “Eat a small amount of good food slowly” is the key to optimizing the gastric band.

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