Medical devices in the abdomen and pelvis are probably less frequently seen than those in the chest or extremities, but they are important and should be recognized. These devices can be grouped into a few major categories: intestinal tubes, genitourinary devices, postoperative apparatus, and a wide variety of odds and ends. Many of these devices are used to monitor or treat gastrointestinal and genitourinary disease. Some of them, such as inferior vena cava filters and drug infusion pumps, treat systemic problems, and some of them are devices used in treating another anatomic region. It is strongly recommended that scout views for chest, abdominal, and pelvic computed tomographic studies be carefully examined for medical apparatus. Medical devices are often more easily recognized on scout images, and their inappropriate locations and complications can be better appreciated on the subsequent cross-sectional images if one is alerted to their presence in the first place. The evaluation of routine medical devices should be considered as important as any other aspect of a radiologic examination.

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Abbreviations: PEG = percutaneous endoscopic gastrostomy, IUD = intrauterine contraceptive device, TIPS = transjugular intrahepatic portosystemic shunt

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Introduction
The abdomen and pelvis contain a complex array of gastrointestinal and genitourinary organs as well as supporting musculoskeletal structures. A moderate variety of devices are used to treat or monitor abdominal and pelvic disease, and many devices are evident in the abdomen and pelvis as incidental findings. It is often too easy to overlook seemingly innocuous and routine medical devices because of rushing to examine the cross-sectional images to assess the patient’s problems. Their evaluation should be considered as important as any other aspect of a radiologic examination.

Although the numbers and types of abdominal devices are less than those for the bones and joints and the chest, abdominal and pelvic medical devices are nevertheless quite common and important. These devices can be easily grouped into a few major categories for simplification. They consist of intestinal tubes, genitourinary devices, postoperative apparatus, and a wide variety of odds and ends.

Gastrointestinal Tubes
Stomach tubes and intestinal tubes have long been employed to decompress the stomach and small intestine. They are also useful for sampling bowel contents and for providing an access for patient nutrition. The most familiar intestinal tube is the large-bore, somewhat stiff, traditional nasogastric tube, which is ubiquitous in hospitals and clinics (Fig 1). It is used for only temporary bowel decompression and fluid sampling.

Small, soft, flexible enteric tubes (feeding tubes) are used to feed chronically ill patients over long periods of time. The larger-bore nasogastric tubes are constructed from polyethylene or polyvinyl chloride that tends to harden if left in the stomach or small intestine for a long period, predisposing the patient to mucosal injury and bowel perforation. Feeding tubes, on the other hand, are constructed of biocompatible plastic, silicone, or other suitable materials designed for patient tolerance and extended use. They usually have flexible metallic tips, which provide a lead point for peristalsis to move the tube through the stomach into the small intestine. Ideally, feeding tubes should be located beyond the stomach in the distal duodenum or proximal jejunum to prevent buildup of fluid within the stomach, which could lead to aspiration (Fig 2).

In prior years, long intestinal tubes, such as the Miller-Abbott or Cantor tube, were used for bowel decompression, particularly in cases of small bowel obstruction. These tubes are no longer used (1). The Miller-Abbott tube was a double-lumen, radiopaque rubber tube with one lumen for bowel decompression and a second lumen to provide a route for injecting mercury into a weighted balloon at the end of the tube. The weighted balloon was designed to help peristalsis “pull” the end of the tube farther distally in the intestinal tract. Similar tubes, such as the Maglinte tube and the multipurpose diagnostic and enteroclysis (MDEC) tube (Mallinckrodt, Hazelwood, Mo), have replaced the Miller-Abbott tube and are designed for enteroclysis or treatment of small bowel distention (2). The Maglinte tube...
was specifically designed for enteroclysis and has an expandable balloon that is used to occlude the small bowel lumen to prevent reflux of fluid into the stomach. The multipurpose (diagnostic and therapeutic) MDEC tube is a closed-end triple-lumen tube made of radiopaque polyvinyl chloride. Its largest lumen is used for suction or fluid installation, and its medium-sized lumen is a sump port, which is connected to the larger lumen by small holes proximal to a weighted tip. The smallest lumen acts as a balloon inflation port. When the balloon is inflated, it prevents the proximal migration of fluid and barium into the stomach during enteroclysis.

Intestinal tubes are safe and effective in most cases. Radiologists should be aware of their proper location and functions. Complications, although rare, include perforation of the gastrointestinal tract, inadvertent placement in the lungs, gastrointestinal hemorrhage, and aspiration of gastrointestinal contents caused by improper tube placement and monitoring (3–5).

Gastrostomy and jejunostomy tubes (Figs 3–5) are surgically, endoscopically, or percutaneously placed in patients who require very long-term, sometimes permanent, assisted feeding. These tubes may be placed in either the stomach or the proximal jejunum. They may be inserted with a combination of endoscopic and percutaneous radiographic techniques (percutaneous endoscopic gastrostomy [PEG]) tubes), or, in some patients, only an open surgical procedure can be used to place the tubes (6). Patients requiring a gastrostomy or jejunostomy tube typically have an esophageal or gastric obstruction or severe neuromuscular problems that render them unable to swallow effectively.
Once a gastrostomy tract has matured after many weeks, the PEG tube can be removed and a PEG button inserted (Fig 4). This button is placed in the anterior abdominal wall, with its rounded acornlike end fastened in the stomach. The capped end sits on the abdominal wall and is available for feedings, insertion of tubes, or withdrawal of stomach contents.

Genitourinary Devices

Urinary Stents
Urteral stents are the most common type of urinary stent (Fig 5). They are designed to traverse an area of ureteral obstruction caused by benign or malignant disease and to allow urine to flow unimpeded into the bladder. Urteral stents are also used to bypass areas of ureteral dehiscence, to bypass obstructing calculi, and to help with fistula healing. These stents may be inserted either percutaneously in an antegrade fashion or in a retrograde fashion at cystoscopy. The most common design for a ureteral stent is the double-pigtail configuration, with one pigtail residing in the renal pelvis and the other in the bladder. Uteral stents can perforate the genitourinary tract, cause severe bleeding, be a source of sepsis, or be a site for calculus formation. Stents should be monitored while in place and promptly removed when no longer needed. They also must be changed periodically if they are to be left in place for long periods (7).

Urethral and bladder neck stents and artificial urinary sphincters are uncommon, but they may occasionally be seen in the bladder neck or in the urethra (Fig 6). They are used to bypass benign or malignant strictures or to provide for healing of dehisced wounds and to treat fistula formation (8).

Artificial urinary sphincters replace the function of the natural urinary sphincter in patients with sphincter damage or neurologic disease. They are most commonly used to treat patients with urinary incontinence following surgery for prostate cancer (8). They are sometimes used in combination with a bladder neck stent. A typical design includes a urethral cuff at the bladder neck or proximal urethra. The cuff is attached to a pump and fluid balloon reservoir. The pump resides in the scrotum and can be manually used to inflate or deflate the urethral cuff by redistributing the fluid in the balloon reservoir. Inflation of the cuff constricts the sphincter, and deflation of the cuff allows urine to leave the bladder and flow through the urethra.
Foley Catheters

Frederick E. B. Foley and Charles Russell Bard developed the first balloon catheter to treat urinary discomfort nearly 100 years ago. Their device evolved into the common present-day Foley catheter. The Foley catheter (or indwelling bladder catheter) is one of the most universal medical devices used in the human body (Fig 7a). If a patient is judged to need a nasogastric tube, he or she is often given a Foley catheter as well. These catheters are made from soft plastic or rubber and come in a large variety of sizes. The Foley catheter consists of a simple tube to which is attached a balloon that is inflated to keep the catheter in place in the bladder. The balloon may be filled with sterile saline, sterile water, or air. Unless the balloon is filled with air or there is contrast agent within the bladder, the catheter is usually not visible radiographically.

Figure 5. Bilateral ureteral stents in a 61-year-old woman. Abdominal radiograph shows the left ureteral stent, which was placed in an antegrade fashion (the tapered end is in the bladder), and the right ureteral stent, which was placed in a retrograde direction (the tapered end is in the renal pelvis). There is also a surgically placed gastrostomy tube with a Malecot tip (G), a left colostomy (O), and a flat silicone drain (D) in the pelvis.

Figure 6. Drawing illustrates the position of the UroLume Endourethral Wallstent prosthesis in the bulbous urethra. (Courtesy of American Medical Systems, Minnetonka, Minn.)

Figure 7. (a) Photograph shows a typical Foley catheter. (b) Pelvic radiograph shows a suprapubic catheter (arrows), which is made visible by the surrounding contrast material in the bladder.

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Foley catheters are used to decompress a distended bladder, collect urine, and monitor patient urine output. Some Foley catheters include a temperature probe to monitor the patient’s urine (body) temperature. The temperature probe, which is an electrically insulated thermistor, is placed in a secondary lumen, with the sensing end near the tip of the catheter (9). Foley catheters are intended for short-term use. At times, long-term urinary drainage is needed. Such treatment is often accomplished by placement of a suprapubic indwelling catheter (Fig 7b). These catheters are placed surgically or percutaneously and are typically sewn in place and attached to a drainage bag.

Nephrostomy Tubes
Surgical and percutaneous nephrostomy drainage of the kidneys is a common procedure. The usual indications for a nephrostomy include external drainage of the renal collecting system in a patient with a high-grade urinary tract obstruction, provision of an access route for placement of a ureteral stent, provision of a route for extraction of a renal or ureteral calculus, treatment of a urinary tract infection superimposed on a urinary obstruction, and treatment of urinary tract leaks and fistulas. Percutaneous placement of a nephrostomy tube is generally preferred to surgical placement and is highly successful most of the time (10,11). Several catheter types may be used for a nephrostomy, including simple angiographic catheters, pigtail catheters, and self-retaining catheters (Fig 8). In the past, the Malecot (mushroom- or tulip-shaped catheter tip) was popular. Today, catheters with a self-retaining design are more common.

Contraceptive Devices
Intrauterine contraceptive devices (IUDs) are a very popular form of contraception worldwide, although their use in the United States is more limited. Most of the previously popular IUDs have been withdrawn from the U.S. market. Nevertheless, IUDs no longer marketed in the United States may still be found in women who keep them in place for many years (Fig 9). IUDs are usually visible on radiographs, and they are recognizable on ultrasonographic (US) and computed tomographic (CT) images if one is familiar with their appearance. They should be located centrally in the uterine canal (12) (Fig 10).

There are two main types of IUDs available in the United States at this time: the Copper Para-

Gard T 380A, a high-dose copper-releasing device (FEI Products, Tonawanda, NY), and the Mirena, a progesterone-releasing device (Berlex, Montville, NJ). All these devices have a somewhat similar T-shaped configuration on radiographs (Fig 10a). They may perforate the uterine wall and become free floating in the peritoneum. In such cases, they are left in place if the patient is asymptomatic and has no signs of infection (13). An IUD carries a risk of causing a miscarriage or premature birth if a patient becomes pregnant.
while an IUD is in place. In such cases, the IUD should be removed regardless of whether the pregnancy is continued. IUDs also increase the risk of a possible ectopic pregnancy.

Although it is not an abdominal or pelvic device, the Norplant contraceptive implant (Wyeth Pharmaceuticals, Madison, NJ) is occasionally encountered during patient examination. The implant consists of six, small, long, thin drug capsules placed in a radial fan distribution in the subdermal tissues of the forearm or upper arm. These capsules release a steady small amount of levonorgestrel, a synthetic progestin. The Norplant implant provides effective birth control for up to 5 years. Norplant capsules are difficult to visualize on radiographs, and they may be difficult to see on US images unless one is aware of their presence (14). Fortunately, the Norplant capsules are usually easily palpated and removed by means of local incision.

The hormonal contraceptive vaginal ring consists of a transparent, flexible polymer ring that releases a continuous low dose of etonogestrel and ethinyl estradiol that is absorbed in the systemic circulation through the vaginal mucosa. The ring is inserted into the vagina between the 1st and 5th days of the menstrual cycle and is left in place for 3 weeks. The ring is then removed, and after 1 week, a new ring is inserted. Vaginal rings are radiolucent and not easily noted on radiographs or even on CT scans. On CT scans, a vaginal ring appears as a low-attenuation circular ring (15). Its shape and appearance are similar to those of a pessary, but it is smaller and may lie in any orientation in the vagina. Pessaries are usually placed only in older multiparous women with pelvic laxity.

**Tubal Ligation and Vasectomy Devices**

Tubal ligation and vasectomy are common forms of birth control. They usually do not have any specific radiographic findings, but occasionally surgical clips may be evident in the pelvis or in the scrotum from these procedures. Sometimes, special tubal ligation clips may be evident (Fig 11). A new metallic implant, the ESSURE device (Conceptus, San Carlos, Calif), has also been developed for permanent contraception. It is a small, expanding microcoil placed in the proximal portion of the fallopian tube. It incites a benign tissue ingrowth, which anchors the device and permanently closes the fallopian tube. It is safe for women with IUDs, vaginal rings, tubal ligation clips, and ESSURE devices to undergo magnetic resonance imaging with static magnetic fields of 1.5 T or less (16,17).

Figure 10. (a) Pelvic radiograph shows a typical IUD (arrowhead). A tampon (arrow) is present in the vagina. (b) Sagittal transvaginal pelvic US image shows a linear region of marked echogenicity (*), the normal appearance of a properly situated IUD. (c) Pelvic CT image of a different patient shows a normal IUD.
Pessaries
Pessaries have been used for over 100 years to treat vaginal and uterine prolapse. They are simple mechanical devices inserted in the vagina and left in place for long periods, even years (Fig 12). Pessaries are designed to press against the wall of the vagina to uplift and displace the bladder forward or to support a prolapsed uterus or vagina (18). A pessary is usually placed in the most posterior aspect of the vagina around the cervix. Even though pessaries are safe and effective, they have largely been replaced by modern surgical treatment for uterine prolapse.

Penile Prostheses
Many types of penile prostheses have been used over the years, but their popularity has decreased since the introduction of effective medications for erectile dysfunction (19,20). Some penile prostheses have semirigid, malleable cores, which are placed in the corpora cavernosa (Fig 13). With such prostheses, the patient has a permanent erection. Other designs allow the patient to control his erection by using an inflatable prosthesis. This device consists of two distensible cylinders implanted in the corpora cavernosa. The cylinders are distended by fluid, to which watersoluble contrast material is added to make them visible. The fluid is pumped into the corporal cylinders from an implantable reservoir located in the abdomen, pelvis, or thigh. There are a series of valves, which are manually controlled by the patient to regulate fluid flow in and out of the corporal implants to control erections.

Tandem and Ovoid Implants for Gynecologic Brachytherapy
Brachytherapy involves placement of implants or radiation sources inside the patient. Brachytherapy is quite useful for treatment of gynecologic tumors, such as cervical and ovarian neoplasms, whereby radioactive cesium or iridium is placed inside or adjacent to the uterus and cervix. This type of therapy is often combined with external...
Three types of applicators are used for gynecologic brachytherapy: tandems, ovoids, and cylinders (Fig 14). The tandem is a metal tube placed in the uterus to treat that area. Ovoids are round, hollow holders that are placed in the vagina on both sides of the cervix, and cylinders are hollow holders that are placed in the vagina. Various combinations of tandems, ovoids, and cylinders may be used for a specific patient. Their exact placement is important and is generally determined by the radiation oncologist caring for the patient (21).

Residual Thorotrast Deposits

A 20% colloidal suspension of thorium dioxide (Thorotrast) was a common contrast agent in the 1930s and 1940s until its discontinuance in the 1950s because of concerns about its safety. Thorotrast produced excellent radiographic contrast, but thorium is radioactive, and Thorotrast was found to induce various neoplasms, particularly cholangiocarcinoma, hepatocellular carcinoma, and liver angiosarcoma. It also caused local and distant fibrosis, cirrhosis, and veno-occlusive disease (22). Even at this late date, there are still some patients alive who have residual Thorotrast in their reticuloendothelial system. Because it was a colloidal suspension, Thorotrast tended to accumulate in lymph nodes, the spleen, and the liver, and it has a characteristic appearance (Fig 15).
Postoperative Surgical Apparatus

Surgical apparatus is frequently visible in patients after abdominal and pelvic operations. Commonly seen materials include large rubber abdominal wall retention sutures, wire sutures, surgical drains, surgical staples, skin staples, vascular clips, and abdominal wound gauze packs and bandages (23–25).

Surgical Sutures, Staples, Clips, and Glue

Surgical sutures, staples, clips, and glue are ubiquitous findings on postoperative images. Major skin lacerations and surgical closure of the skin, subcutaneous tissues, and musculature after major surgery, no matter the body part, require the use of large skin and scalp sutures, vascular clips, and staples of various kinds (Figs 16, 17). The type used depends on the preference of the surgeon and the type of wounds being repaired. The technologic aspects for facilitating wound healing are advancing, and even special surgical glues may be used to close major surgical wounds with or without supporting sutures and staples.

It is sometimes difficult to tell whether a particular set of sutures or large staples are internal to the abdomen or pelvis or whether they are external and present in the skin and subcutaneous tissues. Some abdominal and pelvic surgeries leave behind recognizable signs, such as right upper quadrant clips from gallbladder removal and vascular clips in the pelvis from major prostate or bladder surgery. Vascular clips (hemostatic clips) are very popular (Figs 16c, 17b). They have a great range in size and are mainly used for rapid closure of bleeding vessels, although they may sometimes be used to mark the bed of a resected tumor or lymph node group. Many surgeons also use small surgical staples for various internal anastomoses, such as joining two portions of intestine together after bowel resection or repairing the lung after thoracic surgery (Fig 17).
Surgical Sponges

Radiopaque markers for surgical sponges have been used for years (23–27). The sponge body may be faintly visible on radiographs, but the radiopaque sponge marker provides an important means for radiographically identifying a sponge (Fig 18). Some sponges may be packed into an open wound, but the presence of a sponge after surgery should always be questioned, because in most cases they were inadvertently left inside the patient.

The most common, retained surgical foreign body is the rectangular, cotton laparotomy sponge (Fig 18a, 18c). This sponge is used to pack the corners of the exposed body cavity. It absorbs blood and other fluids. Its ribbonlike marker is characteristic and easily identified on abdominal radiographs, even though the strip often appears crenulated. An open wound that has been packed with such material should be well known to the doctors and nurses caring for the patient. Neurosurgical sponges used in spinal operative procedures are smaller and may be
more difficult to visualize, but they should all contain visible radiopaque markers. It is wise for radiologists to be familiar with the radiographic and CT appearances of the sponges used in their institutions.

**Surgical Needles and Other Miscellaneous Equipment**

There are many types of surgical needles, ties, and drains. These surgical devices have a standard appearance and function, and radiologists should become familiar with those items used at their own medical centers. Some surgical needles, such as those used for fine-detail plastic surgery and ophthalmology, may be only a few millimeters in size and are not easily recognizable because of their small size. Surgical ties are usually indistinct on radiographs, and, as previously noted, hemostatic clips and skin staples can have a similar appearance. Small internal surgical staples used for intestinal or pulmonary anastomoses appear similar to skin staples, except for their tiny size.

**Surgical Drains**

Surgical drains remove blood and extracellular fluid to facilitate wound healing. They are designed to remove fluid collections that could otherwise lead to an infection, abscess formation, or wound breakdown. The use of drains for a particular procedure and the type of drain employed are subject to the experience of the individual surgeon, and it is often a matter of considerable debate. Most drains are radiopaque, and there are three general types: closed-wound suction drains, gravity drains, and sump drains (Figs 5, 19a).

Closed-wound suction drains produce a constant level of suction, often with a choice of suction pressures. Usually, there is an internal drainage catheter attached to an evacuator bottle or collector. Closed-wound suction systems use a soft, inert silicone drain. The drains come in round and flat designs and are of different lengths, hole patterns, and sizes for varying needs. Generic terms used for these drains by surgeons are Jackson-Pratt drains or JP drains. Sometimes, the appearances of a retained surgical sponge and a flat silicone drain may be similar and cause confusion (28).
Gravity drains rely on gravity and fluid tension dynamics to drain fluids away from surgical beds. Traditional gravity drains include the Penrose and T-tube drains. Penrose drains vary in length and width, and they are probably more familiar to many physicians as tourniquets rather than as drains. T-tubes are most often used for bile duct drainage.

Sump drains often have a triple-lumen design. They have a large central lumen for maximum fluid removal, with a second lumen used to suction air into the drain site to maintain pressure for forcing the fluid out of the surgical bed or abscess cavity. The air intake is usually filtered to prevent bacterial contamination of the wound site, and the device often has a suture tab for suturing the drainage tube in place. The third lumen is used to irrigate the drain site and instill medication.

**Biliary Drainage Catheters and Stents**

Drainage of the biliary system is performed for relief of obstructive jaundice. It may be done percutaneously, surgically, or endoscopically, or it may be achieved through a combination of these techniques. The main indications for such drainage are obstructive jaundice with pruritus, sepsis, and deteriorating liver function. Biliary drainage is most commonly used as a palliative procedure for an unresectable malignancy, but benign strictures may be treated with biliary stents. In addition, biliary drainage may be used for preoperative decompression of the biliary tree or as a temporary procedure after surgery. Biliary drainage can be internal-external, such as a T-tube temporarily placed after gallbladder surgery. Alternately, it may consist of retrograde drainage only, with external drainage to a bag or sump tube, or it may be internal, with antegrade drainage of biliary contents via a stent going from the intrahepatic biliary tract to the duodenum.

Most biliary catheters and stents are sufficiently opaque to be visible radiographically (Fig 20). Their designs vary, and some of them are amenable to periodic replacement. However, the majority of biliary drains represent a permanently placed polymer or metallic stent used to bypass an obstructing neoplasm.

**Metallic Stents, Metallic Coils, and Embolic Materials**

Endoprosthetic stents composed of metals were originally designed for intravascular use, but they have been applied to other body systems. Stents have many applications, including treatment of benign and malignant lesions in the biliary tree and the gastrointestinal and genitourinary tracts, as well as treatment of atherosclerotic disease in the vascular system (29,30). Metallic stents are seen in the abdomen and pelvis, mainly in the biliary tree and the vascular tree. Angioplasty and stent placement are common treatment options for atherosclerotic disease in the femoral, iliac,
and renal circulation (Fig 21a). Endovascular stents are also being widely used for treatment of abdominal aortic aneurysms (Fig 21b).

Metallic and plastic stents have found varied use in the tracheobronchial tree, the esophagus, and the coronary artery circulation (31). Vascular stents are more common in the arterial system, but they are also used in major veins, such as the superior vena cava, for malignant and benign disease. Expandable stents are also used for treatment of benign and malignant gastrointestinal obstructions, such as strictures and tumors. Palliative relief of colonic neoplasms is sometimes performed with expandable stents.

Portosystemic shunting is an effective procedure in selected patients for treatment of refractory bleeding from esophageal and gastric varices. Portosystemic shunting may be performed surgically, but placement of a transjugular intrahepatic portosystemic shunt (TIPS) is often the preferred method of therapy. In these circumstances, a self-expanding metallic stent, such as a Wallstent, is deployed to form a bridge between a major portal vein and one of the hepatic veins (32). The stent is sometimes visible on radiographs, and it can be detected at US, which can often be used to establish the patency and flow rate through the stent (Fig 21c) (33).

There are many stent designs, and these are constantly being modified. Some of the stent designs more commonly encountered are the Wallstent (Boston Scientific, Natick, Mass), the Gianturco-Rosch Z stent (Wilson-Cook Medical, Winston-Salem, NC), and the Palmaz stent (Cordis, Miami Lakes, Fla). Correct identification of a particular stent by name would be difficult for a general radiologist, who does not perform interventional vascular procedures. However, the objectives of the general radiologist are not to give a correct name, but to recognize the presence of a...
stent and to reasonably ascertain its function and be aware of its potential complications, such as misplacement.

Transcatheter embolotherapy is a standard tool for treating arteriovenous malformations, for devascularizing tumors before their surgical removal, and for stopping or slowing life-threatening hemorrhage. There are many types of embolic materials, some of which are readily evident on abdominal and pelvic radiographs (Figs 21a, 22). Embolic metallic coils are especially common for controlling bleeding associated with pelvic fractures. Beside metal coils, small particles containing barium, tantalum, oil-based contrast material (Ethiodol), and detachable balloons may be apparent on radiographs. Many materials are not visible at radiography, and these include cyanoacrylates (glues), autologous blood clots, silicone spheres, powder and plugs of absorbable gelatin sponge (Gelfoam), fragments of polyvinyl alcohol, collagen particles, ethanol, hypertonic dextrose, thrombin, and other irritating clot-producing chemical agents.

**Inferior Vena Cava Filters**

Inferior vena cava filters are frequent findings on abdominal imaging studies (Fig 23). They have been widely used for the prevention of thromboembolism in patients with ongoing thromboembolic disease and who have failed heparin therapy or for whom anticoagulation therapy is contraindicated (34). These filters interrupt the transit of clots from the pelvis and lower extremities to the heart and lungs, while they maintain blood flow in the inferior vena cava. There are many types of these filters, and it is hard for the general radiologist to keep up with them and provide a specific name for a particular filter. However, such filters should be recognized, and their location noted. In most cases, inferior vena cava filters are placed in an infrarenal location to preserve the venous drainage from the kidneys, although they are sometimes placed higher if an inferior vena cava thrombus has extended above that level. The most common filters are the Greenfield filter (Boston Scientific), the bird’s nest filter, the Vena Tech filter (B. Braun Medical, Bethlehem, Pa), and the Simon Nitinol filter (NMT Medical, Boston, Mass). These filters were originally designed to be left in place for the duration of the patient’s life, but some newer designs allow temporary replacement and later removal.

**Vascular Grafts**

Vascular bypass surgery is performed in all parts of the body to treat severe atherosclerosis, vascular occlusions, vascular injuries, and aneurysms. Synthetic aortofemoral (iliac) bypass grafts and other vascular bypass grafts are quite common in the abdomen and pelvis. They are typically composed of Dacron, Gore-Tex, or similar materials.
Figure 24. Collimated view of the pelvis shows a Gore-Tex left femoral to right femoral artery bypass graft (white arrows) for an obstructed left iliac artery. There is also a Palmaz stent in the right external iliac artery (black arrow).

Figure 25. (a) Collimated frontal view of the lumbosacral junction shows a drop of Pantopaque contrast material (arrow) remaining from past myelography. Hemostatic clips and pedicle screws are also visible. (b) Collimated view of the upper abdomen in another patient shows Pepto-Bismol (arrows) in the stomach and jejunum. (c) CT scan of a third patient demonstrates lymphangiographic contrast material in the paracaval and paraaortic lymph nodes (arrows). (d) Frontal view of the pelvis in an elderly patient shows a colostomy (arrows), surgical clips from a prostate resection, and residual contrast material in scattered colonic diverticula.
Aortic aneurysms and aortic dissection are usually treated either with an interposition graft and removal of the diseased aorta or with an inclusion graft. For an inclusion graft, the graft is inserted in the diseased aorta, and the aorta is wrapped around the graft.

**Odds and Ends**

Many incidental devices and materials lie within or on top of the lower chest, abdomen, and pelvis. These items include foreign bodies, medications ingested by the patient, and unusual medical devices situated in an abdominal or pelvic location (24,31). Common items include pills in the upper or lower intestinal tract, Pepto-Bismol or similar medication in the stomach, colon and rectal decompression tubes, surgical cholangiography catheters, T-tube biliary catheters, biliary stents, small radiopaque markers to assess gastric emptying and bowel motility, patient restraint devices, ileostomy or colostomy bags, bowel biopsy devices, fetal monitoring equipment, and even residual contrast material from a remote lymphangiographic or myelographic examination (Fig 25).

A properly supplied patient history is often helpful for recognizing these mostly incidental findings. However, it is important to be able to distinguish between the different types of catheters overlying the abdomen, chest, and pelvis. For example, a feeding tube has an appearance similar to that of a pH probe, and intrathecal drug delivery catheters may superficially simulate ven-triculoperitoneal shunts. Ostomy pouches and drainage bags are often overlooked, or they may appear as confusing opacities. Their presence usually indicates a significant medical problem, such as a bowel resection for inflammatory bowel disease (Fig 25d).

Most oral medications are not visible on radiographs. On the other hand, enteric-coated pills and medicines containing heavy metals or halogenated compounds, such as iodies, are often visible radiographically (24). Commonly seen medications include potassium chloride pills, Pepto-Bismol tablets or liquid, iron tablets, some vitamin pills, and barium and iodine radiographic contrast agents (Fig 25b). Pantopaque (iophendylate) is an oil-based myelographic contrast material that has not been used for many years because it has been replaced with safer, low-osmolar water-soluble contrast agents. It forms droplets when mixed with body fluids and is only slowly absorbed by body tissues, remaining present for years. Even today, one can encounter patients who have visible droplets of Pantopaque in the spinal canal or along nerve roots from myelography performed several decades ago (Fig 25a). Ethiodol is another contrast agent that consisted of an ethidized oil, similar to Pantopaque. It was used for lymphography (lymphangiography), and it can remain visible in abdominal and pelvic lymph nodes for many years (Fig 25c).

**Tantalum Mesh**

Tantalum, a noncorrosive malleable metal, and Dacron and other similar materials are sometimes used as a mesh to repair abdominal wall hernias. Although tantalum mesh has a characteristic appearance, other materials may be difficult to recognize on abdominal and pelvic radiographs if a proper patient history is not available (Fig 26).

**Umbilical Arterial and Venous Catheters**

Umbilical arterial and venous catheters have been available for many decades, and they are commonly used in premature infants to administer fluids, parenteral nutrition, and antibiotic therapy. In a neonate with normal anatomy and catheter placement, an umbilical venous catheter passes through the umbilicus, umbilical vein, left portal vein, ductus venosus, middle or left hepatic vein, and inferior vena cava to the junction of the
inferior vena cava with the right atrium (Fig 27). The umbilical arterial catheter should pass through the umbilicus, umbilical artery, and common iliac artery into the aorta (Fig 27). The tip of the umbilical arterial catheter should be away from major vessels so that it does not block the vessel or instill a high-concentration solution directly into an organ-feeding vessel, such as the renal artery. It should be placed either in a high position at the T6 to T10 level or in a low position at the L3 to L5 level. Both the umbilical arterial and venous catheters should be familiar to radiologists, and the referring physician should be notified promptly if such a catheter is in an unusual position (35–37).

Peritoneal Dialysis Catheters
Continuous ambulatory peritoneal dialysis (CAPD) is a common method for treating chronic renal failure. It has the advantage of a lower cost than hemodialysis, and it permits greater patient mobility and requires fewer restrictions on the patient’s diet. The most common catheter used for CAPD is the Tenckhoff catheter (Cook Critical Care, Bloomington, Ind), which is composed of Silastic and has multiple side holes. Other similar catheters are available, and, frequently, one or more Dacron felt cuffs are placed near the end of the catheter to incite an inflammatory reaction to better secure the catheter in place and to prevent a retrograde infection gaining access to the peritoneum (Fig 28a). CAPD catheters may be surgically or percutaneously placed, with the catheter tip typically being inserted into the retrovesical space in men and in the pouch of Douglas in women (38).

Ascites Drainage Catheters
Many catheters and tubes frequently overlie the abdomen and pelvis. Some of these are devices used in treating another anatomic region, such as a pulmonary arterial catheter placed via the inferior vena cava; some of them are directly involved with the gastrointestinal system, such as a feeding tube; and some of them are highly specialized, such as a ventriculoperitoneal shunt (Fig 28b). Treatment of ascites and pleural effusions, particularly malignant ascites and effusions, is unsatisfactory in many cases, and a number of procedures and catheter systems have been developed for such therapy (39,40). These devices include peritoneal jugular shunts (commonly known as LeVeen shunts) for intractable ascites and pleuroperitoneal shunts (Denver shunt) for intractable pleural effusions. Tunneled peritoneal catheters, placed with US or fluoroscopic guidance and left in place semipermanently, have been somewhat successful in relieving rapidly accumulating ascitic fluid collections.
Other Infusion Catheters

There are many types of general-purpose infusion pumps to deliver liquid medications and intravenous fluids to patients through vascular or intrathecal routes at specified flow rates (41,42). In the abdomen, chemotherapy infusion pumps may sometimes be placed to instill therapeutic agents into the hepatic arterial tree for treatment of liver tumors and metastases (Fig 29). Catheters may be inserted into other arterial systems in the abdomen or pelvis to instill agents directly into a tumor bed. Infusion pumps for instillation of intrathecal medication may overlie the abdomen and pelvis, although their catheters may ascend into the thoracic spine (31).

Insulin pumps have recently become more popular for controlling diabetes (43). Insulin pumps have been available for several decades, but their large size and inconvenience precluded a widespread use until more modern electronics allowed miniaturization and microprocessor control. They were developed for treatment of type 1 diabetes and have a particular appeal for treatment of childhood and juvenile insulin-dependent diabetes.
diabetes. More recently, their use has been extended for type 2 diabetes (44). The insulin pump is a small (similar in size to a pack of cards), electronically controlled container. It can be worn on a waistband or carried in a pocket. A cannula for delivering the insulin extends from the pump to a subcutaneous location on the patient’s body, sometimes the abdomen or upper thigh. The pump itself or the cannula may occasionally be visible on abdominal and pelvic images. The cannula must be replaced every few days, and the amount of insulin delivered is controlled by settings made to the pump.

The femoral venous system and the inferior vena cava are less favored than the subclavian and jugular venous systems as routes for central venous catheters, but it is common for ill patients to have multiple vascular access catheters, including femoral venous catheters and sometimes inferior vena cava catheters.

Ventriculoperitoneal catheters commonly drain into the lower portion of the peritoneal cavity. They are usually easily recognized because they extend into the abdomen from an anterior location in the chest wall and can be followed all the way into the ventricular system of the brain. Their proper functioning is difficult to judge on most radiographs, but if they are excessively coiled, kinked, or in an inappropriate location, (eg, in the substance of the liver), the patient’s physicians should be promptly alerted. If one sees a catheter for which an obvious use is not apparent or for which the location seems inappropriate (eg, a femoral venous catheter crossing the midline and going inferiorly on the other side), the patient’s physician should be notified. Moreover, if one is unsure about the location or use for a catheter, then a call to the patient’s physician is wise.

Conclusions
Medical devices in the abdomen and pelvis are probably less frequently seen than those in the chest or extremities, but they are important and should be recognized. Many of these devices are used to monitor or treat gastrointestinal and genitourinary disease. Some of them, such as inferior vena cava filters and drug infusion pumps, treat systemic problems, and some of them are devices used in treating another anatomic region. It is strongly recommended that scout views for chest, abdominal, and pelvic CT studies be carefully examined for medical apparatus. Medical devices are often more easily recognized on scout images, and their inappropriate locations and complications can be better appreciated on the subsequent cross-sectional images if one is alerted to their presence in the first place. It is too easy to overlook seemingly innocuous and routine medical devices because of rushing to examine the cross-sectional images to assess the patient’s problems. Abdominal and pelvic devices are common and important, and most are easily recognized and easily evaluated. Their evaluation should be considered as important as any other aspect of a radiologic examination.

References


