

# Abdominal Wall Hernia Mesh Repair

## Sonography of Mesh and Common Complications

David A. Jamadar, MBBS, Jon A. Jacobson, MD,  
Gandikota Girish, MBBS, Jefferson Balin, MD,  
Catherine J. Brandon, MD, Elaine M. Caoili, MD,  
Yoav Morag, MD, Michael G. Franz, MD

**Objective.** The purposes of this study were (1) to review the sonographic in vitro and in vivo appearances of mesh for surgical repair of abdominal wall hernias, (2) to describe sonographic techniques and discuss the limitations of sonography in evaluation of mesh hernia repair, and (3) to illustrate common complications after mesh repair shown with sonography. **Methods.** We identified interesting cases from the musculoskeletal sonographic database as well as from the teaching files of the authors, with surgical or other cross-sectional imaging corroboration. **Results.** A compilation of the sonographic appearances of mesh used for anterior abdominal wall and inguinal hernia repair and complications diagnosable by sonography is presented. **Conclusions.** Sonography can be effective for evaluation of mesh and complications after mesh repair of anterior abdominal wall and inguinal hernias. **Key words:** abdominal wall hernia; mesh repair; sonography.

### Abbreviations

CT, computed tomography

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Address correspondence to David A. Jamadar MBBS, Department of Radiology, University of Michigan Hospitals, 1500 E Medical Center Dr, Ann Arbor, MI 48109 USA.

E-mail: [djamadar@med.umich.edu](mailto:djamadar@med.umich.edu)

Repair of abdominal wall hernias with synthetic patches was first described in 1962.<sup>1</sup> Since that time, these materials have been used widely, and the various procedures using mesh in abdominal wall repair have become commonplace. Several reports have shown that compared with simple sutures, mesh is superior, with significantly reduced recurrence rates.<sup>2</sup> Materials from which mesh is manufactured are usually derived from polypropylene or polytetrafluoroethylene<sup>3</sup> and typically function by providing a bridge across deficient tissue. The mesh is incorporated into the adjacent tissues and should restore the structure and function of the abdominal wall. Implanted mesh is a foreign body and therefore causes an inflammatory reaction. Potential complications may relate to the mesh as a foreign body or may relate to the surgical repair of abdominal wall hernias.

We present the sonographic in vitro and in vivo appearances of mesh and sonographic techniques for identifying mesh in the anterior abdominal wall. We also describe complications of mesh implants and discuss potential limitations of sonography.

### In Vitro Appearances

Sonography is a useful imaging tool that can effectively evaluate the anterior abdominal wall, identifying mesh and many of the complications associated with its surgical placement.<sup>4</sup> Mesh may be placed in a variety of locations in relation to the structures of the anterior abdominal wall and inguinal region (Figure 1), all of which may be evaluated by sonography.

For inguinal hernia repair, a typical sample of mesh is shown in Figure 2. The mesh is cut to a shape that will facilitate placement in the inguinal region. For open repairs, the mesh is placed superficial to the transversalis fascia and deep in the inguinal canal. During laparoscopic hernia repair, the mesh is usually placed in a preperitoneal location (between the transversalis fascia and peritoneum) at the posterior aspect of the abdominal wall; the mesh may be held in place with metallic tacks (Figure 3), which are inserted through the mesh into the overlying abdominal wall, are radiopaque (Figure 4), and may sometimes be seen on sonography (Figure 5). Tissue glue may also be used for this purpose.<sup>5</sup>

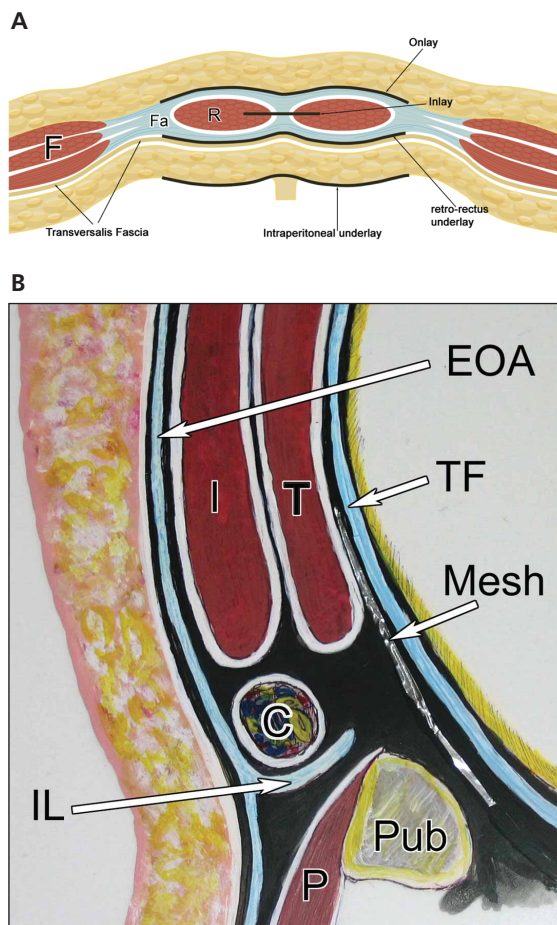
For anterior abdominal wall hernia repair, larger pieces of mesh may be used. The example shown in Figure 6 is a composite mesh derived from polypropylene and extruded polytetrafluoroethylene. This type of mesh may be implanted in patients who, for example, have large anterior abdominal wall incisional hernias (Figure 7A). The small field of view of the ultrasound probe makes assessing the margins of a large implant of this type challenging (Figure 7B). We do not use the extended field of view because this would require the patients to hold their breath, and the diagnosis is more likely found by real-time examination rather than by evaluating a static image.

A mesh plug may be used for repair of indirect inguinal hernias (Figures 8–10) to mechanically decrease the size of the deep ring by filling it, and it may be held in place with sutures or by an overlying piece of mesh.<sup>6</sup> In vivo it is more tightly packed than in vitro because the multiple folds are more closely approximated.

### Laparoscopic Placement of Mesh

Laparoscopic placement of mesh for ventral or inguinal hernia repair is a form of minimally invasive surgery in which the surgery may be accomplished without a large surgical incision.

**Figure 1. A,** Anterior abdominal wall in cross section above the arcuate line. The mesh (black lines) may be anterior to the fascia (Fa) at the rectus abdominis muscle (R, Onlay), at the level of the rectus abdominis muscle (Inlay), between the rectus abdominis muscle and fascia and the transversalis fascia (retro-rectus underlay), or intraperitoneal deep to the transversalis fascia (Intraperitoneal underlay). Sonographically, it is difficult to differentiate the retro-rectus underlay from the intraperitoneal underlay locations. F indicates flank muscles: external oblique, internal oblique, and transversus abdominis. **B,** Inguinal region in the parasagittal plane at the pubis. The mesh is often placed between the transversalis fascia (TF) posteriorly and the anterior structures, including the transversus abdominis muscle (T) superiorly, the spermatic cord (C) and inguinal ligament (IL), and the pubic bone (Pub) inferiorly. The other structures shown in this plane include the internal oblique muscle (I), external oblique aponeurosis (EOA), which folds to form the inguinal ligament, and the pectineus muscle (P).



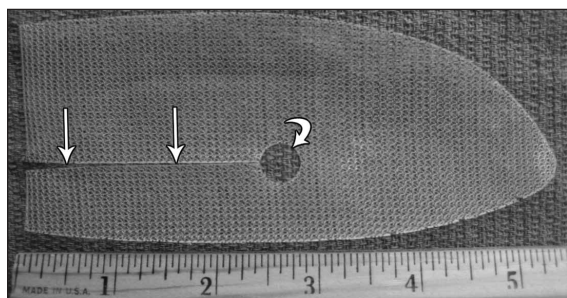
To place an intraperitoneal underlay graft for ventral hernia repair (Figure 1A), the laparoscope is introduced into the peritoneal cavity, and carbon dioxide (a commonly used distension medium) is introduced to distend the abdomen and allow the bowel to fall away from the anterior parietal peritoneum. The mesh is introduced into the peritoneal cavity and under direct vision is fixed to the anterior abdominal wall. To place mesh in the preperitoneal space for inguinal hernia repair (Figure 1B), a trocar is introduced into this space (between the transversalis fascia and transversus abdominis muscle), and a large balloon is used to bluntly dissect away the transversalis fascia from the more superficial tissues. The balloon is deflated and carbon dioxide is introduced, forming a space in which the surgeon can work to fix the mesh to cover the abdominal wall defect, the entire procedure remaining extraperitoneal.<sup>7</sup>

Laparoscopic surgery is not without its complications, which range from local morbidity such as wound infections and hernias through a laparoscopic port site to bleeding, gas embolization, lacerations of intra-abdominal viscera, and in a small percentage of patients, death.<sup>8,9</sup>

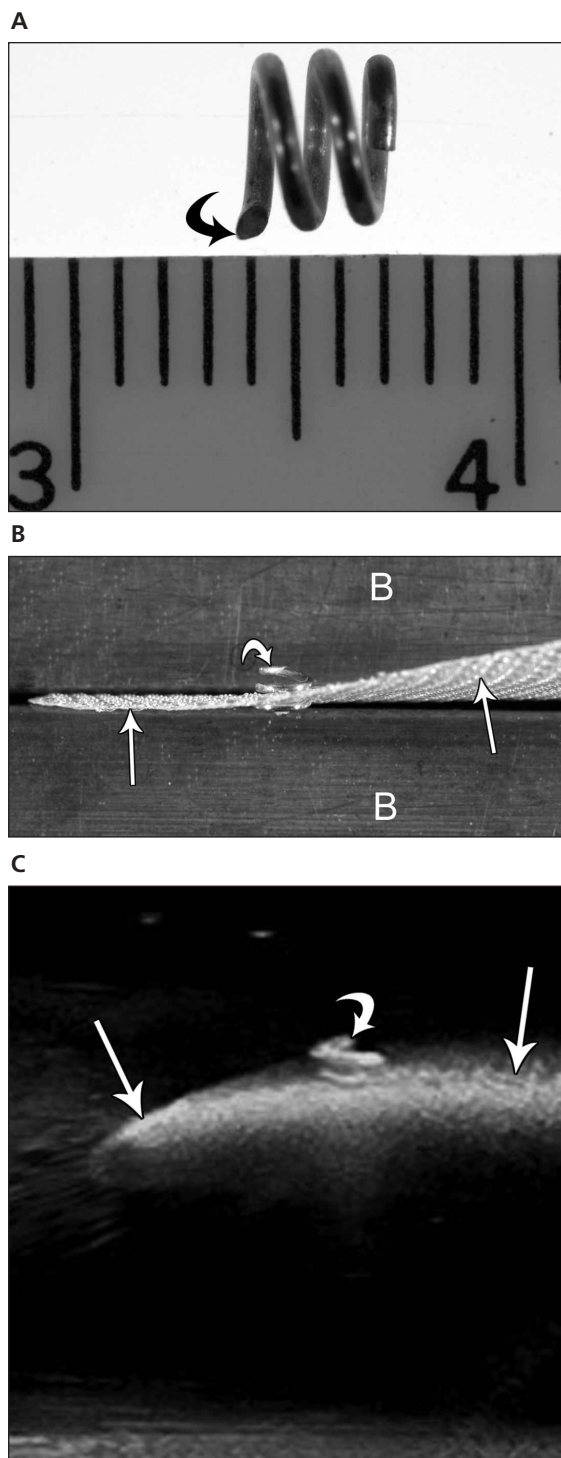
### Technique and Normal Sonographic Appearances

In general, a 7-MHz transducer is effective for most types of body habitus. The mesh most commonly appears as a linear echogenic interface with posterior acoustic shadowing, but the echogenicity of the mesh may vary (Figures 11

**Figure 2.** Cut polypropylene monofilament mesh with a round defect (curved arrow) and a contiguous linear defect (straight arrows) permitting placement and a snug fit around the spermatic cord, used to provide support at the deep ring and posterior inguinal canal.



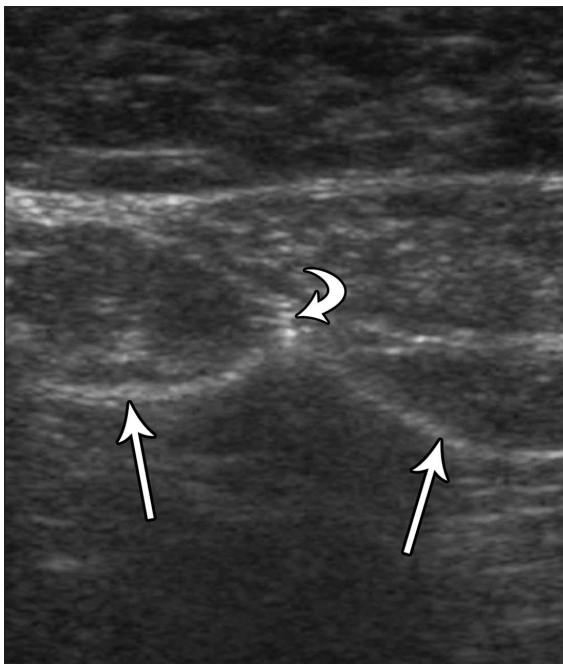
**Figure 3.** Metal autosuture (Protac; Tyco Healthcare, Norwalk, CT). **A**, Magnification to show the detail of the spiral with the cutting edge at the left (arrow). **B**, Polypropylene mesh (straight arrows) shown end-on supported between 2 blocks of wood (B) and traversed by the Protac autosuture (curved arrow). **C**, In vitro sonography of the Protac autosuture shows the detail of the spiral tack (curved arrow) traversing the polypropylene mesh, which shows a smooth echogenic interface (straight arrows) in the water bath.





**Figure 4.** Laparoscopic right inguinal hernia repair in a 43-year-old man. The radiolucent mesh is located posterior to the transversalis fascia (between the transversalis fascia and peritoneum) and secured with radiopaque Protac autosutures (arrow).

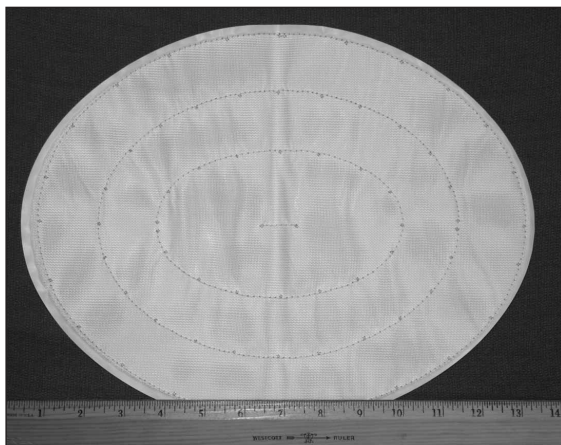
**Figure 5.** Mesh repair of an epigastric ventral incisional hernia using a retro-rectus underlay mesh in a 29-year-old man. Sonography shows the mesh (straight arrows) and Protac autosuture (curved arrow).

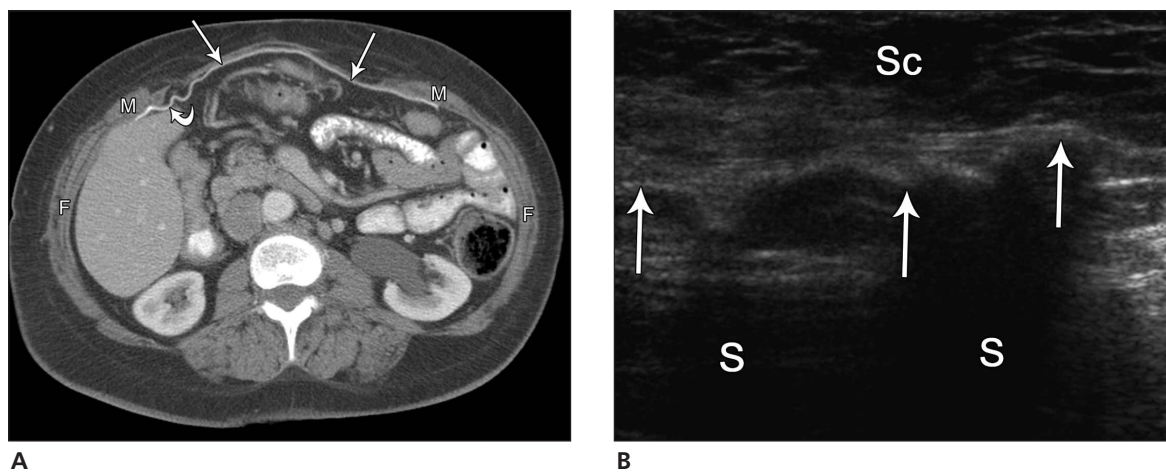


and 12). Mesh may be differentiated from bowel by its broad superficial location and the absence of peristalsis. The mesh is not often flat but may be wavy (Figure 13) or “crinkly” (Figure 14). This irregular appearance due to “mesh shrinkage” is a function of the healing process, with scarring and incorporation of the mesh implant into the adjacent tissues.<sup>10</sup> By increasing the field of view (depth), the posterior acoustic shadowing may be better appreciated, increasing confidence for identification of mesh (Figure 15). Implanted mesh for inguinal hernia repair may remain difficult to identify, and clinical information indicating the presence of mesh is important.

The Valsalva maneuver (Figure 10) is used liberally while all margins of the mesh implant are carefully evaluated with sonography. This is a critical component of the examination because a reducible hernia may only be appreciated with an increase in intra-abdominal pressure. The movement of the hernia produced by the Valsalva maneuver also facilitates diagnosis, particularly with small fat-containing hernias, which otherwise may be difficult to differentiate from the adjacent normal adipose tissue. As in the evaluation of any hernia, sonographic examination in the supine position as well as in the erect position may be necessary.<sup>11–13</sup> Care must be taken not to apply too much compression when scanning because this may prevent

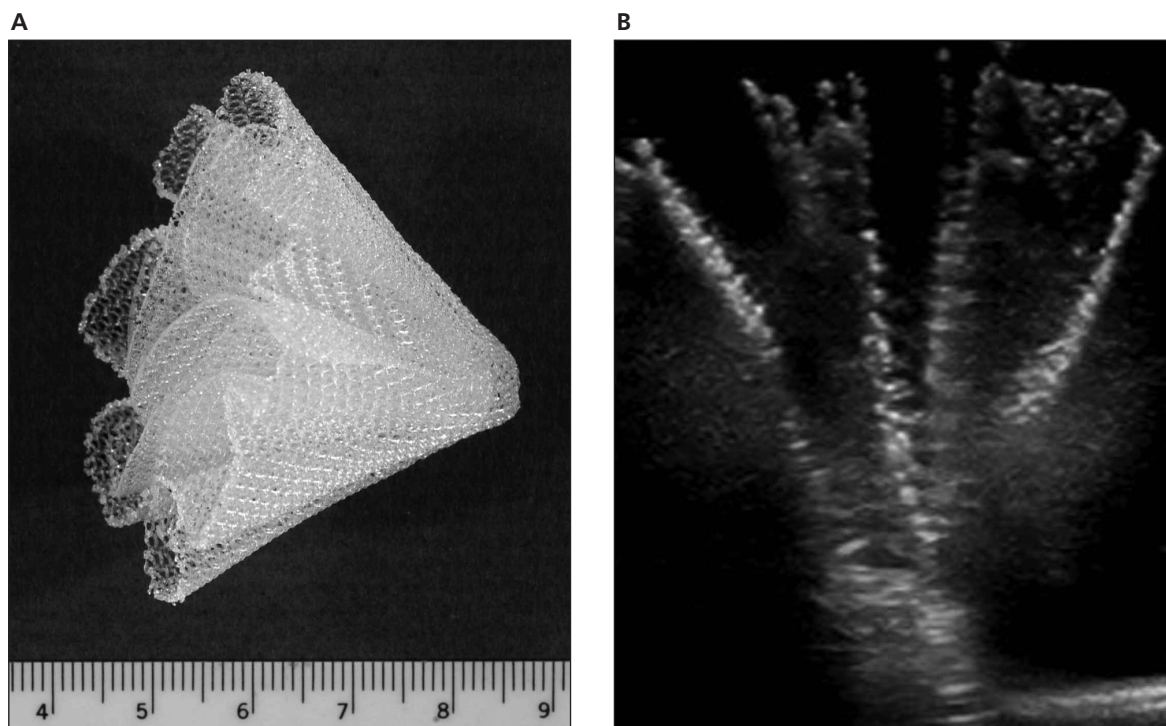
**Figure 6.** Composite polypropylene and extruded polytetrafluoroethylene mesh (Composix E/X; C. R. Bard, Inc, Cranston, RI) for ventral hernia repair. Note the larger size with reinforcing concentric stitching.





**Figure 7.** Large ventral hernia repair in a 60-year-old woman. **A**, Computed tomography of the mesh (straight arrows) in the underlay location. Note that the right lateral margin of the mesh (curved arrow) has a wavy contour. The mesh bridges a wide midline ventral defect between the rectus abdominis muscles (M). F indicates flank muscles. **B**, Sonography shows the left lateral margin of the mesh (arrows) with posterior acoustic shadowing (S). Sc indicates subcutaneous tissue. Note that the narrow field of view gives a different perspective from that of the CT scan.

**Figure 8.** Mesh monofilament polypropylene plug (PerFix; C. R. Bard, Inc). **A**, Mesh plug designed to fill a hernia ring, often adjacent to the spermatic cord, mechanically preventing inguinal hernia occurrence. The plug can be placed medially (direct inguinal) or laterally (indirect inguinal) within the inguinal canal. **B**, In vitro sonography of a vertically oriented mesh plug in a water bath shows obliquely oriented echogenic interfaces in a conical configuration. The in vivo mesh plug (see Figure 10) is more tightly compressed and echogenic.





**Figure 9.** Mesh plug for right inguinal hernia repair in a 63-year-old man. A triangular mesh plug with soft tissue attenuation (arrow) is shown in the right inguinal region with a mass effect on the adjacent bladder (B).

herniation from occurring around the mesh margin, resulting in a false-negative diagnosis for a recurrent hernia. Color Doppler imaging shows vascularity and should be used to assist in differentiating a hypoechoic fluid collection from a mass adjacent to a mesh implant.

### Complications

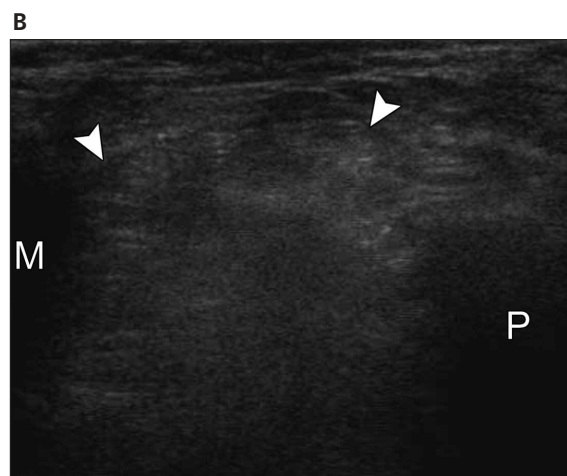
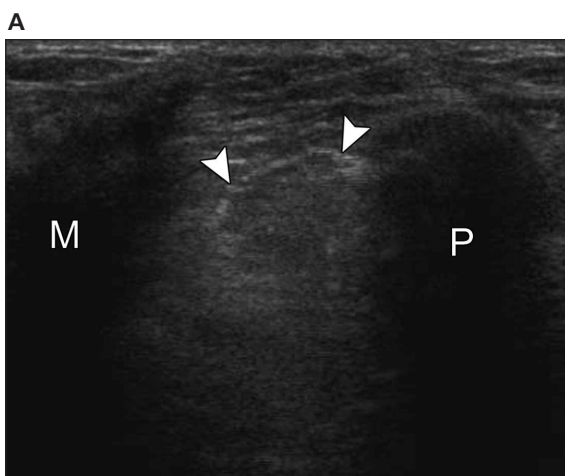
Sonography has been found to be useful in evaluating postoperative complications in patients who have had abdominal wall and inguinal hernias repaired with mesh.<sup>14</sup> Crespi et al<sup>4</sup> found that sonography was better at identifying mesh than computed tomography (CT) in patients

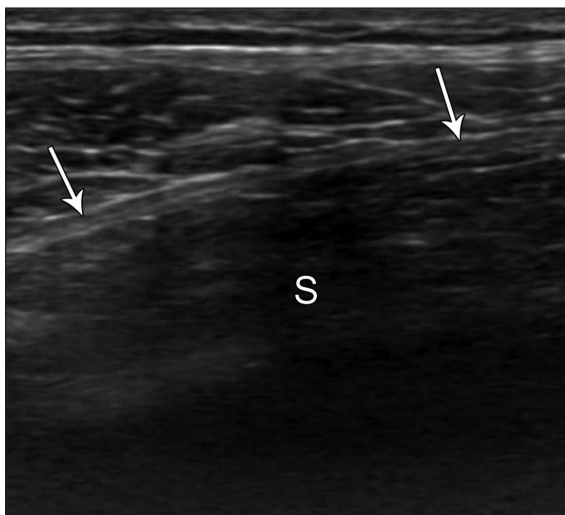
who had inguinal hernioplasty with polypropylene mesh, although Parra et al<sup>15</sup> thought that CT performed better than sonography in identifying mesh placed for hernia repair. When sonographic findings are negative in a symptomatic patient, our surgeons would request CT.

Recurrent hernias<sup>15</sup> usually occur at the margin of the implant (Figure 16A) and may be reducible or irreducible. An irreducible hernia is one where its contents cannot be returned to the peritoneal cavity in the absence of other complications. An obstructed hernia is one where viable bowel within the hernia becomes mechanically obstructed, preventing enteric flow. A strangulated hernia is one where bowel within a hernia undergoes vascular impairment and may become necrotic and perforate. Doppler evaluation may detect blood flow in the bowel loop (Figure 16B), suggesting viability, but minimal flow may be present in ischemic bowel.<sup>16</sup>

Hematomas<sup>14</sup> of the abdominal wall may be seen in the postoperative period, usually resolve uneventfully, and show variable sonographic appearances depending on their age.<sup>17,18</sup> They may appear in the subcutaneous, intramuscular, and preperitoneal planes. Most hematomas are hypoechoic or of mixed echogenicity, although echogenicity varies. Seromas<sup>19</sup> may also occur postoperatively and

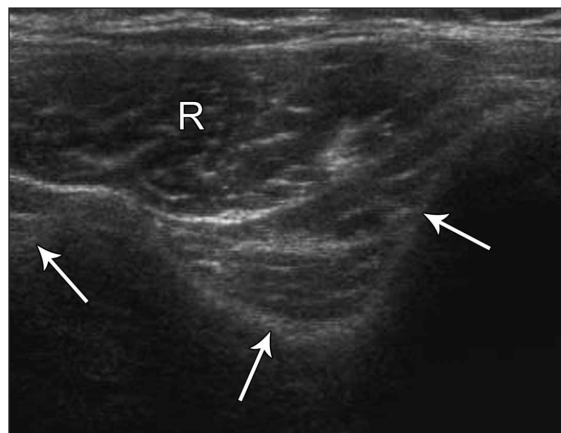
**Figure 10.** Hernia after a left inguinal hernia repair with a mesh plug in a 79-year-old man. **A**, Sonography at rest shows a hernia (arrowheads) between the mesh (shadowing from the mesh [M]) and mesh plug (shadowing from the mesh plug [P]). **B**, With the Valsalva maneuver, there is separation between the mesh (shadowing from the mesh) and mesh plug (shadowing from the mesh plug) caused by a protruding hernia (arrowheads). In this patient, both the mesh and the mesh plug are difficult to identify as distinct structures.





**Figure 11.** Right inguinal mesh in a 49-year-old man. On sonography, the mesh is difficult to see and appears linear and minimally hyperechoic (arrows) with posterior acoustic shadowing (S). The clinical history was important in helping identify the mesh in this patient.

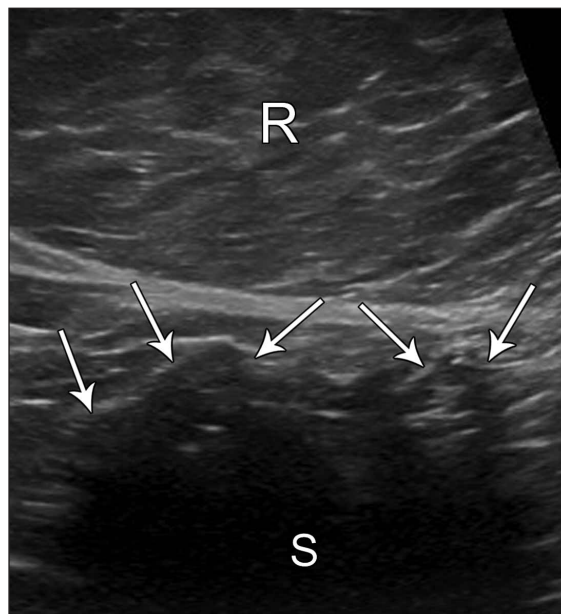
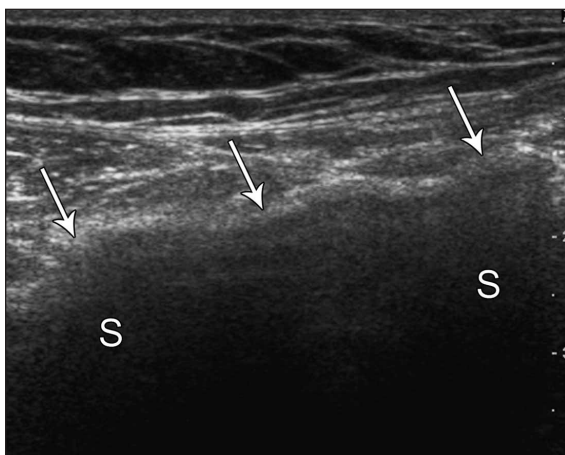
may appear anechoic on sonography (Figure 17). Abscesses (Figure 18) should be considered with any postoperative fluid collection, especially when heterogeneous or complex. Rarely an enterocutaneous fistula may develop



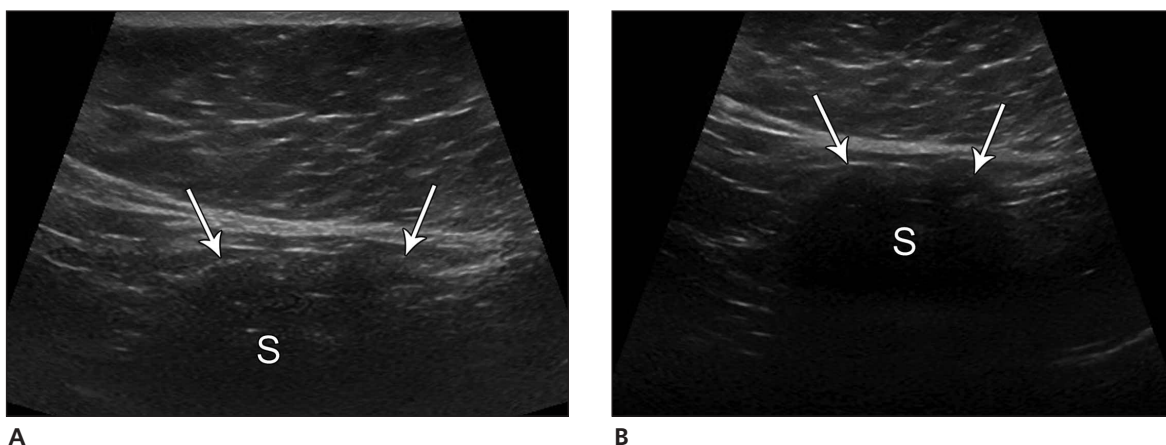
**Figure 13.** Left inguinal mesh in a 47-year-old man. Sonography shows the mesh (arrows) with a wavy contour. R indicates rectus abdominis muscle.

(Figure 19). The latter is an unusual complication and would require other imaging because the posterior acoustic shadowing from gas and mesh on sonography limits evaluation of deep soft tissue structures.<sup>20</sup>

**Figure 12.** Right inguinal mesh in a 21-year-old man. Sonography shows the hyperechoic mesh (arrows) with a wavy contour and posterior acoustic shadowing (S).



**Figure 14.** Underlay mesh in a 39-year-old woman. Sonography shows a very wavy (crinkly) appearance of the mesh (arrows). R indicates rectus abdominis muscle; and S, posterior acoustic shadowing.

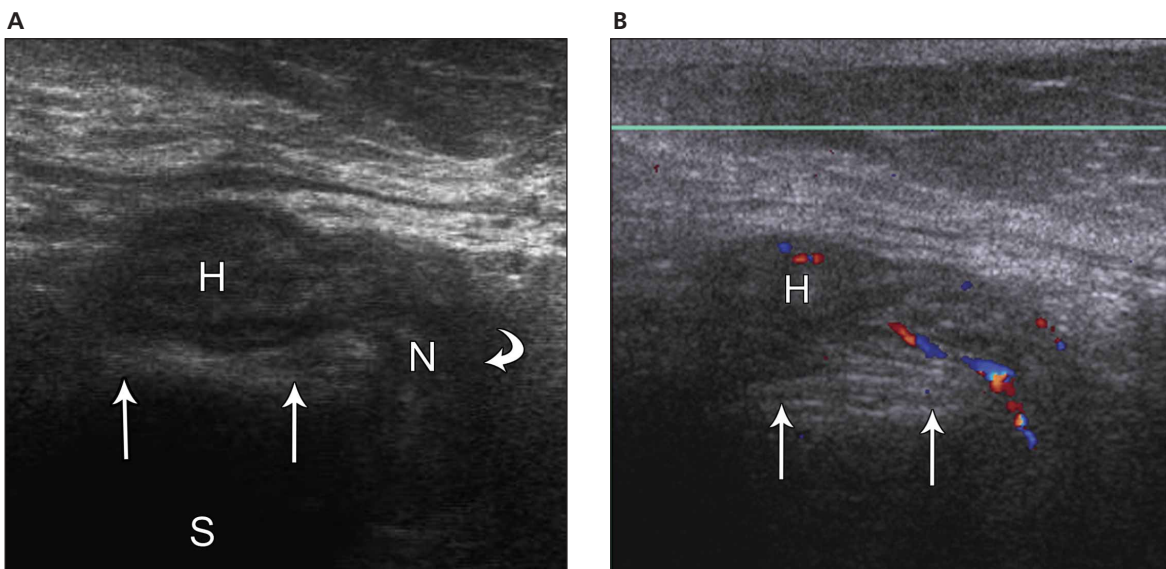


**Figure 15.** Right upper quadrant underlay mesh repair of an incisional hernia after laparoscopic cholecystectomy in a 39-year-old woman. **A**, Identification of the mesh (arrows) and acoustic shadowing (S) may be limited with the smaller field of view (depth). **B**, An increased field of view (depth) allows better appreciation of acoustic shadowing and identification of the mesh (arrows).

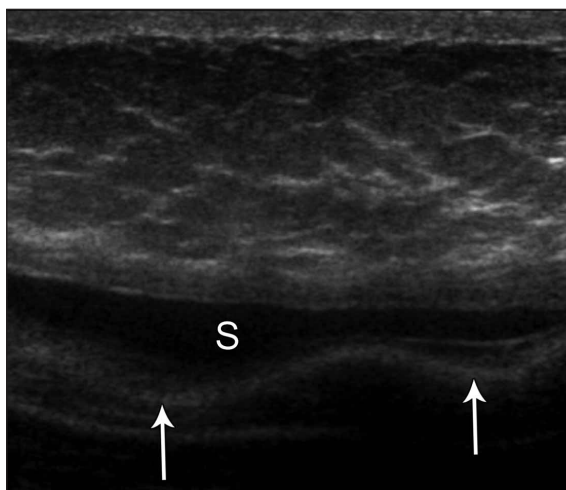
The margin of the mesh may appear as a palpable mass (Figure 20) and may cause concern for a new mass or a recurrent hernia. The margin of the mesh may fold back on itself (Figure 21) and cause focal irritation. Structures passing over the margin of the mesh may become kinked (Figure 22) and irritated. This usually occurs after inguinal hernia repair in which the spermatic cord and its contents and adjacent nerves may deviate

from their course passing over the margin of the mesh. The mesh plugs may be displaced by a recurrent hernia alongside the plug (Figure 10). If a migrated mesh plug enters the peritoneal cavity, it may potentially perforate the bowel as a further complication. Other complications include migration of mesh and the mesh plug,<sup>21-23</sup> intestinal obstruction, perforation and fistula formation,<sup>24-26</sup> strangulated hernias, and a burst abdomen.<sup>2,27</sup>

**Figure 16.** Recurrent hernia at the left lateral margin of the mesh after an underlay repair of a ventral midline incisional hernia in a 60-year-old woman. **A**, The irreducible fat-containing hernia (H) lies directly on the lateral border of the mesh, with its neck (N, curved arrow) well demarcated by the lateral border of the echogenic mesh (straight arrows) medially. **B**, Color Doppler imaging shows blood flow in this irreducible hernia lying on the lateral margin of the mesh (arrows).

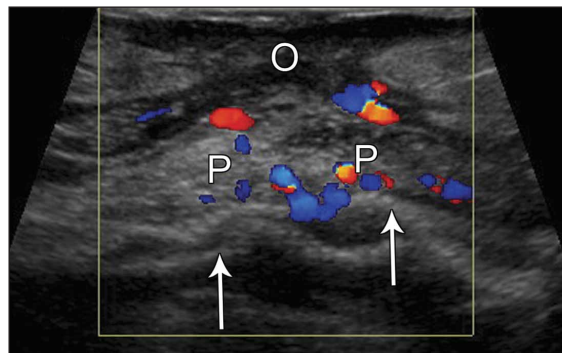
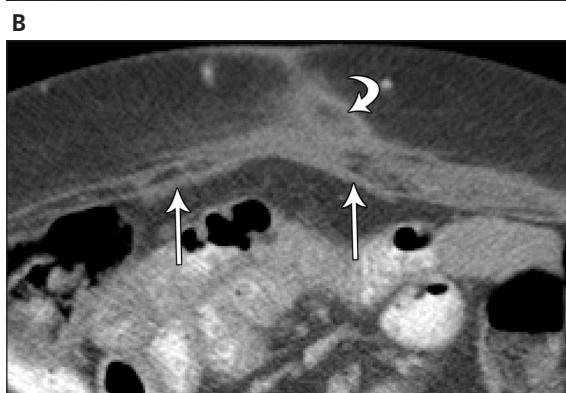
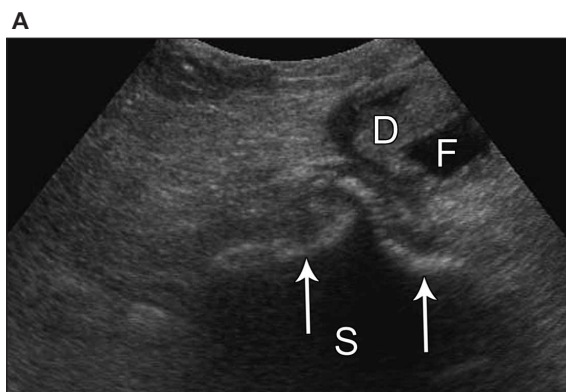






**Figure 17.** Seroma in a 68-year-old man. Sonography shows an anechoic fluid collection (S) at the superficial surface of the wavy echogenic mesh (arrows) after repair of a ventral midline incisional hernia.

**Figure 18.** Complex wound collection after mesh placement for a ventral midline incisional hernia in a 50-year-old woman. A draining sinus discharged sterile purulent-looking material. **A**, Sonography in the axial plane shows the mesh with an echogenic folded contour (arrows) and posterior acoustic shadowing (S). An adjacent collection comprising both fluid (F) and debris (D) is shown just superficial to the mesh. **B**, Computed tomography shows the anterior abdominal wall mesh (straight arrows) and adjacent collection (curved arrow).



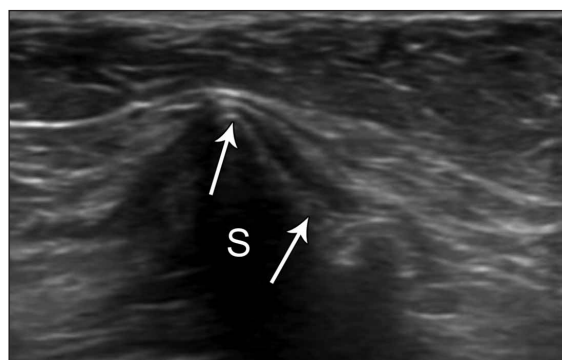
**Figure 19.** Enterocutaneous fistula after mesh placement in the anterior abdominal wall of a 53-year-old woman. Sonography shows the cutaneous opening (O) and the hyperemic echogenic phlegmon (P) lying superficial to 2 layers of wavy echogenic mesh (arrows).

Sonography may identify an indication for surgery, such as a tight neck around a loop of bowel, a loop of bowel where there is suspicion of strangulation, or a fluid collection that is infected. Pain, nausea, and limited abdominal wall function associated with a hernia defect lower the surgeon's threshold for surgery.

### Limitations

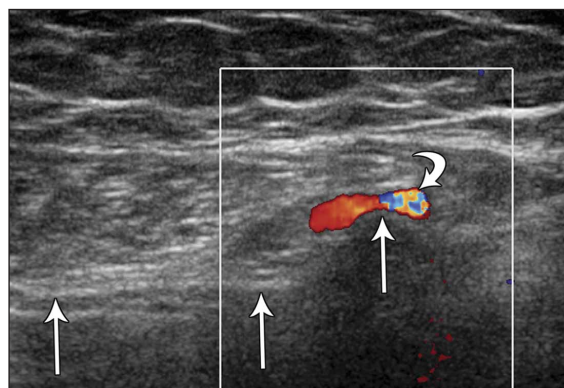
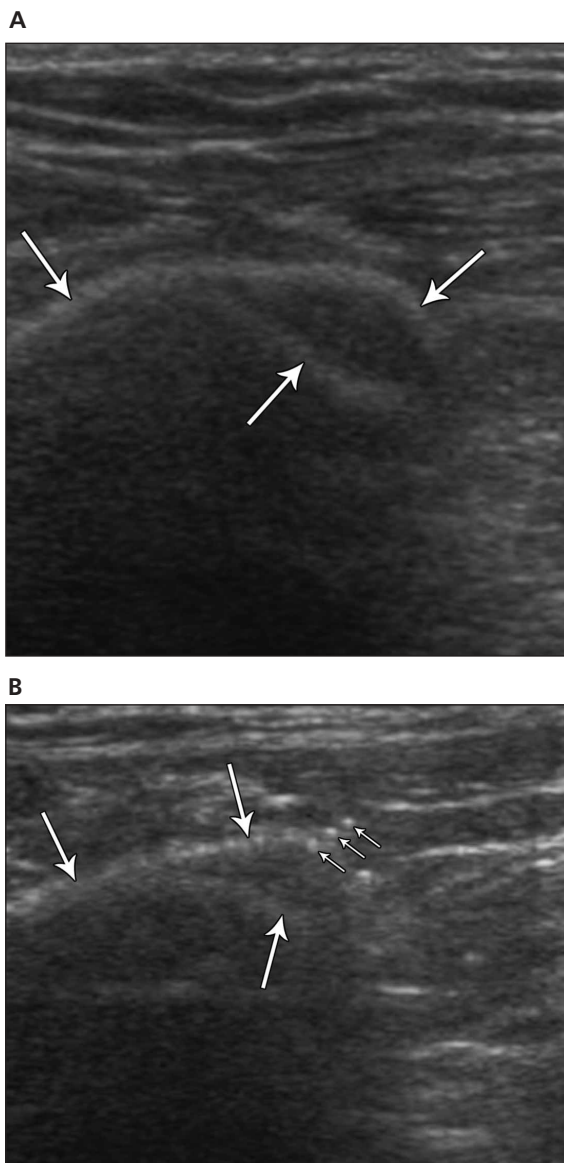
With sonography, the acoustic shadowing deep to the mesh makes evaluation of structures deep to the mesh difficult if not impossible to evaluate. The distorted anatomy after hernia repair may be confusing, particularly with large midline implants. In these cases, the smaller

**Figure 20.** Palpable edge of mesh after midline incisional hernia repair in a 46-year-old woman. The palpable epigastric lump corresponded to the superficial free edge (arrow at left) of the implanted mesh (arrows) rather than a recurrent hernia. S indicates posterior acoustic shadowing.



field of view provided by the ultrasound transducer may limit the perspective. The relative small field of view may also make evaluation of the surface and margins of a large mesh implant time-consuming, especially with repeated Valsalva maneuvers.

**Figure 21.** Deformity of the lateral margin of mesh with continuing pain after laparoscopic left inguinal hernia repair with mesh in a 24-year-old man. **A**, The lateral margin of the mesh folds on itself (large arrows), producing a double echogenic line. **B**, Note the echogenic tack (small arrows) at the lateral margin of the folded mesh.



**Figure 22.** Laparoscopic left inguinal hernia mesh repair in a 32-year-old woman. The round ligament and accompanying vessels (curved arrow) are kinked over a prominent border (straight arrow at far right) of the echogenic inguinal mesh (straight arrows), corresponding to focal tenderness.

### Conclusions

Sonography can be a useful tool for evaluating hernias repaired with mesh implants, including potential complications that may occur. Precise anatomic delineation of a mesh implant and a recurrent hernia is important for surgeons considering revision operations. Dynamic imaging offers advantages over other cross-sectional techniques because recurrent hernias may be transient with the Valsalva maneuver.

### References

1. Usher FC, Hernia repair with Marlex mesh: an analysis of 541 cases. *Arch Surg* 1962; 84:325–328.
2. Burger JW, Luijendik RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J. Long-term follow-up of a randomized controlled trial of suture versus mesh repair of incisional hernia. *Ann Surg* 2004; 240:578–585.
3. Novitsky YW, Harrell AG, Hope WW, Kercher KW, Heniford BT. Meshes in hernia repair. *Surg Technol Int* 2007; 16: 123–127.
4. Crespi G, Giannetta E, Mariani F, Floris F, Pretolesi F, Marino P. Imaging of early postoperative complications after polypropylene mesh repair of inguinal hernia. *Radiol Med (Torino)* 2004; 108:107–115.
5. Topart P, Vandenbroucke F, Lozac'h P. Tisseel versus tack staples as mesh fixation in totally extraperitoneal laparoscopic repair of groin hernias: a retrospective analysis. *Surg Endosc* 2005; 19:724–727.
6. Frey DM, Wildisen A, Hamel CT, Zuber M, Oertli D, Metzger J. Randomized clinical trial of Lichtenstein's operation versus mesh plug for inguinal hernia repair. *Br J Surg* 2007; 94:36–41.

7. Felix EL. Laparoscopic extraperitoneal hernia repair. In: Eubanks WS, Swanstrom LL, Soper NJ (eds). *Mastery of Endoscopic and Laparoscopic Surgery*. Philadelphia, PA: Lippincott Williams & Wilkins; 2000:443–455.
8. Opitz I, Gantert W, Giger U, Kocher T, Krahenbuhl L. Bleeding remains a major complication during laparoscopic surgery: analysis of the SALTS database. *Langenbecks Arch Surg* 2005; 390:128–133.
9. Bower CE, Reade CC, Kirby LW, Roth JS. Complications of laparoscopic incisional-ventral hernia repair: the experience of a single institution. *Surg Endosc* 2004; 18:672–675.
10. Gonzalez R, Fugate K, McClusky D III, et al. Relationship between tissue ingrowth and mesh contraction. *World J Surg* 2005; 29:1038–1043.
11. Rettenbacher T, Hollerweger A, Macheiner P, et al. Abdominal wall hernias: cross-sectional imaging signs of incarceration determined with sonography. *AJR Am J Roentgenol* 2001; 177:1061–1066.
12. Bradley M, Morgan D, Pentlow B, Roe A. The groin hernia: an ultrasound diagnosis? *Ann R Coll Surg Engl* 2003; 85: 178–180.
13. Jamadar DA, Jacobson JA, Morag Y, et al. Sonography of inguinal region hernias. *AJR Am J Roentgenol* 2006; 187: 185–190.
14. Furtschegger A, Sandbichler P, Judmaier W, Gstir H, Steiner E, Egender G. Sonography in the postoperative evaluation of laparoscopic inguinal hernia repair. *J Ultrasound Med* 1995; 14:679–684.
15. Parra JA, Revuelta S, Gallego T, Bueno J, Berrio JI, Farinas MC. Prosthetic mesh used for inguinal and ventral hernia repair: normal appearance and complications in ultrasound and CT. *Br J Radiol* 2004; 77:261–265.
16. Liang RJ, Wang HP, Huang SP, Wu MS, Lin JT. Color Doppler sonography for ventral hernias in patients with acute abdomen: preliminary findings. *J Clin Ultrasound* 2001; 29:435–440.
17. Wicks JD, Silver TM, Bree RL. Grey scale features of hematomas: an ultrasonic spectrum. *AJR Am J Roentgenol* 1978; 131:977–980.
18. Rankin RN, Hutton L, Grace DM. Postoperative abdominal wall hematomas have a distinctive appearance on ultrasonography. *Can J Surg* 1985; 28:84–85.
19. Susmallian S, Gewurtz G, Ezri T, Charuzi I. Seroma after laparoscopic repair of hernia with PTFE patch: is it really a complication? *Hernia* 2001; 5:139–141.
20. Aube C, Pessaux P, Tuech JJ, et al. Detection of peritoneal adhesions using ultrasound examination for the evaluation of an innovative peritoneal mesh. *Surg Endosc* 2004; 18: 131–135.
21. Dieter RA Jr. Mesh plug migration into the scrotum: a new complication of hernia repair. *Int Surg* 1999; 84:57–59.
22. Chowbey PK, Bagchi N, Goel A, et al. Mesh migration into the bladder after TEP repair: a rare case report. *Surg Laparosc Endosc Percutan Tech* 2006; 16:52–53.
23. Celik A, Kutun S, Kockar C, Mengi N, Ulucanlar H, Cetin A. Colonoscopic removal of inguinal hernia mesh: report of a case and literature review. *J Laparoendosc Adv Surg Tech A* 2005; 15:408–410.
24. Ferrone R, Scarone PC, Natalini G. Late complication of open inguinal hernia repair: small bowel obstruction caused by intraperitoneal mesh migration. *Hernia* 2003; 7: 161–162.
25. Benedetti M, Albertario S, Niebel T, et al. Intestinal perforation as a long-term complication of plug and mesh inguinal hernioplasty: case report. *Hernia* 2005; 9:93–95.
26. Miller K, Junger W. Ileocutaneous fistula formation following laparoscopic polypropylene mesh hernia repair. *Surg Endosc* 1997; 11:772–773.
27. Leber GE, Garb JL, Alexander AI, Reed WP. Long-term complications associated with prosthetic repair of incisional hernias. *Arch Surg* 1998; 133:378–382.