

COMMON QUESTIONS ABOUT BIPS

A MANUAL FOR NEW AND EXPERIENCED “BIPERS”

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What are BIPS?

Key point

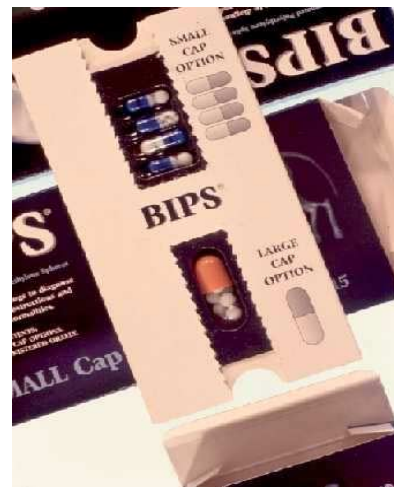
BIPS are an innovative contrast agent for the diagnosis of GI obstructions and motility disorders

❖ 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”?

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

One of the most stressful decisions a veterinarian faces is ruling out an obstruction. BIPS greatly help this decision.

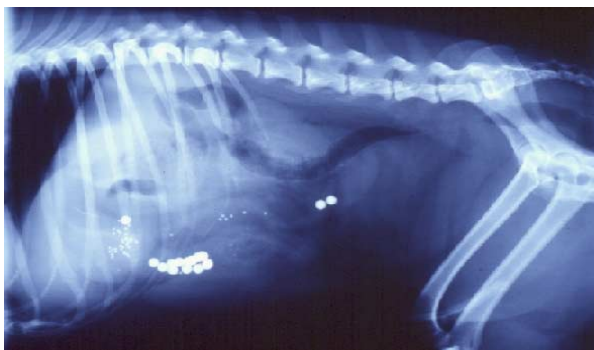
What are the indications for performing a BIPS study?

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

**Legend:**

Spot the obstruction in this vomiting dog.

**Legend:**

There it is! The majority of the large BIPS have accumulated road of an obstruction in the duodenum. See Case 2 for more details.

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.

Key Point

BIPS have a number of important advantages over liquid barium but don't replace this technique

❖ **How do BIPS compare with other diagnostic methods?**

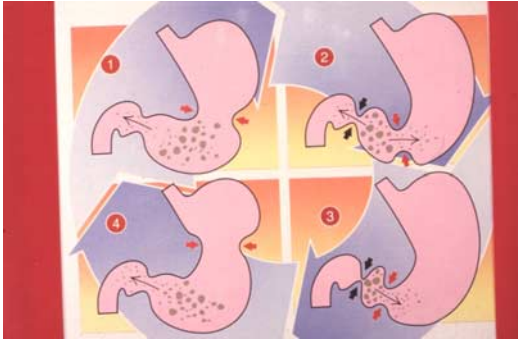
BIPS do not replace any currently available diagnostic modalities. Rather, they are a valuable alternative approach. The BIPS are of more value to private practitioners than clinicians working in well-equipped referral institutions because the diagnostic spectrum of ultrasound and scintigraphy overlap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

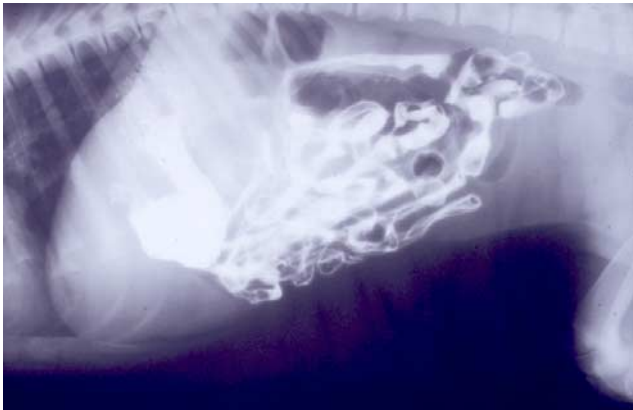
Gastrointestinal obstructions are rarely complete. In the small intestine, clinical signs usually begin once the bowel lumen has been reduced to a diameter of approximately 5 mm. This is the diameter of the large BIPS. These settle in the stagnant loop in front of the obstruction unlike liquid barium 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.

Key Point

Primary & secondary disorders of GI motility are collectively common. BIPS provide the only convenient and accurate way to diagnose such disorders.

❖ 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.

Common questions about the administration of BIPS

Key point

Perform BIPS studies on an empty stomach in acute GI presentations and with Hills d/d, i/d or r/d for diagnosis of chronic GI problems

❖ 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?

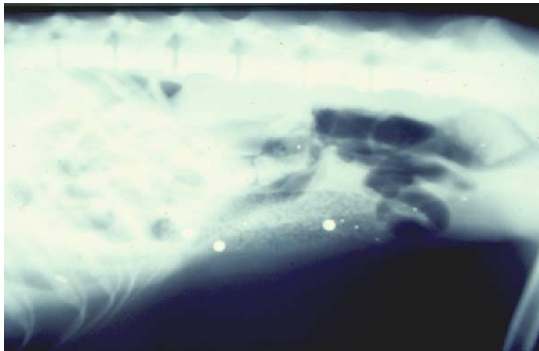
BIPS are usually given with d/d or i/d during the work-up of chronic vomiting or small bowel-type diarrhea. The study is performed with food because in animals with chronic gastrointestinal complaints, clinicians are often interested in ruling out both obstructions and motility disorders. The transit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

Key point

BIPS must be used with the Hills diets recommended by the manufacturer or the BIPS reference curves will be invalid

❖ **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 oral of the partial obstruction slowing the transit of BIPS and increasing the chance of detecting the partial obstruction. However, the accumulation of the fiber oral of the obstruction can worsen the signs of obstruction. For this reason, BIPS are not given routinely with r/d.

**Legend:**

Subtle partial obstruction in a dog revealed by administering BIPS with Hills r/d. A previous study using BIPS administered with Hills i/d resulted in a transient bunching of the BIPS in the small intestine and a subtle delay of their orocolic transit. When the study was repeated with r/d the accumulation of the fibre oral of the narrowed segment made the diagnosis

❖ **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.

<p>Key point Attempting to rush BIPS studies is a common reason for misdiagnosis</p>

Common questions about radiographic technique for BIPS studies

❖ 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.

❖ **Are two views of the abdomen required?**

Key Point

Never attempt to interpret a BIPS study without 2 views.

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 tranquilized 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?

Key Point

The transit rate of BIPS can be accelerated or slowed by drugs.

❖ 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.

❖ **Can I use tranquilizers 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

Key Point

Transit calculations are straight forward but are of less importance in diagnosing obstructions than motility disorders.

❖ 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.

❖ 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.

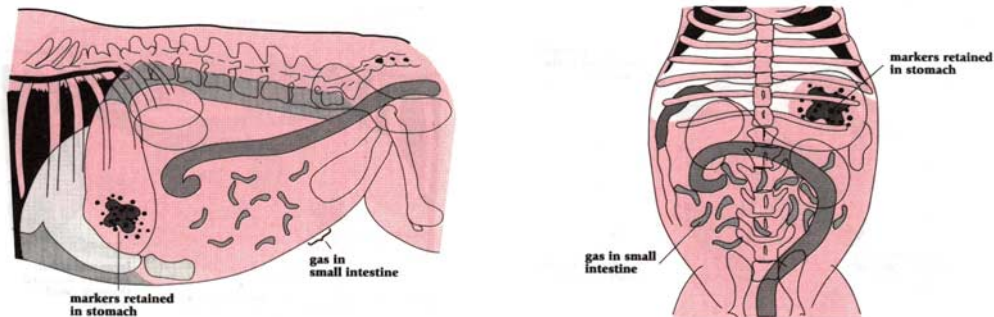
Interpreting BIPS studies – specific radiographic patterns

Key Point

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

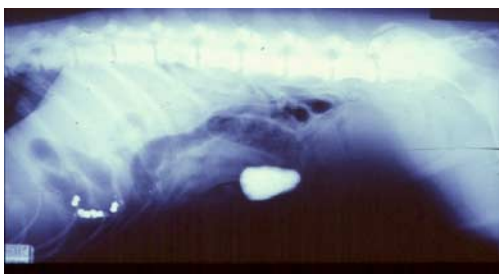
❖ Retention of large and small BIPS in the stomach

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.



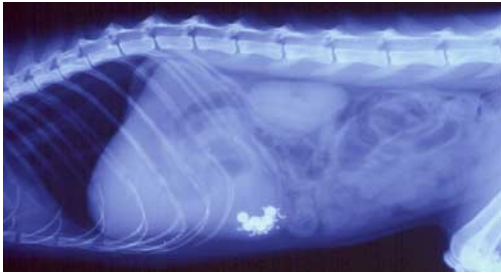
Legend:

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

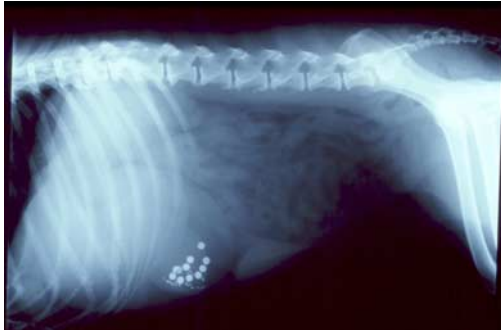


Legend:

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.

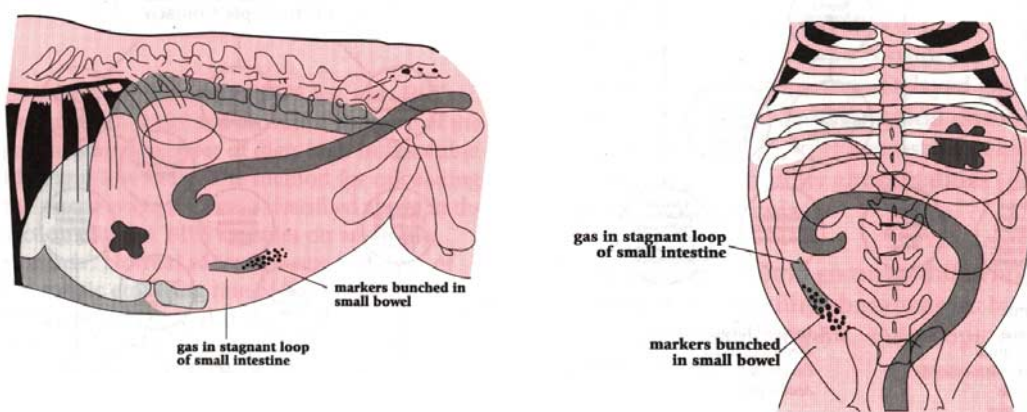
Key Point

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

❖ Delayed orocolic transit with bunching of BIPS in the small intestine

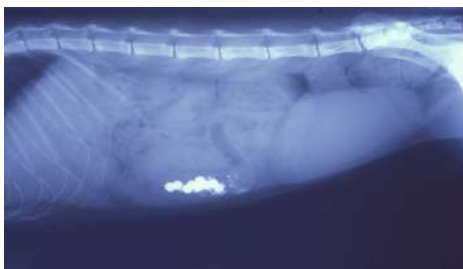
Persistent bunching of BIPS in the small intestine is highly suggestive of physical obstruction of the small bowel, particularly if the markers have bunched in a dilated loop of small intestine or "gravelling" is apparent. Gravelling refers to the accumulation of indigestible ingested material (such 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.



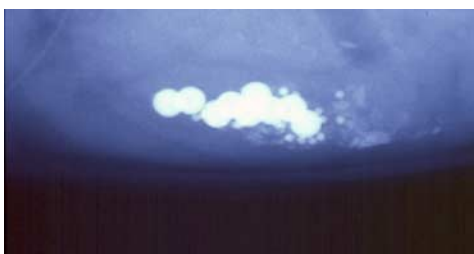
Legend:

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.

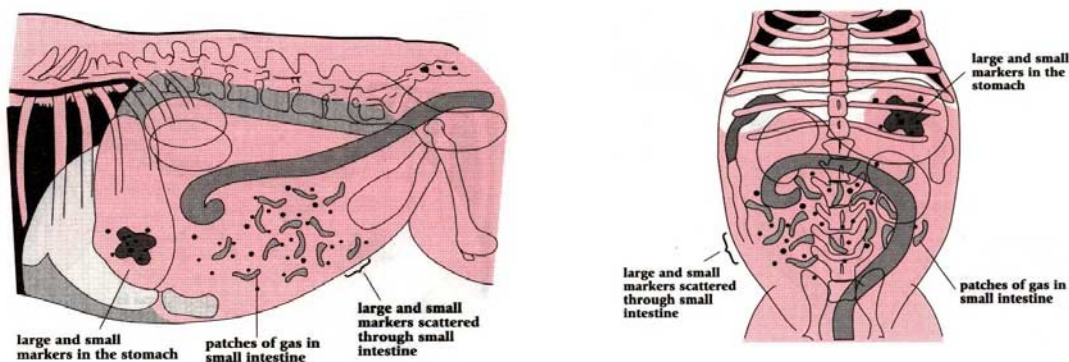


Legend:

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

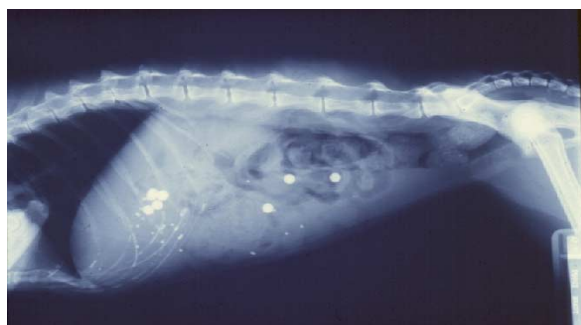
❖ Delayed gastric emptying and orocolic transit without bunching of the BIPS

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.

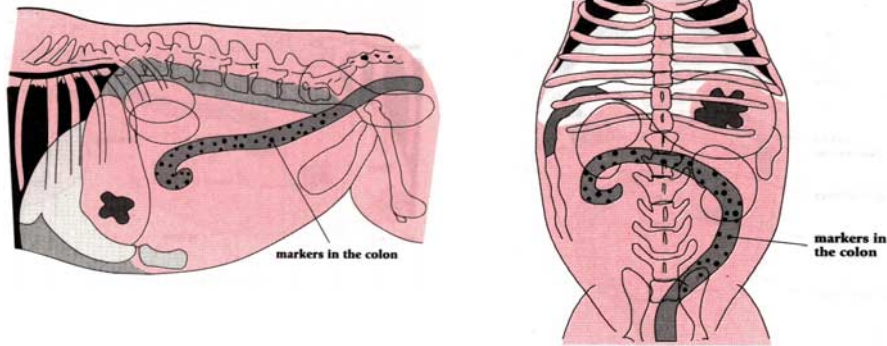
Key Point

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**

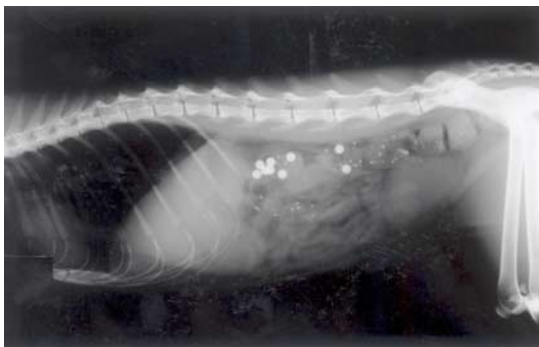
If the rate at which the BIPS leave the stomach and arrive in the colon is within the reference intervals provided by the manufacturer, the patient's clinical signs are unlikely to be due to obstruction of the bowel or motility disorders such as delayed gastric emptying or gastric dumping. However, a 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

Key Point

An air enema is a simple method to determine if BIPS have reached the colon if their position is uncertain on the survey radiographs.

❖ 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").

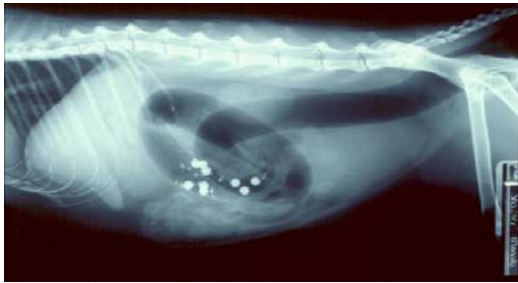
❖ How can I be sure BIPS are in the colon?

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)



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.

❖ **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.

Key Point

Bunching of BIPS without supportive radiographic evidence of obstruction requires careful interpretation.

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 oral 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

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.

Key Point

A BIPS study is a safe way to rule out a linear foreign body.

❖ **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.

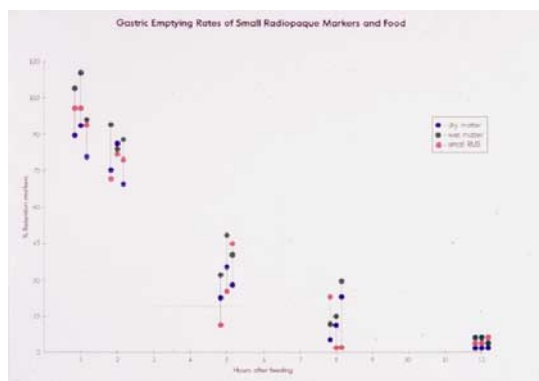
Key Point

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

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.



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.