Questions & Answers

What are BIPS? What diagnostic purpose do they serve?
BIPS (barium impregnated polyethylene spheres) are small plastic spheres of two sizes embedded with barium. Combined with radiography, they are a useful diagnostic tool to rule out blockages of the gut and to detect motility problems in the stomach and intestines. BIPS are administered in food (or in capsules by mouth) and avoid the problems commonly experienced when administering liquid barium. Unlike barium, BIPS spheres behave similarly to food in the gut. By comparing the gut transit time of the small BIPS in your patient with the average gut transit time in a healthy animal, motility disorders can be diagnosed.

Under what circumstances would I use BIPS?

Acute gastrointestinal complaints. In cases with acute onset of anorexia, vomiting and/or abdominal discomfort, BIPS are useful for ruling out physical obstructions of the pylorus or bowel.

Chronic gastrointestinal complaints. With chronic vomiting or diarrhea, BIPS will help to detect delayed gastric emptying, gastric dumping, partial bowel obstructions, and intestinal motility disorders. Better sensitivity for detecting these disorders is obtained if BIPS studies are performed with patients that are fed rather than fasted. Because the food type fed markedly affects gastric emptying rate, Hill’s Prescription Diet d/d must be used in order to make comparisons with the normal values.

Animals suspected of a partial obstruction. Administering BIPS in a high fiber diet is more sensitive than administration on an empty stomach for diagnosing partial obstructions of the intestinal tract with a luminal diameter of 5mm or more. Fiber accumulates orad to the partial obstruction, arresting passage of the markers. The result: delayed transit and persistent bunching of markers in the abnormal intestinal segment (stagnant loop sign). Carefully examining the bowel area containing the static markers may reveal an intestinal segment dilated by ingesta.

A blockage of the bowel is highly likely if delayed gut transit is associated with a bunching of the BIPS in the small intestine (in two views). A blockage is highly unlikely if abdominal radiographs demonstrate the large BIPS in the colon.

When do I shoot my first x-ray?
Because BIPS is an interpretative product, the answer depends on the patient’s condition and what you suspect the problem may be. The BIPS booklet and transit rate charts will provide a more complete explanation.

To rule in or rule out a physical obstruction…wait until the large BIPS have had enough time to pass through to the colon (typically 6-24 hours). Please refer to the transit rate charts in the BIPS booklet to compare your patient’s transit time with a known healthy patient to best determine when to take the x-ray. In some cases, BIPS can be administered and the patient sent home to return the next day for an x-ray. If the large BIPS have reached the colon, then a blockage can be ruled out. If the large BIPS have not reached the colon, and there appears to be a persistent bunching of the large BIPS in the small intestine, that is highly suggestive of a physical obstruction of the small bowel.

To diagnose for motility disorders…wait until the small BIPS have had enough time to pass part way through the digestive tract (typically 6-16 hours). Please refer to the transit rate charts in the BIPS booklet to compare your patient’s transit time with a known healthy patient to best determine when to take the x-ray. BIPS travel at the same rate as food, not liquid. This allows you to accurately measure transit time, thus determining possible motility malfunctions. For example, one possibility is that delayed passage of the BIPS, associated with a wide scattering of the BIPS throughout the stomach and small intestine, is usually due to depressed gastrointestinal motility. However, this does not rule out the possibility of a physical obstruction of the bowel.

Does the pet's weight and size determine the BIPS dose amount?
No, the dosage is the same for large and small pets. For the study to be effective, each patient must receive 10 large (5mm) and 30 small (1.5mm) spheres…by administering capsules or opening the capsules and sprinkling the BIPS on food. The recommended number of large and small spheres is inserted in a single gelatin capsule (1” long x 3/8” diameter), which is the preferred option. If an animal isn’t able to swallow the single, larger capsule, the same number of spheres (10 large, 30 small) can be given in four smaller capsules, which is the recommended dosage if the small capsules are being used.

Aren't BIPS too expensive when compared to a liquid procedure?
No, BIPS are actually much less expensive. When making comparisons, please consider the total procedure cost. Using BIPS, many times you’ll need only one x-ray to obtain an accurate diagnosis. Give the animal one capsule, wait the desired amount of time, and then shoot an x-ray. Compare this with a liquid procedure…the time needed to shoot multiple x-rays, the personnel involved, the interruption of a busy practice, and the clean up before and after use.
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**What are BIPS?**

Barium Impregnated Polyethylene Spheres (BIPS) are a mixture of plastic and barium sulfate. Mixed as powders, the combination is subjected to sufficient heat to render the plastic fluid and this is injection moulded into precision dies which yield solid, non-dissolving spheres of two sizes (5 mm and 1.5 mm) containing inexorably bound barium sulfate. BIPS employ the same barium (barium sulfate) that is in the liquid suspensions used in conventional contrast studies.

**What are BIPS “Options”?**

The small capsule option consists of four small gelatine capsules collectively containing 1 dose of BIPS. The small capsules are easier to administer to cats and small dogs. The large capsule is more convenient to administer to large dogs.

BIPS are available in two capsule sizes (or “options”). The large capsule option consists of a large gelatine capsule containing 1 dose of BIPS (ie. ten 5.0 mm and thirty 1.5 mm BIPS).

The small capsule option consists of four small gelatine capsules collectively containing 1 dose of BIPS. The small capsules are easier to administer to cats and small dogs. The large capsule is more convenient to administer to large dogs.

**Key Point**

Regardless of the animal’s size, administer one large... or four small capsules. Each option contains the proper number of large and small BIPS spheres for an effective study.
What are the indications for performing a BIPS study?

The indications for BIPS studies are frequent in small animal practice. BIPS are an accurate and convenient way to rule out physical obstructions of the bowel and are the only practical way for veterinarians in private practice to assess gastrointestinal motility and the transit of food. The principal indications for BIPS studies include:

- ruling out obstructions of the GI tract in dogs and cats with acute-subacute vomiting
- ruling out linear foreign bodies in cats
- screening patients with chronic vomiting or diarrhea for partial obstructions of the bowel (eg. from neoplasia) and for motility disorders
- investigating dogs with chronic or recurrent bloating for delayed gastric emptying
- investigating cats and dogs with inexplicable anorexia for “low” partial obstructions
- investigating cause and prognosis of animals with recurrent idiopathic constipation

**Key point**
One of the most stressful decisions a veterinarian faces is ruling out an obstruction. BIPS greatly help this decision.
What are the contraindications and limitations of BIPS?

- The patient with shock or peracute signs is not a candidate for a BIPS study. Urgency will demand immediate treatment, be this surgical or medical.
- BIPS are not indicated in patients too weak to swallow or in those with "coffee ground" vomitus or melena.
- BIPS are of little value in animals which vomit so frequently that the BIPS are not retained long enough for gastric emptying to begin. In general, BIPS studies can be successfully performed on patients that are vomiting less than 4 times per day.
- BIPS are not indicated for the detection of non-obstructive gastric or intestinal diseases (e.g. ulcers, inflammatory bowel disease) although they often show motility abnormalities secondary to such diseases.

How do BIPS compare with other diagnostic methods?

BIPS do not replace any currently available diagnostic modalities. Rather, they are a valuable alternative approach. The BIPS are of more value to private practitioners than clinicians working in well-equipped referral institutions because the diagnostic spectrum of ultrasound and scintigraphy overlap somewhat with that of BIPS. See specific comparisons below:

How do BIPS compare with the use of barium sulfate suspensions?

Compared to barium sulfate solutions, BIPS offer the following advantages:

- they increase the likelihood of detection of obstructions by those who experience difficulty interpreting barium-follow-through studies (see below)
- they are more sensitive for the detection of motility disorders because they provide quantitative information on gastric emptying and intestinal transit times and they mimic the transit of food not liquid (the transit of liquid is rarely disrupted by motility disorders as much as the transit of food
- their administration is more convenient; no stomach tubing is required and radiographs do not need to be made at set intervals
- they are less likely to be aspirated and are less likely to cause peritonitis if the bowel is perforated
- they do not obscure abdominal detail on the radiographs reducing the need for survey films prior to the contrast procedure

**Legend:**
The gastric emptying of solids is more complex than that of liquids. It requires antral grinding to reduce particle size and intimate coordination between antral, pyloric and duodenal contractions.

Compared to barium sulfate, BIPS have the following disadvantages:
- they do not provide as much information about mucosal detail as can be obtained by a single or double contrast gastrogram
- they do not outline the luminal borders of the GI tract and so are less valuable for differentiating dilated or displaced organs (eg megaesophagus or GDV)
- studies can take longer as the BIPS move somewhat more slowly through the GI tract than liquid

**Key point**
If large BIPS enter the colon it is highly unlikely the patient has a gastrointestinal obstruction

❖ **Why are GI obstructions easier to rule out with BIPS than liquid barium?**

Gastrointestinal obstructions are rarely complete. In the small intestine, clinical signs usually begin once the bowel lumen has been reduced to a diameter of approximately 5 mm. This is the diameter of the large BIPS. These settle in the stagnant loop in front of the obstruction unlike liquid barium which can pass through. Thus, if large BIPS enter the colon it is highly unlikely the patient has a gastrointestinal obstruction. In contrast, if barium liquid enters the colon, an obstruction is still entirely possible. The accuracy of
radiopaque markers for the diagnosis of partial obstructions has recently been found to be equivalent to CT scans in humans (see abstracts).

**Legend:**
Lateral abdominal radiograph clearly showing bunching of BIPS orad of a partial obstruction of the small intestine.

**Legend:**
The typical barium follow-through examination presents veterinarians with the dilemma of whether narrowings of the barium column are due to peristalsis or obstruction. In contrast, BIPS do not usually pass an obstructed bowel segment more clearly identifying the presence of the obstruction.

**Can BIPS be used with liquid barium?**
Liquid barium can be used after a BIPS study but BIPS cannot be used for 24-48 hours after a liquid barium study. Liquid barium is most often used after a BIPS study if the BIPS demonstrate delayed gastric emptying but do not reveal the cause. In this situation, the liquid barium is usually used in the absence of endoscopy and in the hope of detecting gastric abnormalities such as ulcers.
How do BIPS compare with the use of ultrasound?

In contrast to ultrasound, a BIPS study provides more functional information on gastric emptying rate and intestinal transit time but less morphologic information about the abdomen.

How do BIPS compare with endoscopy?

BIPS complement the diagnostic spectrum of endoscopy because they allow diagnosis of motility disorders and obstructive diseases of the lower small bowel (such as annular adenocarcinoma), neither of which can be diagnosed by current endoscopic techniques.

How do BIPS compare with scintigraphy?

In contrast to scintigraphy, BIPS offer a more practical method of quantifying emptying and transit. However, scintigraphy allows greater accuracy and the potential to assess the passage of specifically tagged nutrients.

Key Point
Primary & secondary disorders of GI motility are collectively common. BIPS provide the only convenient and accurate way to diagnose such disorders.
Common questions about the administration of BIPS

❖ What is the recommended dose for BIPS in dogs and cats?
Thirty small BIPS and 10 large BIPS.

❖ Can I give less BIPS than the recommended dose?
It is highly recommended to give the entire diagnostic set of 30 small and 10 large BIPS when patient compliance allows. The fewer BIPS used, the harder it is to interpret the studies and the greater likelihood of errors. It is difficult to accurately determine gastric emptying and orocolic transit percentages when fewer than the recommended number of BIPS are used. It is also more difficult to ascertain where the BIPS are in the bowel and whether they have bunched.

❖ When do I give BIPS with food and when do I give them on an empty stomach?
In acute GI presentations, BIPS are usually given on an empty stomach. This is done because patients are usually anorexic when suffering from acute diseases. Furthermore, in acute vomiting, clinicians tend to be more concerned with ruling out gastrointestinal obstructions than with assessing the transit of food. BIPS given on an empty stomach move more quickly through the gastrointestinal tract than when given with food. This time saving can be helpful when diagnosing animals suspected of obstructions.

❖ When do I give BIPS with Hills Prescription diets d/d or i/d?
BIPS are usually given with d/d or i/d during the work-up of chronic vomiting or small bowel-type diarrhea. The study is performed with food because in animals with chronic gastrointestinal complaints, clinicians are often interested in ruling out both obstructions and motility disorders. The transit of food (as measured by the transit of BIPS) is a clinically relevant method of quantifying gastrointestinal motility.
When do I give BIPS with Hills Prescription diet r/d?

BIPS are usually given with r/d to investigate recurrent constipation cases or when subtle partial obstructions of the small bowel are suspected. In the latter situation, the fiber will accumulate orad of the partial obstruction slowing the transit of BIPS and increasing the chance of detecting the partial obstruction. However, the accumulation of the fiber orad of the obstruction can worsen the signs of obstruction. For this reason, BIPS are not given routinely with r/d.

Do I need to be careful to mix the BIPS throughout the test meal?

Yes. Dumping the BIPS in one place in the meal can give misleading results.

Can I give BIPS with any foods other than i/d, d/d or r/d?

No. The emptying rate of particles, such as BIPS, from the stomach depends on the properties of the food (e.g. density, fat content etc) in which they are suspended as well as the properties of the particles themselves (especially size and density). This means that for the diagnosis of motility disorders, BIPS can be administered only in foods in which they suspend well and for which normal gastric emptying curves have been determined.

What do I do if I have mixed BIPS in a meal that the patient will not eat?

If the patient refuses to eat the meal, try the usual tricks to increase the palatability of the food (e.g. warming the meal, flavouring it with small amounts of other highly palatable
foods etc). If this fails, consider the use of appetite stimulants such as intravenous diazepam (0.1 mg/kg IV to cats) which does not significantly affect the transit rate of BIPS. Force-feeding should be a last resort. It is difficult to recover the BIPS after they have been mixed in a meal that has been refused by the patient. Try and avoid this wastage by testing the patient's appetite with a teaspoon or two of the test diet before mixing in the BIPS.

Key Point
To avoid large BIPS being left in the food bowl by cats, split the capsules and bury the half capsules in different places in the food. The gelatin softens disguising the BIPS.

❖ **How can the administration of BIPS capsules to cats be facilitated?**
It can be difficult to administer the capsules containing BIPS to some cats. In this situation, lubricating the capsules can be helpful. Alternatively, some pill administering devices can be used. Many cats are able to detect the large BIPS in the food and will purposefully avoid eating those they discern. The large BIPS can often be disguised by leaving them in the gelatin capsule. Split each of the 4 capsules containing the BIPS. Sprinkle the small BIPS on the food and mix. Bury the half capsules containing the large BIPS in different places in the food. The gelatin of the capsule softens quickly and the halved capsules will usually be eaten in their entirety.

❖ **Can I perform a BIPS study if the patient is vomiting frequently?**
Frequent vomiting (greater than 4 times per day) usually results in the loss of most BIPS in the vomitus and an inadequate study. Less frequent vomiting usually allows enough time for the majority of the BIPS to enter the small intestine and the study to be successful.
Common questions about radiographic technique for BIPS studies

Key point

Attempting to rush BIPS studies is a common reason for misdiagnosis

❖ How many radiographs should I take and at what time should I take them?

- The best time to take radiographs during a BIPS study depends on the reason for the study, the clinical state of the patient, whether BIPS were given with food and logistical concerns such as time of presentation and the availability of staff.

- If all the clinician wishes to achieve with a BIPS study is to rule out obstructions of the pylorus and small intestine, all that is required is one set of radiographs 6-24 hours after administration (on an empty stomach). For example, if a clinically stable patient with a possible bowel obstruction is presented during an evening clinic, it may be appropriate to administer BIPS, begin supportive treatment, and radiograph the patient the next morning.

- In cats and dogs that present for chronic vomiting or diarrhea, a standard protocol is to administer the BIPS with food and take a set of radiographs 8 hours later to detect delayed gastric emptying. If the radiographs taken at 8 hours do not reveal some large BIPS in the colon, a second set of radiographs should be taken later that night or early the next morning in an attempt to rule out partial obstructions of the bowel. Additional sets of radiographs may be required if delayed orocolic transit or bunching of the markers in the small intestine is detected and the clinician wishes to determine if the delay or bunching is transient.

- If gastric dumping is suspected, one set of radiographs is required within 1-2 hours of administration.

- If large bowel transit is being assessed, remove most of the retained feces, administer the BIPS with r/d and radiograph at 24, 48 and 72 hours.
- The only time it is not appropriate to take radiographs during a radiopaque marker study is when the reference interval is so wide as to prevent differentiation of normal from abnormal passage. For example, a glance at the reference values shows that a radiograph taken at 4 hours in a dog fed BIPS mixed with d/d is of little diagnostic value because some healthy dogs have emptied little food from their stomachs at 4 hours whereas others have emptied the majority of their food by this time.

**Key Point**
Never attempt to interpret a BIPS study without 2 views.

- Are two views of the abdomen required?

Yes. Without two views, it is very hard to accurately determine the position of the BIPS in the abdomen. Furthermore, it is easy to mistake BIPS in the transverse colon for BIPS bunched in the small intestine if only a lateral abdominal view is taken.

- How can I restrain a difficult patient for radiographs?

Sedatives should be avoided during radiopaque marker studies because at the doses required to provide effective restraint, most drugs influence gastrointestinal motility. However, if necessary, intractable cats can be given acetylpromazine. Acetylpromazine at the high dose of 0.1 mg/kg SC slightly accelerates gastric emptying rate of BIPS. As a result, the manufacturer now provides separate reference intervals for the gastrointestinal transit of markers in cats tranquillized with high-dose acetylpromazine. As an alternative to chemical restraint, a transient dissociative state analogous to scruffing can often be induced by applying 3 or 4 spring-loaded clothes pins (pegs) to the scruff of cats. An assistant then needs to gently restrain only the cat’s limbs to obtain good radiographic positioning.

**Legend:**
The dissociative state resulting from application of clothes pins/pegs to the scruff of a cat.
What effect do drugs have on a BIPS study?

- **What drugs interfere with a BIPS study?**

  Drugs which alter gastrointestinal motility make interpretation of a BIPS study difficult. It is particularly important to avoid anticholinergic drugs and opioids which can profoundly slow orocolic transit and the passage of BIPS, potentially leading to misdiagnosis.

- **Can I use antiemetics while doing a BIPS study?**

  Yes. Promazine derivatives such as chlorpromazine and prochlorperazine are preferred because they are unlikely to slow gastrointestinal transit. Metoclopramide can be used as an antiemetic but it will hasten gastric emptying of BIPS. Anticholinergics should not be used.

- **Can I use prokinetic drugs during a BIPS study?**

  Yes - but only in selected circumstances. Because prokinetics will hasten gastric emptying and/or intestinal transit, they should be avoided prior to the use of BIPS for the diagnosis of motility disorders. However, if delayed transit of BIPS has been observed and a functional obstruction secondary to reduced gastrointestinal motility is suspected, prokinetics may be used to improve gastrointestinal motility. The response of BIPS to prokinetics occasionally helps differentiate depressed bowel motility from physical bowel obstructions because prokinetics accelerate the transit of BIPS in the former but not the latter. Prokinetic drugs should not be used if the BIPS have definitively revealed a physical obstruction of the bowel because the treatment is surgical. In addition, there is a very slight risk that use of a prokinetic drug in an obstructed patient may increase the chance of bowel perforation. Experience indicates that perforation as a result of use of prokinetics is highly unlikely, however. Animals with long-standing physical bowel obstructions and/or peritonitis from a perforation commonly develop markedly depressed bowel motility which is usually unresponsive to prokinetics.

**Key Point**
The transit rate of BIPS can be accelerated or slowed by drugs.
Can I use tranquillizers during a BIPS study?

Acepromazine slightly speeds gastroenteric transit but can be used if tranquillization is needed. Separate reference values for acepromazine sedated cats are provided in the appendix. Opioids should be avoided as they slow gastroenteric transit.
Interpreting BIPS studies

General approach & calculating emptying/transit rates

- **General approach to reading the radiographs**

  First review radiographic technique for adequacy and then methodically examine the radiograph for the survey radiographic information (eg spine, abdominal organ size, intestinal gas patterns etc). Next establish if the BIPS have bunched in the small intestine (see below). If there is no evidence of bunching the next step is to determine if motility is normal by calculating the gastric emptying time and orocolic transit time of the BIPS (see below). The patient’s gastric emptying rate and/or orocolic transit rate is then compared with the reference range gastric emptying and orocolic transit time curves provided by the manufacturer (see Appendix). The transit rate of the BIPS through the large intestine may also be of interest in some clinical circumstances.

- **How is gastric emptying rate calculated?**

  Note the time after BIPS administration that the set of radiographs was taken. Count the small BIPS in the stomach, small intestine and large intestine. Determine the percentage of small BIPS that have left the stomach. Compare the percentage of small BIPS that have left the stomach during the time period since they were administered with the reference intervals provided by the manufacturer. Do not include BIPS of uncertain position in the GI tract in the numerator or denominator of your percentage calculations. Repeat the calculations for the large BIPS.

  Note – it is routine to calculate the gastric emptying rates of both small and large BIPS. The gastric emptying rate of the small BIPS is most closely correlated to the gastric emptying of food and is therefore given the most weight in the diagnosis of motility disorders. The gastric emptying rate of the large BIPS is given the most weight in the diagnosis of partial obstructions of the pylorus and intestine.

**Key Point**

Transit calculations are straightforward but are of less importance in diagnosing obstructions than motility disorders.
How is orocolic transit rate calculated?

The orocolic transit time is the time taken from the administration of the BIPS until the first BIPS arrive in the proximal colon. Note the time after BIPS administration that the set of radiographs was taken. Count the small BIPS in the stomach, small intestine and large intestine. Determine the percentage of small BIPS that have entered the large intestine. Compare the percentage of small BIPS that have entered the large intestine during the time period since they were administered with the reference intervals provided by the manufacturer. Do not include BIPS of uncertain position in the GI tract in the numerator or denominator of your percentage calculations. Repeat the calculations for the large BIPS.

Note – it is routine to calculate the orocolic transit rates of both small and large BIPS. The intestinal transit of both is affected by motility disorders. The orocolic transit rate of the large BIPS is given the most weight in the diagnosis of partial obstructions.

How is transit rate through the large intestine calculated?

Note the time after BIPS administration that the set of radiographs was taken. Count the small BIPS in the proximal large intestine (ascending and transverse colon) and distal large intestine (descending colon). Determine the percentage of small BIPS in each region of the large intestine. Compare the percentage of small BIPS in each region and the time period since they were administered with the reference intervals provided by the manufacturer. Exclude BIPS in the rectum from your calculations (ie those caudal to the brim of the pelvis) because the rate of transit through the rectum is determined predominantly by the conscious decision to defecate. Do not include BIPS of uncertain position in the GI tract in the numerator or denominator of your percentage calculations. Repeat the calculations for the large BIPS.
Interpreting BIPS studies

Acute versus chronic upper-gastrointestinal presentations

Key Point
Because the order of the rule out list varies in acute versus chronic GI presentations, so does the approach to the BIPS study.

Interpretation of BIPS studies in acute upper gastrointestinal presentations

In patients presented with acute upper gastrointestinal problems, a frequent concern is to rule out physical obstructions of the bowel. In this situation, the most pertinent question during interpretation of a radiopaque marker study is whether the large BIPS have successfully reached the large intestine. If large BIPS are in the colon, a physical obstruction of the bowel is highly unlikely and a celiotomy to check for a bowel obstruction can usually be avoided. If it is not clear if BIPS have reached the colon, an air enema should be performed to outline the colon (instill ~20 ml/kg of air via a Foley catheter) and radiographs repeated.

If no BIPS have reached the colon a number of possibilities need to be considered. First, consider if adequate time has elapsed for BIPS to reach the colon by checking the reference intervals. Alternatively, the failure to reach the colon may be due to physical obstruction of the bowel, functional obstruction, or both. The decision as to whether an obstruction is functional or physical is made by interpretation of the history, clinical signs, laboratory findings, survey radiographic findings, the radiographic pattern of the BIPS (see below) and, when appropriate, treatment trials. When making this decision, it is important to remember that dogs and cats with acute gastrointestinal problems often develop delayed orocolic transit due to adynamic ileus. Therefore, in acute situations, slow orocolic transit is to be expected and modest delays in the transit of the BIPS should not be over-interpreted. For the same reason, if the clinical or radiographic findings do not support that the delayed transit of the BIPS is due to a physical obstruction, the clinician is often better to err on the side of conservative management. Conservative treatment is continued unless follow-up radiographs 24-48 hours later support physical obstruction or a deterioration of the patient’s condition dictates the need for a celiotomy.
Interpretation of BIPS studies in chronic upper gastrointestinal presentations

In patients presented with chronic upper gastrointestinal problems, radiopaque marker studies are primarily used to diagnose motility disorders and partial obstructions. Careful assessment of the gastric emptying and orocolic transit rate of the BIPS is comparatively more important in chronic than in acute presentations because there is usually a greater emphasis on the diagnosis of motility disorders in chronic presentations. As with acute presentations, delayed orocolic transit rates may be due to physical obstructions, functional obstructions or both. Once again, these disorders are differentiated by synthesis of the history, clinical signs, laboratory findings, survey radiographic findings and the radiographic pattern of the BIPS (see below). If transit time is normal, partial obstructions of the bowel (due to disorders such as annular adenocarcinoma) are unlikely and disorders causing chronic delayed gastric emptying or gastric dumping are highly unlikely. Episodic motility abnormalities (eg irritable bowel syndrome) remain a possibility.

Interpretation of BIPS studies in chronic constipation

The primary uses of BIPS in animals with chronic constipation are to rule out strictures and to assess the severity of motility dysfunctions. Strictures are infrequent and are usually secondary to trauma or neoplasia. BIPS bunch at the site of strictures but they also bunch orad of impacted feces. The most severe colonic motility dysfunction occurs in cats with idiopathic megacolon. The more severe the motility dysfunction the poorer the prognosis and the less likely medical therapy will be successful.

Legend:
Radiograph of a cat with idiopathic megacolon syndrome 3 days after the administration of BIPS. The BIPS have settled in the descending colon and show no evidence of aborad progression. There is also no evidence of mixing (segmented) contractions. The latter usually remain in “simple” constipation and result in BIPS remaining admixed with the feces rather than settling out on the “floor” of the colon as illustrated in this radiograph. This cat did not respond to medical management and underwent a successful subtotal colectomy.
Interpreting BIPS studies – specific radiographic patterns

Key Point
The location and transit rate of the BIPS assists differential diagnosis.

- **Retention of large and small BIPS in the stomach**

Gastric retention of BIPS can be due to physical obstructions to gastric outflow (eg. foreign bodies, pyloric stenosis, neoplasia) or motility abnormalities (eg. adynamic ileus, gastric dysrhythmias). If the clinician wishes to confirm that the gastric emptying of the BIPS is significantly delayed, their gastric emptying rate can be calculated (see above) and compared with the reference intervals provided by the manufacturer. The clinician should go on to differentiate physical and motility abnormalities causing gastric retention by clinical, endoscopic (procedure of choice), diagnostic imaging (eg. a barium liquid gastrogram or ultrasound), and/or surgical means. It is important to note that physical obstructions of the small intestine can produce gastric retention of the BIPS, presumably as a result of adynamic ileus.

Legend:
Gastric retention of markers compatible with pyloric obstruction, ileus or gastric motility disorders.

Legend:
This radiograph illustrates that adynamic ileus from an obstruction (the stone) can result in gastric retention of BIPS.
Legend:
Profound delayed gastric emptying in cat. All BIPS are retained in the stomach after eight hours.

Legend:
Delayed gastric emptying in a dog. All BIPS are retained in the stomach after 8 hours. Lateral and DV views.

Legend:
Close up of the dilated pyloric antrum.

Legend:
Eventually the dog was shown by endoscopy to have a pyloric stenosis similar to that shown in this picture.
Retention of large but not small BIPS in the stomach

This is a common pattern in healthy cats and is occasionally seen in toy dogs. It is physiologic for the antrum and pylorus to retain large, indigestible particles until the onset of strong “house keeping” contractions near the end of gastric emptying. Inadequate mixing of the BIPS in the test diet can also cause this pattern. For example, the administration of the large BIPS after a cat has eaten the meal containing the small BIPS can lead to this pattern. On rare occasions, this pattern is due to early pyloric stenosis whereupon the retention of the large markers is usually persistent and there are compatible clinical signs of vomiting due to delayed gastric emptying.

Retention of small but not large BIPS in the stomach

This is an uncommon pattern. When it occurs, it is most likely due to chance or to inadequate mixing of the BIPS in the test diet. This pattern has also been observed in a dog with a duodenal obstruction that was causing marked duodenal-gastric reflux.

Key Point
Bunching of BIPS in the small intestine is highly suggestive of obstruction.

Delayed orocolic transit with bunching of BIPS in the small intestine

Persistent bunching of BIPS in the small intestine is highly suggestive of physical obstruction of the small bowel, particularly if the markers have bunched in a dilated loop of small intestine or "gravelling" is apparent. Gravelling refers to the accumulation of indigestible ingested material (such as bone fragments) in an intestinal loop. If the small bowel loop in which the bunching occurs is not dilated or gravelling is not apparent, a repeat radiograph should be taken an hour or two later to ensure the bunching is persistent. The repeat radiograph is important because sometimes the empty stomach will expel the markers in small groups, presumably as a result of the strong contractions of the interdigestive migrating motor complex. Furthermore, transient bunching of some BIPS at the ileocolic valve will occasionally occur. This is most often seen in healthy cats but is occasionally seen in toy dogs and animals with weak but not absent peristalsis. Bunching of BIPS at the ileocolic valve can readily be differentiated from bunching of BIPS at the site of an obstruction by the transient nature of the bunching (often less than
2 hours), by the absence of supportive evidence of physical obstruction on the radiograph and by consideration of the anatomic location of the ileocolic valve. In the ventrodorsal view, the ileocolic valve is usually located on the right, at about the level of L3-L4. Gas in the ascending colon often marks the position of the ileocolic valve. Lastly, when determining the significance of bunching of BIPS, it is important to examine two radiographic views. Failure to do so can lead to misdiagnosis because on a lateral view accumulation of BIPS in the pyloric antrum or transverse colon can be mistaken for bunching of markers in the small intestine.

Legend:
Delayed transit of BIPS associated with the “stagnant loop sign” suggestive of physical obstruction of the small bowel.

Legend:
Lateral abdominal radiographs of a cat presented with chronic vomiting. BIPS have accumulated orad of a partial obstruction. See Case 1 for more details.

Legend:
Close up of the obstructed segment revealed indigestible material accumulated with the BIPS. This is referred to as the “gravelling sign”.

Legend:
Delayed gastric emptying and orocolic transit without bunching of the BIPS

Delayed passage of BIPS associated with a wide scattering of BIPS throughout the stomach and small intestine is usually due to a generalised depression of gastrointestinal motility. The lack of peristalsis creates a functional obstruction. If the clinician wishes to confirm the delay, the gastric emptying rate and orocolic transit rate of the BIPS can be calculated (see above for an explanation of how to make these calculations) and compared with the reference intervals provided by the manufacturer. In an acute presentation, depressed gastrointestinal motility is usually due to adynamic ileus which, in turn, can be caused by many conditions including acute gastroenteritis, pancreatitis and hypokalemia. Importantly, however, depressed motility can also occur following prolonged blockage of the bowel by a foreign body. Therefore, this radiographic pattern does not rule out a physical obstruction of the bowel and affected patients should undergo repeat radiography after appropriate symptomatic management (eg. fluids with added potassium and prokinetic drugs) to ensure that the BIPS eventually do arrive in the colon. Not until large BIPS appear in the colon can the clinician consider a physical obstruction improbable.

Legend:
Delayed transit of BIPS associated with scattered distribution of BIPS in the small intestine and stomach suggestive of ileus.

Legend:
Delayed gastric emptying and orocolic transit (without bunching) in a cat due to depressed gastrointestinal motility associated with uraemia.
Normal gastric emptying rate but slow orocolic transit without bunching of BIPS
This pattern suggests an early partial obstruction of insufficient luminal narrowing to cause the BIPS to bunch or a segmental motility disorder affecting part or all of the small intestine but sparing the stomach (eg pseudo-obstruction syndromes). A second BIPS study with r/d is indicated to rule out the subtle partial obstruction (see above).

Overly rapid gastric emptying of BIPS
Overly rapid gastric emptying of BIPS suggests a gastric dumping disorder. Dumping disorders are relatively rare in small animals. Therefore, if a BIPS study suggests a dumping disorder, the clinician should carefully consider whether inadequate mixing of the BIPS in the food may have been responsible for the rapid emptying rather than a dumping disorder. A repeat study is warranted before confirming the diagnosis.

Overly rapid small intestinal transit of BIPS
Overly rapid small intestinal transit of BIPS suggests an intestinal dumping disorder.

Key Point
A normal BIPS study means the patient’s clinical signs are unlikely to be due to an obstruction or motility disorder but does not rule out other GI disorders.

Normal gastrointestinal passage of the BIPS
If the rate at which the BIPS leave the stomach and arrive in the colon is within the reference intervals provided by the manufacturer, the patient’s clinical signs are unlikely to be due to obstruction of the bowel or motility disorders such as delayed gastric emptying or gastric dumping. However, a normal radiopaque marker study by no means rules out gastrointestinal disease. For example, infiltrative disorders (such as inflammatory bowel disease) or erosive disorders (such as gastric ulcers) need not interfere with the passage of the radiopaque markers. Similarly, some patients with non-obstructing gastrointestinal neoplasms (eg diffuse intestinal lymphoma) can have normal
radiopaque marker studies. Gastric foreign bodies producing intermittent obstruction of the pylorus can be missed as can non-obstructing radiolucent intestinal foreign bodies, albeit very rarely. For these reasons, radiopaque marker studies should be performed along with other diagnostic procedures as appropriate to the particular clinical situation.

Legend:
Normal orocolic transit. All markers are in the colon. Relax, the bowel is not obstructed.

Legend:
Lateral radiograph of the cat showing BIPS in ascending, transverse and descending colon.
Interpreting BIPS studies – miscellaneous questions

❖ What BIPS pattern supports a physical obstruction?

Persistent failure of BIPS to reach the colon along with a bunching of BIPS in the small intestine is highly suggestive of physical obstruction of the small bowel particularly if the bunching is associated with a dilated loop of small intestine, hair-pin loops or the "gravelling sign". The gravelling sign refers to the accumulation of indigestible material oral to the partial obstruction (see above section on “Interpretation of BIP studies in acute upper-gastrointestinal presentations”).

❖ How can I be sure BIPS are in the colon?

If you cannot determine if the BIPS in the colon because of poor abdominal contrast, repeat the radiograph after performing an air enema (20 ml/kg) preferably administered by way of a Foley (balloon) catheter. The air will outline the colon and confirm the position of the BIPS.

Legend:
This young cat was presented for vomiting and suspected to have an obstruction. A BIPS study was run overnight and radiographs taken the next morning. The veterinarian reading the radiographs was unsure if BIPS were bunched in the small intestine or if they had simply collected in the ascending colon and so performed an air enema (see below)
Are there any reasons for BIPS to bunch in the intestine without there being a physical obstruction of the bowel?

In cats and small dogs, there may be a brief bunching of the BIPS just cranial to the ileocolic junction. Sometimes the empty stomach will expel the markers in small groups, presumably as a result of the strong contractions of the interdigestive migrating motor complex. Thus, if bunching of a small group of BIPS is detected on a radiograph, the radiograph should be repeated to determine if this pattern is persistent, particularly if there is no evidence of an associated dilated loop of bowel. Mistaken identification of BIPS in the pyloric antrum or transverse colon on a lateral radiographic view can give the mistaken impression of bunching in the small intestine.

How should I interpret bunching of BIPS at the ileocolic valve?

In cats and to a lesser extent dogs there may be a brief (less than 2 hours) bunching of the BIPS just orad to the ileocolic junction. If BIPS are bunched in this position without other radiographic evidence of physical obstruction, beware of "calling" a physical obstruction. Persistent bunching of BIPS at this site is problematic to interpret. It can be due to a

Legend:
The air enema clearly shows the BIPS are in the ascending colon. An obstruction was ruled out and the cat recovered uneventfully with symptomatic therapy.
physical obstruction at this site but segmental motility disorders of this valve seem to be more common than previously recognised.

- **Do the BIPS detect linear foreign body obstructions?**

  Yes. The BIPS usually bunch orad of the plicated bowel loops. If the condition is advanced and adynamic ileus has occurred the BIPS may remain in the stomach. A normal study rules out linear foreign body obstructions and is particularly helpful in obese cats in which the bowel sometimes appears bunched giving the radiographic appearance of a linear foreign body. Unlike barium liquid, BIPS do not create a risk to the patient if bowel perforation has occurred.

- **How should I interpret apparent reflux of BIPS from the intestinal tract back into the stomach?**

  This is rarely seen but will occasionally occur in a nauseous animal (as gastroduodenal reflux is a standard part of the vomiting reflex) or in animals with duodenal obstructions. Reingestion of BIPS expelled in feces by coprophagic animals will occasionally give the mistaken impression of gastrointestinal reflux of BIPS.

- **How should I interpret discordance between the transit of the small and large markers?**

  In the event of discordance between the passage rates of the small and large BIPS, it is noteworthy that the movement of the small BIPS is a more reliable predictor of the transit of food (for diagnosis of motility disorders). In contrast, the passage of the large BIPS is more sensitive for the detection of physical obstructions.

- **What do I do if I cannot identify the position of all the markers?**

  Discount the markers of uncertain location from your calculations.
What do the 95% confidence intervals in the reference intervals mean?

Values lying outside the 95% confidence interval are highly unlikely to be normal. Obviously, at those time points when the 95% confidence intervals reach right to the baseline, it is impossible to separate normal and delayed gastric emptying or small intestinal transit. Avoid taking radiographs during these times.
Common concerns about BIPS

Have BIPS been scientifically validated?

BIPS have received extensive validation and are supported by numerous publications in the peer-reviewed literature. Reference intervals for gastric emptying and orocolic transit time of BIPS in healthy fasted and fed cats and dogs have been determined. Reference values for colorectal transit of the BIPS in healthy cats and dogs have also been assessed. The repeatability of the technique and the influence of "stress" have been examined. In cats, the influence of tranquilization with acetylpromazine to facilitate radiography and IV valium administration to encourage ingestion of test diets have been investigated. The correlation of the gastric emptying rate of BIPS with the gastric emptying rate of food has been evaluated indirectly by repeated measurement of gastric diameter on radiographs, and directly by measurement of dry matter disappearance from the stomach. Variability in the assessment of the position of BIPS in the GI tract between different radiologists has been estimated. The correlation between radiographic assessment of the position of the BIPS within the GI tract and their actual position as determined by necropsy has also been assessed. Lastly, the performance of the markers in clinical patients has been closely evaluated. These studies have supported the use of BIPS in the manner currently recommended. A selection of abstracts from the literature about BIPS are given in the appendix.

Key Point

BIPS have been more thoroughly validated than most published veterinary scintigraphic techniques.

Legend:

This figure shows the close correlation between the emptying of BIPS and that of dry matter and wet matter from the stomach of dogs fed Hills Prescription Diet d/d.
Why do gastric emptying rates determined by BIPS and scintigraphy rarely agree?
Usually because they are measuring the gastric emptying of different things. BIPS assess the gastric emptying of particulate solids whereas scintigraphy measures the emptying of the radioactive label bound to a chosen nutrient.

Will the BIPS worsen an obstruction by blocking the remaining lumen?
No. The BIPS settle out in the stagnant loop proximal to the obstruction and do not lodge in the narrowed lumen. The obstruction can be worsened by high fibre diets, however.

Does stress affect the study?
The gastric emptying rate of some animals is slowed by stress. For this reason the reference intervals provided by the manufacturer were derived from dogs and cats that were not acclimatised to the radiographic table. This study population was chosen to mimic the stress of the procedure likely to occur in pets undergoing radiography.

Do BIPS have any therapeutic value like barium sulfate suspensions?
No, but the therapeutic value of barium sulfate suspensions is anecdotal and at best mild.

Will BIPS detect gastric ulcers?
BIPS will not reliably diagnose ulcers because they do not outline the gastrointestinal mucosa. However, many gastric ulcers are associated with secondary motility abnormalities resulting in delayed gastric emptying of the BIPS. In addition, BIPS will occasionally roll into the ulcer crater where they are retained for prolonged periods. The technique of choice for diagnosing ulcers is endoscopy.
Will BIPS cause any problems if they enter the abdomen through a bowel perforation?

No. BIPS are inert and do not appear to induce any major inflammatory reaction in the peritoneum.

Will BIPS leak barium into the abdomen if left behind at surgery?

No. The barium is impregnated in an inert plastic. Barium will not leak from the plastic.
CASE STUDIES

Case 1. A Cat with Chronic Vomiting

Case 2. A Dog with Acute Vomiting

Case 3. A Cat with Chronic Vomiting following a Subtotal Colectomy

Case 4. A Cat with Intractable Vomiting and Azotemia

Case 5. A Dog with Chronic Vomiting

Case 6. A Cat with Acute Vomiting
CASE 1 - A CAT WITH CHRONIC VOMITING

Clinical examination

A 3-year-old DSH was presented with a history of chronic vomiting and occasional diarrhea. The vomiting had been occurring for 18 months and was steadily increasing in frequency to the point where two bouts of vomiting were occurring twice per week. The vomiting was initially small in volume and contained predominantly fluid and remnants of food. Lately, the vomiting had become more liquid, larger in volume and foul smelling. A complete blood count and serum chemistry profile performed by the referring veterinarian were unremarkable. The cat was referred for endoscopy with the primary differential diagnoses of inflammatory bowel disease or lymphosarcoma. Physical examination at Massey University was unremarkable. The cat was scheduled for endoscopy the following day. In view of the history of large volume, foul smelling vomitus, a BIPS study was performed to rule out partial obstructions.

BIPS study - method

The BIPS were given on an empty stomach because the cat was anorexic and the primary aim of the procedure was to rule out obstructions rather than evaluate motility. They were administered late in the afternoon and a left lateral and ventrodorsal radiograph was taken early the next morning 16 hours later.

BIPS study - interpretation

The radiographs revealed a tight bunching of the markers in the small intestine associated with "gravelling". These radiographs were diagnostic of a physical obstruction of the small intestine.

Treatment

Exploratory laparotomy revealed a narrowed piece of bowel. This was resected and an end-to-end anastomosis was performed. Histology revealed lymphoma.
Follow-up

The clinical condition of the cat improved rapidly after surgery. Adriamycin therapy was instituted and the cat remains well 1 year after diagnosis.

Comment

The BIPS are tightly bunched in the small intestine and the gravelling and dilated small bowel loop at the site of the obstruction provides firm supportive evidence of a long-standing partial obstruction of the bowel.

Legend:
Lateral abdominal radiographs of a cat presented with chronic vomiting. BIPS have accumulated orad of a partial obstruction.

Legend:
Close up of the obstructed segment revealing indigestible material accumulated with the BIPS. This is referred to as the “gravelling sign”.
CASE 2 - A DOG WITH ACUTE VOMITING

Clinical examination

A 7-year-old male fox terrier was presented to Massey University with a history of acute onset of anorexia and vomiting. The vomiting was infrequent and contained large volumes of liquid. Physical examination revealed a bright and alert dog with mild cranial abdominal discomfort. A complete blood count and serum chemistry profile revealed no abnormalities except for a mild elevation in amylase along with a normal lipase. Survey radiography revealed a slightly dilated loop of small bowel but was not diagnostic of a physical obstruction of the bowel. A BIPS study was performed to rule out a physical obstruction.

BIPS study - method

The BIPS were given on an empty stomach because the dog was anorexic and the primary aim of the procedure was to rule out a physical obstruction rather than evaluate motility. They were administered early in the morning. The dog vomited 4 hours later losing some of the BIPS. Another set of BIPS was administered and left lateral and ventrodorsal radiographs were taken at a convenient time 7 hours later.

Legend:

Survey radiograph. No convincing evidence of an obstruction can be seen.
BIPS study - interpretation

The radiographs revealed a tight bunching of the majority of the BIPS in the proximal small intestine associated with "gravelling". These radiographs were diagnostic of a physical obstruction of the small intestine.

Treatment

Exploratory laparotomy revealed a peach stone in the caudal duodenum. This was successfully removed.

Follow-up

Recovery was uneventful.

Comment

This case demonstrates the classic BIPS radiographic pattern occurring with physical obstruction of the small bowel. The BIPS are tightly bunched in the small intestine at the site of the

Legend:
Lateral and ventrodorsal radiographs. The majority of the large BIPS have accumulated orad of an obstruction in the duodenum.
obstruction. The accumulation of other indigestible material ("gravelling") at the same site as the BIPS and the dilated loop of small bowel provides firm supportive evidence of a bowel obstruction. The reason most of the small BIPS remain in the stomach was unknown but may have been due to chance or gastroduodenal reflux.
CASE 3 - A CAT WITH CHRONIC VOMITING FOLLOWING A SUBTOTAL COLECTOMY

Clinical examination

An 11-year-old DSH was presented to Massey University with a 1-month history of a declining appetite and an increasing frequency of vomiting. The cat had been presented 3 months previously with severe obstipation leading to a diagnosis of idiopathic megacolon syndrome. A subtotal colectomy was performed and the cat had been well for 2 months. Physical examination revealed a bright and alert cat that had lost considerable amounts of weight. Small amounts of soft feces were present in the colon but abdominal palpation was otherwise unremarkable. A CBC and serum chemistry profile were non-diagnostic. A BIPS study was performed to rule out a partial obstruction of the bowel.

Legend:
Lateral radiographs of cat with a subtotal colectomy.

BIPS study - method

The BIPS were given on an empty stomach because the cat was anorexic and the primary aim of the study was to rule out an obstruction rather than to assess gastrointestinal motility. Left lateral and ventrodorsal radiographs were taken at a convenient time 12 hours later.
**BIPS study - interpretation**

The radiographs revealed a bunching of the BIPS in a small intestinal loop in close proximity to the colon. Note the gravelling in the stagnant loop (i.e., accumulation of indigestible debris). These radiographs were diagnostic of a physical obstruction of the small intestine. It was considered most likely that a stricture had developed at the ileocolic anastomosis (i.e., where the ileum and remaining colon were sutured back together).

**Outcome**

An exploratory laparotomy and surgical resection of the stricture was recommended but declined by the owner. The cat was euthanised and a stricture with a luminal diameter of 2-3 mm was confirmed at necropsy.

![Legend: Stricture at the site of the anastomosis.](image)

**Comment**

This case demonstrates the classic BIPS radiographic pattern occurring with physical obstruction of the small bowel. The BIPS are bunched at the site of the obstruction. The accumulation of other indigestible material at the same site as the BIPS confirms the obstruction.
CASE 4 - A CAT WITH INTRACTABLE VOMITING AND AZOTEMIA

Clinical examination

A 13-year-old Siamese was presented to Massey University with a 2-week history of inappetence, weight loss, vomiting and polyuria/polydipsia. Physical examination revealed poor coat condition, muscle wasting and small kidneys. Blood work demonstrated a moderate azotemia (BUN and creatinine approximately 2 times normal) in association with a low urine specific gravity. A diagnosis of renal azotemia was made. The clinical signs were considered to be most likely due to uremia although it was acknowledged that the serum BUN and creatinine concentrations were not sufficiently high to be diagnostic of uremia. Diuresis and administration of chlorpromazine antiemetics failed to control the vomiting in spite of a 50 % reduction in the azotemia. A BIPS study was performed to rule out a concurrent physical obstruction or a dysmotility.

BIPS study - method

The BIPS were given on an empty stomach because the cat was anorexic. Left lateral and ventrodorsal radiographs were taken at a convenient time 24 hours later.

Legend:
Delayed gastric emptying and orocolic transit (without bunching).
**BIPS study - interpretation**

The radiographs revealed BIPS scattered throughout the GI tract with most still in the stomach and small bowel and only a few in the colon. A glance at the reference intervals for the gastric emptying rates and orocolic transit times of fasted healthy cats reveals that this cat’s gastric emptying rate and orocolic transit time are markedly slowed. The scattered pattern of the markers suggests that the delay is most likely due to an adynamic ileus and not due to a physical obstruction.

**Treatment**

The cat's antiemetics were changed to a prokinetic drug (metoclopramide – Reglan; Maxalon) which increased the bowel's motility and stopped the vomiting. A follow-up radiograph 12 hours later showed all BIPS in colon confirming the diagnosis of a dysmotility associated with uraemia and ruling out a concurrent obstruction.

**Follow-up**

The cat was discharged on metoclopramide and dietary management and was continuing to do well at the time of writing.

**Comment**

This case demonstrates the classic BIPS radiographic pattern occurring with functional obstruction of the gastrointestinal tract. The BIPS are scattered throughout the stomach and bowel. The gastric emptying and orocolic transit rates are slow as a result of the weak and ineffectual motility associated with adynamic ileus. It is important to note that this pattern does not rule out a physical obstruction of the bowel because physical obstructions can result in secondary adynamic ileus. For this reason, a follow-up radiograph was performed after the administration of the prokinetic drug. This radiograph revealed the BIPS had arrived in the colon, a location which ruled out physical obstruction of the upper gastrointestinal tract.
CASE 5 - A DOG WITH CHRONIC VOMITING

Clinical examination

A 7-year-old male dog was presented to Massey University with a 2 month history of vomiting and hematemesis. Surgery at the referring veterinarians had revealed a deep ulcer in the pyloric antrum in association with numerous Helicobacter organisms. The ulcer was resected and the dog treated with antibiotics. The response was poor. On presentation to Massey, the dog was vomiting large amounts of food 4-6 hours after eating. Physical examination, a CBC, and a serum chemistry profile were non-diagnostic. Delayed gastric emptying was suspected and a BIPS study was performed to confirm or rule out this possibility.

BIPS study - method

The BIPS were given with Prescription Diet d/d (Hills Pet Products). The BIPS were given with food because the aim of the study was to determine if the gastric emptying rate of food was delayed. Prescription diet d/d was used because the gastric emptying rate of this diet and that of BIPS have been shown to be closely correlated. Lateral and ventrodorsal radiographs were taken 8 hours later.

Legend:
Lateral radiograph revealing a dilated pyloric antrum containing the BIPS.
**BIPS study - interpretation**

The radiographs revealed that all the BIPS remained in the stomach, specifically in the pyloric antrum, which is the dilated thick-walled circular, structure surrounding the BIPS. A glance at the reference intervals showing the gastric emptying rates of BIPS in dogs fed Prescription Diet d/d reveals that this dog's gastric emptying rate is significantly delayed. Retention of BIPS in the stomach can be due to many different causes including pyloric stenosis, obstruction of the pylorus by a foreign body or tumor, primary gastric motility disorders (e.g., due to damage to the stomach's intrinsic nervous system), secondary gastric motility disorders (e.g., due to gastritis or electrolyte disturbances), generalized depression of gastrointestinal motility (adynamic ileus) or even a physical obstruction of the small bowel resulting in a secondary adynamic ileus. Obviously, further diagnostic steps were required.

**Further Diagnostic Steps**

An endoscopy was performed. This revealed that the previous surgery to remove the ulcer had interfered with antral motility. Food was no longer being carried adequately to the pylorus but instead was remaining in the gastric body.

**Treatment**

The dog underwent a Y-U pyloroplasty procedure which resulted in an immediate improvement in its clinical signs and gastric emptying rate (as confirmed by a follow-up BIPS study).

**Follow-up**

Unfortunately, the dog died acutely several weeks after the surgery of unknown causes.
**Comment**

This case demonstrates the classic BIPS radiographic pattern occurring with markedly delayed gastric emptying. This pattern is the least specific of the BIPS patterns. It indicates a serious gastrointestinal dysfunction but gives little indication as to the cause of that dysfunction. Therefore, the veterinarian must choose his or her next diagnostic steps carefully depending on which disorders he or she considers most likely. Further diagnostic steps of value include blood work to rule out systemic disorders; endoscopy, double-contrast or liquid gastrograms to detect ulcers, foreign bodies or tumors; and ultrasound to detect outflow obstructions. Ultimately, however, biopsy of the stomach is often required and hence endoscopy or exploratory laparotomy is usually necessary.
CASE 6 - A CAT WITH ACUTE VOMITING

Clinical examination

A young cat was presented to an evening emergency clinic with an acute onset of vomiting. The cat was bright and alert and hemodynamically stable but the clinician could palpate a tender area in the abdomen along with some gas-filled loops of bowel. The clinician was concerned about the possibility of an obstruction but did not have enough evidence to justify an exploratory surgery. She decided to place the cat on fluids and antibiotics and rule out a physical obstruction with a BIPS study.

BIPS study - method

The BIPS were given on an empty stomach because the primary aim of the study was to rule out a physical obstruction. Radiographs were taken early the next morning.

BIPS study - interpretation

The radiographs revealed that the BIPS were scattered throughout the ascending, transverse and descending colon. This effectively ruled out an obstruction and the cat was spared an unnecessary exploratory laparotomy.

Legend:
Lateral radiograph of the cat showing BIPS in ascending, transverse and descending colon.
Treatment

Fluids and antibiotics were continued and the cat made a rapid and uneventful recovery.

Comment

This case demonstrates the value of BIPS in ruling out an obstruction. Note on the lateral view the apparent bunching of the BIPS. This is due to collection of BIPS in the transverse colon (revealed by a VD radiograph - not provided). If a clinician is in doubt as to whether the BIPS are in the colon an air enema can be performed to outline the colon.
Appendix 1

Selected Publications about Radiopaque Markers


Appendix 2

Selected Abstracts about Radiopaque Markers

Reference Intervals for BIPS in Healthy Dogs and Cats


Despite the potential importance of gastric motility disorders, there is currently no method available to accurately quantitate gastric emptying times in dogs in the veterinary practice environment. Scintigraphy is not widely available and studies using barium sulfate liquid provide little useful quantitative information about the emptying of solids from the stomach. The objective of this study was to develop a quantitative method of assessing the gastric emptying of food. Twenty healthy border collie crosses were each given a quarter of their calculated daily calorie requirements (Hills D/D canned) mixed with thirty 1.5 mm and ten 5 mm diameter barium sulfate impregnated plastic spheres on days 1, 6 and 9 of the study. Left lateral and ventrodorsal radiographs were taken immediately after ingestion of the test meal and every subsequent hour until all markers had left the stomach. On the days between the radiographic series, the dogs were trained to lie on the radiography table. Preliminary results showed that the 1.5-mm diameter markers had a mean 50% gastric emptying time on days 1, 6 and 9 of 5.7 hours, 3.8 hours and 4.4 hours respectively. The percent marker emptying versus time curves had a sigmoid shape. The 5 mm markers left the stomach at variable rates. These data suggest that the 1.5 mm radiopaque markers may provide a practical method of quantitating gastric emptying.


Determinations of gastric emptying time (GET) and small intestinal transit time (SITT) are useful in detecting gastrointestinal motility disorders and partial intestinal obstructions. Barium impregnated, polyethylene radiopaque spheres (BIPS) with diameters of 1.5 mm and 5.0 mm are used for quantitative assessment of gastrointestinal transit. This study evaluated GET and SITT using BIPS in ten healthy cats, using a repeated measures design. The cats were Randomly
assigned to three treatment groups: fasted, fed, and fed plus sedation (acepromazine maleate, 0.10 mg/kg, SQ). The mean GET of 50%, 75% and 90% of the 1.5 mm and 5 mm spheres were determined from the GET curves. Treatment effect on SITT was examined by comparing the area between the GET curves and the colonic filling curves. The mean GETs of 50%, 75% and 90% for the 1.5 mm and 5 mm spheres were significantly more rapid in the unfed cats than in either of the groups of fed cats. The mean GETs of 50% and 75% of the 1.5 and 5 mm, and of 90% of the 1.5 mm spheres, were significantly more rapid than that of the 5 mm spheres in the fed cats. The SITT was not significantly different among the treatment groups or between the 1.5 and 5 mm spheres. In conclusion, the GET of spheres given to fasted cats is significantly more rapid than that of fed cats. The slower initial gastric emptying of the 5 mm spheres may indicate that they are treated as indigestible material and retained by the stomach, then emptied by a housekeeper-like contraction. Acepromazine at this dose reduces GET in fed cats.

**Chandler ML, Guilford WG, Lawoko CRO, Whittem T. Gastric emptying and intestinal transit times of radiopaque markers in cats fed a high-fiber diet with and without low-dose intravenous diazepam. Vet Radiol & Ultrasound 40:3-8,1999.**

Reference ranges for gastric emptying time (GET), small intestinal transit time (SITT), and colonic transit time of 1.5-mm and 5-mm radiopaque markers in healthy cats fed a high-fiber meal were determined, and the influence of low-dose diazepam intravenous injection on the gastrointestinal transit of the markers was examined. The mean GETs and SITTS, and the mean residence times (MRTs) and geometric centers (GCs) of markers in the colon were determined. The effect of intravenous diazepam injection and marker size on these parameters was examined. Diazepam injection had no significant influence on gastrointestinal transit. The GETs of the 1.5-mm markers were significantly more rapid than those of the 5.0-mm markers. There were no significant differences between the SITTS or GCs of the 1.5-mm and 5.0-mm markers. Reference values were developed for GET, SITT, and colonic transit of radiopaque markers for cats fed a high-fiber meal. Diazepam injection had no effect on these parameters.

Objectives: To determine accuracy of abdominal radiography in locating radiopaque markers in the gastrointestinal tract and to assess correlation between gastric emptying rate of radiopaque markers and that of canned food. Animals: 17 healthy dogs. Procedure: Dogs were fed thirty 1.5-mm markers and ten 5-mm markers mixed in sufficient food to meet 25% of their daily caloric intake. They were then euthanatized by administration of an overdose of barbiturate at 1, 2, 5, 8, or 12 hours after eating and the abdomen was radiographed. The stomach, small intestine, and large intestine were then separated and radiographed in isolation. The wet and dry weights of the stomach contents were determined. The apparent and actual locations of the markers and the gastric emptying rates of markers, wet matter, and dry matter were compared, using rank correlation. Results: All comparisons indicated significant (P < 0.025), high correlation coefficients (> 0.92). The mean difference between the apparent and actual locations of the markers was < 3% for all comparisons. The mean difference between the percentage of small markers and large markers retained in the stomach and that of dry matter was 7.8 (SD, 6.2; range, 0 to 18)% and 11.9 (SD, 12.5; range, 0 to 44)%, respectively. Conclusions: The gastric emptying and orocolic transit rates of the markers were accurately predicted by abdominal radiography. The gastric emptying rate of the diet and the small markers and, to a lesser extent, the large markers was closely correlated. Clinical Relevance: When fed with a special canned food diet, radiopaque markers can be used to assess the gastric emptying rate of food with sufficient accuracy for clinical purposes.


Ten healthy dogs were fed thirty 1.5 mm and ten 5 mm radiopaque markers (BIPS, MedID, Grand Rapids) mixed with sufficient quantities of a high fiber diet to meet 25% of their estimated daily caloric requirements. Abdominal radiographs were taken every two hours until 90% of the small and large markers had left the colon and entered the rectum. The mean
residence times (MRT) of each size of marker in the proximal, distal and total colon were calculated via a kinetic analysis. The MRT’s of the small markers were 4.87 hours (SD 4.36), 7.13 hours (SD 3.28) and 12.00 hours (SD 7.12) respectively. The MRT’s of the large markers were not significantly different to the small markers except in the proximal colon where they were significantly shorter (3.24 hours, SD 2.32). Reference colonic filling and colonic transit curves for both sizes of markers were constructed. These may be useful to detect abnormal colonic transit in dogs.


Commercial barium-impregnated polyethylene spheres (BIPS) were administered to 12 healthy adult cats according to the manufacturer's instructions (30 small BIPS and 10 large BIPS to each cat) together with 60 g of a canned food, Radiographs were taken at hourly intervals until seven hours after feeding, and then at eight, 10, 12, 14, 17, 23 and 30 hours or until all the BIPS had left the stomach and at least 50 per cent had entered the colon, Six cats were sedated immediately after being fed the BIPS and six cats remained unsedated, For small BIPS (1.5 mm diameter), the gastric transit time (first exit of BIPS from the stomach) in the sedated cats had a median of 6 hours (range 3 to 8) and in the unsedated cats a median of 2.5 hours (range 2 to 6), Values for other transit times were not significantly different between the two groups, and the pooled data revealed a median 50 percent gastric emptying time of 6.4 hours (range 2.5 to 10.9), a complete gastric emptying time of 12 hours (range 6 to 27), an orocaecal transit time (first appearance of BIPS in the colon) of 6.5 hours (range 4.0 to 12.0) and a 50 per cent orocaecal transit time of 8.8 hours (range 4.6 to 12.8), The gastrointestinal transit of large BIPS (5 mm diameter) was significantly correlated with the passage of small BIPS but, except for the complete gastric emptying time, was significantly slower.
Use of Radiopaque Markers in Animals Other Than Dogs and Cats


Solid radiopaque markers were compared with barium sulphate suspension for the video-taped fluoroscopic investigation of oesophageal groove closure and forestomach bypass in 30 recently-fed Romney hoggets, 10 months old. Oesophageal groove closure was clearly identifiable using both methods, although the 1.5-mm diameter solid markers showed a tendency to become lodged in the oesophageal groove and omasum, limiting their value for the study of forestomach bypass. Forestomach contractions, closure of the oesophageal groove and omasal function could be assessed using the solid radiopaque markers, which are potentially useful for studies of ruminant digestion. 10 ml of a 2% copper sulphate solution, when administered to the back of the oral pharynx 10 s before oral dosing, induced oesophageal groove closure in 55% of the hoggets. 10 ml of a 2% cobalt sulphate solution had a similar effect, although the numbers of sheep investigated were too small for statistical comparison.


The gastric emptying of different forms of ingesta occurs by a variety of mechanisms and dysfunction may selectively affect different components of the gastric contents. A technique for assessing gastric emptying of solid, indigestible, radiopaque markers was developed. Emptying of these markers in four ponies was variable in both pattern and rate (half emptying time ranged from less than one hour to more than 24 hours). However, whereas in man physically similar markers appear to empty relatively rapidly when fasting but are delayed by a meal, no such delay was evident in these ponies. The horse does not interrupt cyclical motility when fed ad libitum. The data, therefore, suggest that the mechanism of emptying of non-digestible markers differs between man and the pony.
Some Comparisons of Scintigraphy versus Radiopaque Markers


Gastric emptying in 18 healthy cats was assessed simultaneously using scintigraphy and barium-impregnated polyethylene spheres (BIPS). Canned Prescription Diet Feline c/d labelled with 99mTc-disofenin was fed on 4 separate days. Scintigraphic images were obtained at time 0 and then every 30 min for 6 h. On the fourth scan day, 30 small (1.5 mm) and 10 large (5 mm) BIPS were mixed with the labelled meal, and in addition to scintigraphy, radiographs were made at 60-min intervals for 6 h. Gastric emptying was 11 to 15% slower on the day of simultaneous radiography compared with the 3 days when only scintigraphy was performed. Percentage retention of 1.5 mm BIPS in the stomach was significantly greater than the percentage retained gastric activity at hours 1, 2, 3, 4, 5 and 6. BIPS were clustered in the pyloric region of the stomach by 3 h in all cats. In 10 of 18 animals, all BIPS were retained in pyloric region of the stomach at 6 h, despite decreased size of the gastric silhouette and less than or equal to 15% retained gastric activity. It is concluded that gastric emptying of 1.5-mm BIPS does not parallel gastric emptying of 99mTc-disofenin labelled canned Prescription Diet Feline c/d. Stress associated with radiography may delay gastric emptying.

[Note – In this study BIPS were shown not to remain in suspension in a diet of Hills c/d. This diet should be avoided for radiopaque marker studies]


The rate and pattern of gastric emptying of a radiolabelled meal containing 30 small (1.5 mm) barium impregnated polyethylene spheres (BIPS) was evaluated in 6 healthy dogs by simultaneous comparison of the radiopaque marker method and a scintigraphic method. Serial scintigraphic images and radiographs were obtained for 8 h or until 95% of the markers had left the stomach. Emptying curves were constructed and statistical analyses performed. There were
significant differences in gastric emptying times and lag phase characteristics between the BIPS and scintigraphic studies. It is suggested that in healthy dogs there are differences in both the rate and the pattern of solid-phase gastric emptying of a radiolabelled meal as assessed by scintigraphy and the gastric emptying of small BIPS.

[Note – this study is compromised by methodological errors and statements within the discussion not supported by the data but, nevertheless, demonstrates that radiolabeled egg exits the stomach more quickly than BIPS mixed with Hills d/d]


The objective of this study was to compare scintigraphy and radiopaque markers (ROMs) as methods for measuring gastric emptying in healthy volunteers and patients. A secondary objective was to determine if patients with small intestinal bacterial overgrowth (SIBO) had delayed gastric emptying. 20 healthy subjects and 21 patients, 11 with SIBO and 10 with insulin-dependent diabetes mellitus (IDDM), were included. A standard meal with a [99mTc]MAA-labelled omelet and 20 ROMs was given. Scintigraphic emptying and ROM emptying were followed simultaneously. Reference values for gastric emptying of ROMs were determined in 50 healthy subjects. The scintigraphic method and the radiologic method correlated significantly in healthy subjects, and in patients (P<0.001), when comparing half-emptying time for both methods. Scintigraphic half-emptying time correlated significantly with emptying of ROMs after 6 h. Six of 11 patients with SIBO (P<0.02) and 7/10 patients with IDDM (P<0.02) had delayed scintigraphic emptying of solids using the 95th percentile in the controls as the upper reference value. Gastric emptying of ROMs was, similar to solid scintigraphic gastric emptying, slower in women than in men. In conclusion, scintigraphic emptying of solids and emptying of ROMs are closely correlated. The radiologic method can be used as a simpler and more readily available method. Women have slower gastric emptying of ROMs than men, which necessitates separate reference values. A high proportion of patients with symptomatic IDDM and with SIBO have delayed gastric emptying.

In this retrospective analysis, we compared different methods to evaluate gastric emptying function, aiming to improve the sensitivity and the clinical availability of our diagnostic testing. In the first study, we compared, in 72 patients clinically suspected of gastroparesis, the emptying of a meal containing two solid nutrients with different disintegration rates: In-111-labeled scrambled eggs and Tc-99-labeled liver cubes. Gastric emptying of In-111-labeled egg was delayed in 12 of our patients and the evacuation of the Tc-99-labeled liver was prolonged in 19 patients. The choice of the nutrient was not important for the identification of diabetic gastroparesis (43% vs 57%; NS), but it was determinant in the case of patients suspected of idiopathic gastroparesis (12% were positive with the egg and 25% with the liver; P < 0.05). In the second study, we compared two different diagnostic methods in 46 patients: a simple radiological detection of the gastric emptying of radiopaque pellets, and the scintigraphic emptying of a solid meal containing Tc-99-labeled liver cubes. Both tests correlated perfectly in 78% of our patients. In 15% of the population (six of these seven patients were diabetics suspected of gastroparesis) the scintigraphic method was normal, while the evacuation of radiopaque pellets was delayed. For clinical purposes, we therefore propose: (1) the scintigraphic method should use liver rather than egg as a radiolabeled tracer in order to improve the sensitivity of the test for detection of gastroparesis; and (2) the radiological detection of radiopaque markers is a reliable and convenient method for the detection of gastroparesis in clinical practice. It is possibly more sensitive than scintigraphy.

Veterinary Clinical Abstracts Using Radiopaque Markers


Spherical, polyethylene radiopaque markers (RMs) with a diameter of 1.5 mm and 5.0 mm have been developed to aid in the diagnosis of gastrointestinal (GI) motility disorders and partial obstructions in the private practice setting. The gastric emptying rates of RMs in healthy dogs has been reported previously. Preliminary information is now available on the gastric emptying rates of RMs in healthy cats and on the intestinal transit times of RMs in both healthy dogs and
cats. Below we report observations from clinical cases presented to the Massey University Veterinary Hospital. The GI transit of RMs in dogs and cats with a variety of GI and non-GI diseases was studied. RMs were administered with a test meal (1/4 daily calorie requirements of canned Prescription Diet™ d/d™) but if the animal was vomiting RMs were administered in a gelatin capsule on an empty stomach. Delayed GI transit of RMs was observed in patients with uraemia, megacolon, pancreatitis, pyloric disorders and in dogs with surgically corrected gastric dilation-volvulus. In animals with adynamic ileus, RMs are either retained in the stomach or are evenly distributed throughout the entire upper GI tract. Conversely, in animals with either naturally occurring or surgically created partial obstructions the RMs tend to bunch in the loop of bowel immediately oral to the site of obstruction. In comparison to barium suspensions we found RMs to be convenient and safe and to provide quantitative information. These preliminary data suggest RMs are a useful clinical tool for the diagnosis of functional or physical obstructions.


Traditionally, metoclopramide has served as the drug of choice to treat dogs with gastric retention from a variety of causes. The side effects, however, may limit its clinical utility. Recently, the prokinetic activities of cisapride and erythromycin have been observed to enhance gastric emptying in people with gastroparesis. The objective of this study was to investigate gastric emptying of solids in 8 normal dogs following administration of erythromycin, cisapride, and metoclopramide. A latin square experimental design was used to compare gastric emptying with and without treatment. The prokinetic agents were administered at clinically recommended doses 48 hours prior to the radiographic study. Barium-impregnated spheres were used as a measure of gastric emptying of solid particles. Radiographs were taken of each subject hourly until 90% or more of the markers had left the stomach. The mean % gastric emptying (%GE) averaged over time for the controls was 44.5%. The mean %GE for metoclopramide, erythromycin, and cisapride were 46.3%, 52.1%, and 53.1%, respectively. A Dunnett’s one-tailed T test was used to compare significant treatment effects. Of the three treatments, cisapride was shown to enhance gastric emptying rates (P < .05). Erythromycin showed a trend in increasing gastric emptying rates, but was not statistically significant. Metoclopramide did not
enhance gastric emptying in normal dogs. It can be concluded that erythromycin and cisapride may be superior to metoclopramide in enhancing gastric emptying in normal dogs.


For decades, radiopaque markers have been used to measure gastric emptying in people. In this report, the radiographic technique was used successfully on dogs with chronic postprandial vomiting to confirm gastric hypomotility.


Enteroplication has been recommended to prevent recurrence of intussusception in dogs and cats. This study investigated the impact of enteroplication on subsequent function of the plicated small intestine as measured by transit time of barium impregnated polyethylene spheres (BIPS) and compared two methods of achieving enteroplication - sutures using polydioxanone and cyanoacrylate tissue adhesive. Twenty-two healthy young cats were used - four controls, nine sutured and nine glued. The mean +/- SD transit times before, one week after and four weeks after enteroplication were respectively 2.0 +/- 0.80 hours, 1.6 +/- 0.80 hours, 2.2 +/- 1.18 hours. There was no significant difference in transit time or in the time to create enteroplication in the two plicated groups. Maintenance of intestinal adhesion was greater for the sutured plications. There was no significant change in internal diameter with either technique. Adverse clinical signs after enteroplication were not severe, however, they were more prevalent in cats which had glued plication. The inflammation associated with the suture was of a greater depth initially but that associated with the adhesive was more widespread and persisted for the four weeks of the experiments. Enteroplication in cats was a relatively benign procedure which did not cause significant alterations in small intestinal function. However, cyanoacrylate tissue adhesive cannot be recommended for this clinical procedure.

The recovery of gastrointestinal motility was compared in dogs undergoing either laparoscopic or open sigmoidectomy. During surgery, bipolar recording electrodes were placed on the proximal and distal antrum, mid- and distal colon, and the rectum. Fasting myoelectric data were recorded postoperatively. Scintigraphic gastric emptying studies employing a solid test meal were performed before and after [postoperative day (POD) 2] operation. Ten radiopaque markers were given just before operation and retained markers were counted daily by abdominal x-ray. Gastric emptying on POD 2 was significantly delayed in the open group at 120 min compared with preoperative studies for the open group and compared with the laparoscopic group on POD 2 (P < 0.05 and P < 0.01, respectively). A significant difference in the number of retained markers was observed between the groups on POD 4 (P < 0.05). There were no significant differences in slow-wave frequency, presence of dysrhythmias in the proximal and distal antrum, or presence of either discrete or continuous electrical response activity in the colon and rectum between groups on any days. We conclude that using a laparoscopic approach results in more rapid recovery of fed-state gastrointestinal motility following colon resection. These data also suggest that myoelectric activity alone is not a sensitive enough parameter to detect these differences in recovery in this animal model.

Human Clinical Abstracts – a few examples of numerous radiopaque marker publications


Gastric emptying was studied using radiopaque markers in 10 men with end-stage renal disease on continuous ambulatory peritoneal dialysis and in 15 normal men. Dialysis patients were studied twice, once without peritoneal dialysate in the abdomen (drained) and once with 2 litres of dialysate in the abdomen (full). Each normal man and 9 of 10 dialysis patients, when drained,
emptied all 10 markers by 6 h after a test meal. In contrast, 5 of the 10 dialysis patients, when full, had delayed emptying of radiopaque markers.


Confirming partial small bowel obstruction is often a diagnostic challenge. In this case report, 4 mm solid radiopaque markers were used in 4 patients to show partial small bowel obstruction. Results of enteroclysis were normal in 2 of the 4 patients, and the markers were used to challenge suspected partial obstruction. The markers coalesced in the region of the partial obstruction, which was confirmed at surgery. Enteroclysis is the examination of choice in the diagnosis of partial small bowel obstruction. However, examinations with false negative results can occur, particularly with adhesive and/or intermittent obstructions. The use of radiopaque markers in these cases proved an effective and useful method of establishing the diagnosis of partial small bowel obstruction, particularly in the 2 cases in which enteroclysis results were normal. Prospective studies are needed to establish the feasibility of this novel technique.


149 patients (18-81 years old, 84% women) with chronic constipation, attending 2 gastroenterology departments in Munich, Germany, between January 1988 and March 1993, were treated with Plantago ovata seeds, 15-30 g/day, for at least 6 weeks. Repeated symptom evaluation, oro-anal transit time measurement (radiopaque markers), and functional recto-anal evaluation (proctoscopy, manometry, defecography) were performed. Patients were classified on the basis of the result of dietary fibre treatment: no effect (n=84); improved (n=33) and symptom free (n=32). 80% of patients with slow transit and 63% of patients with a disorder of defecation did not respond to dietary fibre treatment, whereas 85% of patients without a pathological finding improved or became symptom free. It is concluded that slow gastrointestinal transit and/or a disorder of defecation may explain a poor outcome of dietary fibre therapy in patients with chronic constipation. High dose fibre treatment should be conducted before technical investigations are performed.

Background: Irritable bowel syndrome (IBS) has been identified as a physiologic abnormality, but no test has been established as a diagnostic standard for gastrointestinal dyskinesia in IBS patients. The aim of this study was to investigate gastrointestinal motility in patients with IBS by using radiopaque markers. Methods: Gastrointestinal motility was studied in IBS patients (n = 72), constipation patients (n = 19), diarrhoea patients (n = 9), and healthy controls (n = 23). Using three types of radiopaque markers, analysis was performed to establish the transit time and a new indicator, the 'scattering index'. Results: Transit times were not characteristic in IBS. The patients with IBS had significantly higher scattering indexes in the colon and total gut than the healthy controls and the patients with constipation and diarrhoea. The transit time and scattering index of the colon were linearly correlated in the healthy controls and the constipation and diarrhoea patients but were not correlated in the IBS patients. Using transit time and scattering index was a reliable means of evaluating gastrointestinal motility in IBS patients, with a sensitivity of 65% and a specificity of 96%. Conclusion: Three days' use of the radiopaque marker method was useful for providing an objective means of detecting gastrointestinal dysmotility in IBS patients.


Background: Abnormal gastric slow-wave frequencies have been observed in diabetic gastroparesis. To evaluate the effect of cisapride on gastric dysrhythmia and emptying of indigestible solids, 20 type-II diabetic patients with symptoms suggestive of gastroparesis were enrolled in this study. Methods: Cutaneous electrogastrography, gastric emptying of radiopaque markers, and evaluation of upper gastrointestinal symptoms were performed before and after administration of an 8-week course of cisapride. Results: The fasting-state percentages of dominant frequency in normal and tachygastric ranges improved significantly after an 8-week course of cisapride treatment (P<0.01 and P<0.05, respectively). The post-meal percentages of dominant frequency in the tachygastric range also improved significantly after cisapride
treatment (P<0.05). The upper gastrointestinal symptoms score decreased significantly, and gastric emptying of radiopaque markers also increased significantly after 8 weeks of cisapride treatment (P<0.01). Conclusions: In conclusion, this study showed that cisapride can improve gastric dysrhythmia during both fasting and post-meal phases in patients with diabetic gastroparesis. In addition, upper GI symptoms and gastric emptying of indigestible solids may also show significant improvement after 8 weeks of cisapride treatment.


Background: Gastrointestinal symptoms without demonstrable lesions in the upper gastrointestinal tract are common in diabetic patients; Scintigraphic liquid-and solid-phase gastric emptying studies and gastric emptying of indigestible particles were performed to determine the gastric emptying function in type-II diabetes mellitus patients with dyspepsia. Methods: Twenty type-II diabetic patients with symptoms suggestive of delayed gastric emptying were included. A gelatin capsule containing 10 rod-shaped radiopaque markers was ingested, along with the solid-phase test meal, to assess the emptying of indigestible particles. Scintigraphic liquid-phase gastric emptying studies were performed on a separate day. Results: There were 7 patients (35%) with delayed liquid-phase gastric emptying, 14 patients (70%) with delayed solid-phase gastric emptying, and 14 patients (70%) with abnormal gastric emptying of indigestible particles. There were only three patients (15%) with normal gastric emptying of both the liquid and solid phase. Furthermore, only one patient showed normal results in all three gastric emptying studies. Conclusions: For determining abnormalities in gastric emptying function for type-II diabetic dyspepsia patients, comprehensive gastric emptying studies, including scintigraphic liquid-and solid-phase gastric emptying studies and gastric emptying of indigestible particles, are most helpful.
Appendix 3

Reference Intervals for BIPS

Healthy Dogs. Small BIPS. No Food

Healthy Dogs. Large BIPS. No Food
Healthy Dogs. Small BIPS fed with Hills Prescription Diet r/d.

Healthy Dogs. Large BIPS fed with Hills Prescription Diet i/d.
Healthy Dogs. Small BIPS fed with Hills Prescription Diet d/d.

Healthy Dogs. Large BIPS fed with Hills Prescription Diet d/d.
Healthy Cats. Small BIPS. No Food.

Healthy Cats. Large BIPS. No food.
Healthy Cats. Small BIPS fed with Hills Prescription Diet d/d.

Healthy Cats. Large BIPS fed with Hills Prescription Diet d/d.
Healthy Cats. Acepromazine sedation.
Small BIPS fed with Hills Prescription Diet d/d

Healthy Cats. Acepromazine sedation.
Large BIPS fed with Hills Prescription Diet d/d.
Box plot depicting the gastric emptying of the small BIPS at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines).

Box plot depicting the gastric emptying of the large BIPS at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines).
Box plot depicting the orocolic transit rate of the small BIPS at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines).

Box plot depicting the orocolic transit rate of the large BIPS at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines).
Box plot depicting percentage of small BIPS in the proximal colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines).

Box plot depicting percentage of large BIPS in the proximal colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and maximum and minimum values (lines).
Box plot depicting percentage of small BIPS in the distal colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and range (lines). Note – BIPS in the rectum are not counted in the numerator.

Box plot depicting percentage of large BIPS in the distal colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and maximum and minimum values (lines). Note – BIPS in the rectum are not counted in the numerator.
Box plot depicting percentage of small BIPS in the total colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and maximum and minimum values (lines). Note – BIPS in the rectum are not counted in the numerator.

Box plot depicting percentage of large BIPS in the total colon at different times after administration in dogs fed Hills r/d diet. The graph shows median values, upper and lower quartiles (bars) and maximum and minimum values (lines). Note – BIPS in the rectum are not counted in the numerator.
Healthy Cats. Small BIPS fed with Hills Prescription diet r/d.

Healthy Cats. Large BIPS fed with Hills Prescription Diet r/d.
Filling of proximal colon with small BIPS in cats fed Hills r/d.

Filling of the proximal colon with large BIPS in cats fed Hills r/d.
Filling of the descending colon with small BIPS in cats fed Hills r/d.

Filling of descending colon with large BIPS in cats fed Hills r/d.
Filling of total colon with small BIPS in cats fed Hills r/d.

Filling of total colon with large BIPS in cats fed Hills r/d.
BIPS study in a dog- obstruction.

Close up showing 'gravelling sign' and dilated bowel loops supporting proof of an obstruction.

Profound delayed gastric emptying in a cat

Air enema outlines colon showing the BIPS are in the colon - no obstruction

Barium study in a vomiting dog

Adynamic ileus in a cat with renal failure- radiograph taken 36 hours after administration- very slow transit but no bunching

✔ For an accurate in-clinic diagnosis of gastrointestinal obstructions & motility disorders in cats and dogs.

✔ Reduces the need for exploratory surgery.

✔ BIPS are administered easily in food or by mouth.

BIPS... The safe, economical, practical diagnostic procedure, individually packaged to meet the needs of concerned veterinarian’s world wide!