Pericardiocentesis

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16.1 Surgical Anatomy

- The pericardium is a thin, double-walled sac surrounding the heart and the roots of the great vessels. It is bordered inferiorly by the diaphragm, laterally by the pleural sacs, anteriorly by the sternum, and superiorly by the roots of the great vessels. It is fixed at the root of the great vessels (Fig. 16.1).
- The pericardial cavity contains a small amount (<50 mL) of pericardial fluid under normal physiologic conditions (Fig. 16.1).
- Surface anatomic landmarks for pericardiocentesis include the xiphoid process and the fifth and sixth ribs at the sternocostal junction (Fig. 16.2).
- A pericardial effusion can be visualized sonographically in several views:
  - Subxiphoid
  - Apical four-chamber
  - Parasternal
- A subxiphoid view is obtained inferior to the xiphoid process, with the probe directed at the patient's left shoulder (Fig. 16.3).
  - The right atrium and ventricle appear in the near field, and the left atrium and ventricle in the far.
  - The myocardium appears gray, while blood-filled chambers appear black/hypoechoic.
  - Fluid (effusion) appears as an anechoic stripe around the heart.
- An apical view is obtained in the fifth intercostal space at the point of maximal impulse (Fig. 16.4). The probe is directed to the patient's left back:
  - The apex is closest to the probe.
  - Both ventricles appear in the near field and both atria in the far.
- A parasternal view is obtained between the third and fifth intercostal spaces just to the left of the sternum (Fig. 16.5). The probe is directed toward the patient's right shoulder:
  - The right ventricle is in the near field, followed by the left ventricle and aortic outflow tract. The left atrium is in the far field.
  - The probe can also be rotated 90 degrees clockwise to visualize the heart in short axis. The right and left ventricles are then seen side by side.

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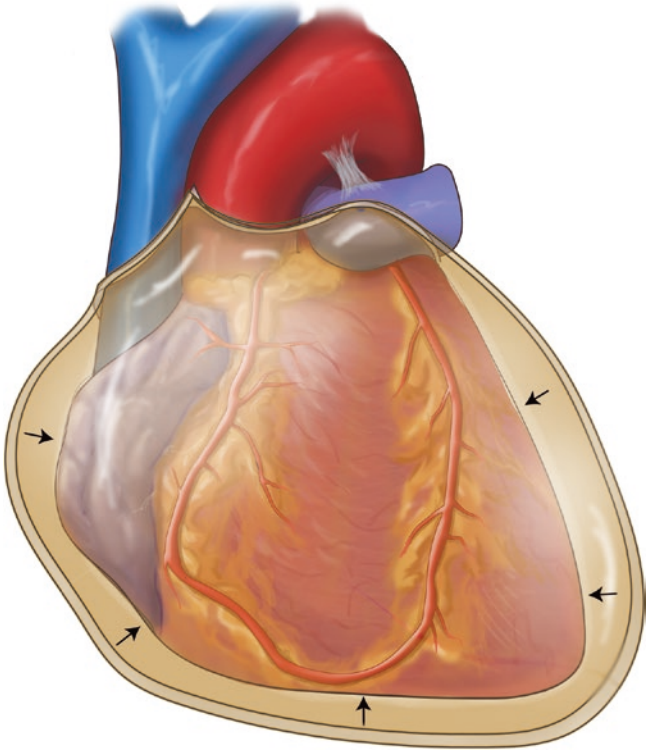

Fig. 16.1 Anatomy of the pericardium

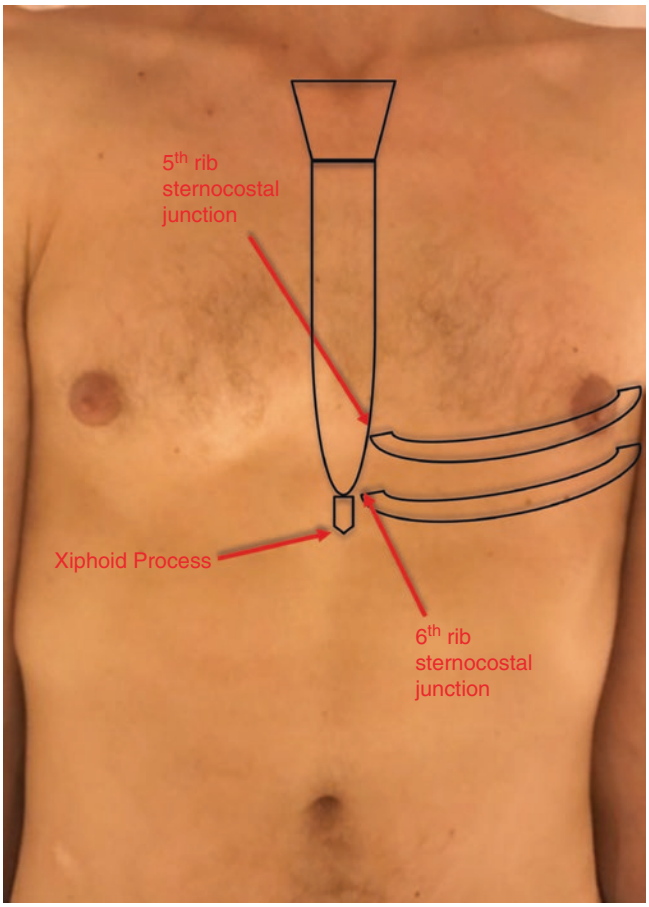

Fig. 16.2 Surface anatomic landmarks for pericardiocentesis

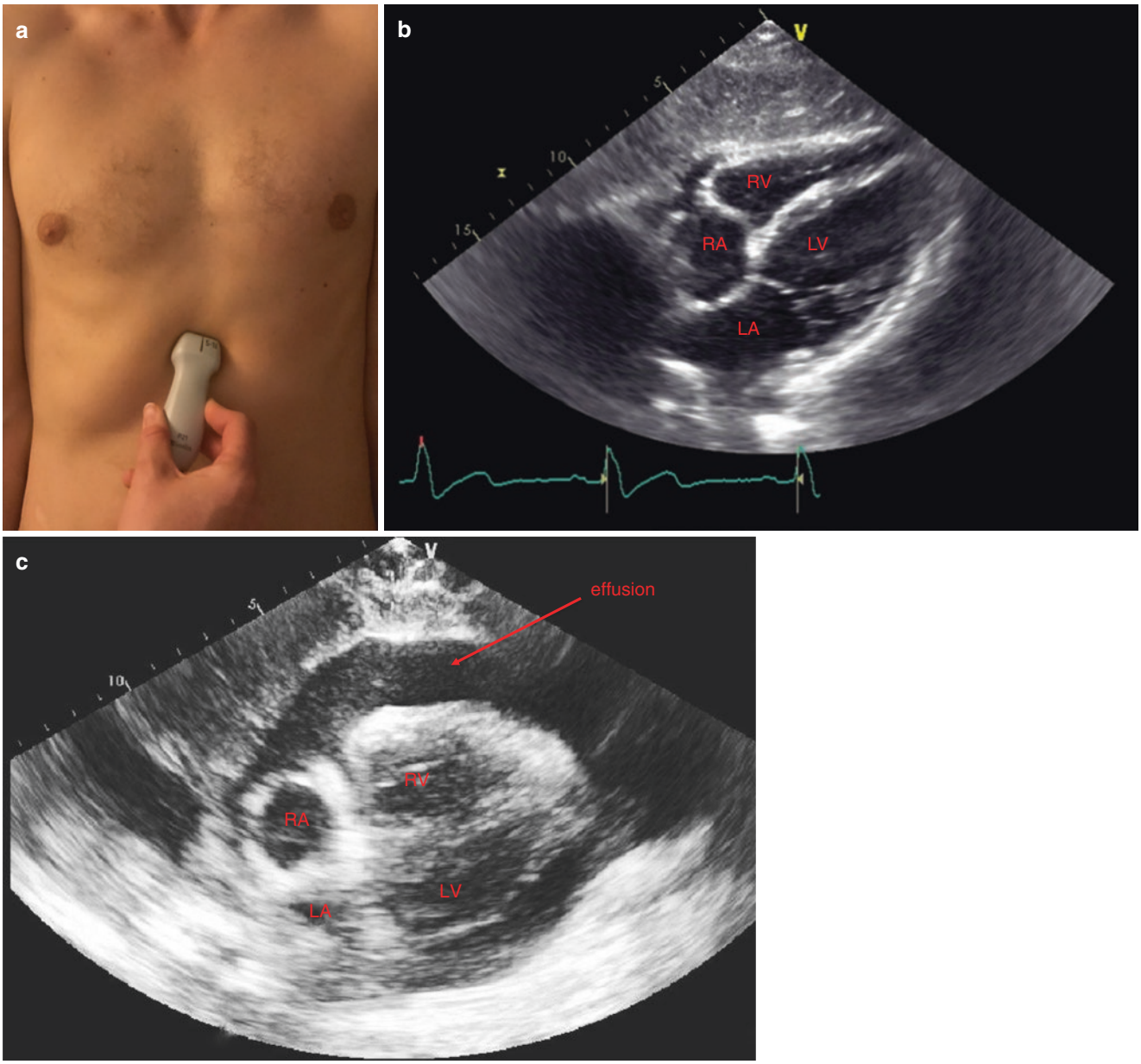

Fig. 16.3 (**a**) Subxiphoid probe position. (**b**) Normal ultrasound image subxiphoid view. (**c**) Subxiphoid view with pericardial effusion

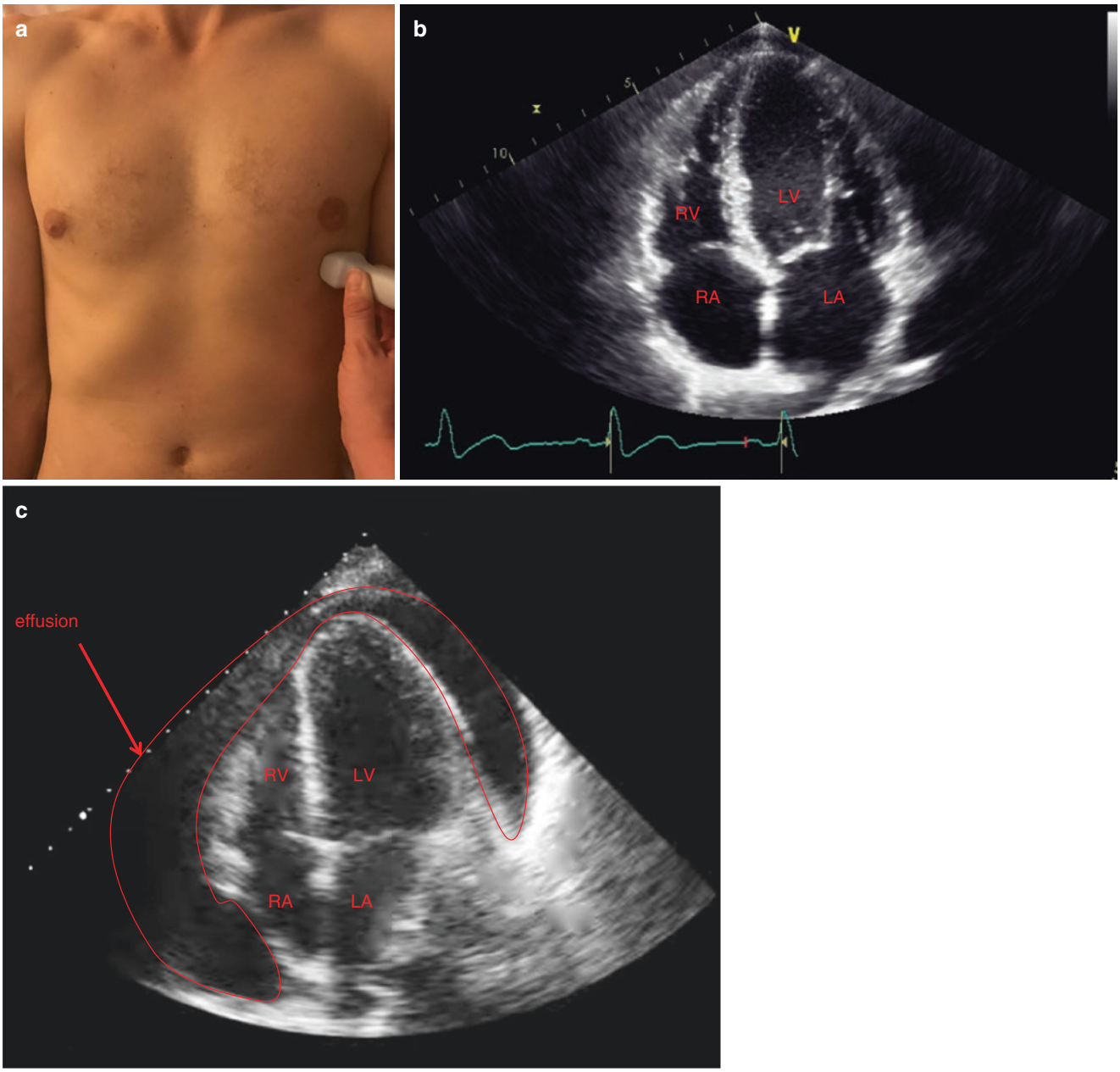

Fig. 16.4 (**a**) Apical probe position. (**b**) Normal ultrasound image apical four-chamber view. (**c**) Apical view with pericardial effusion

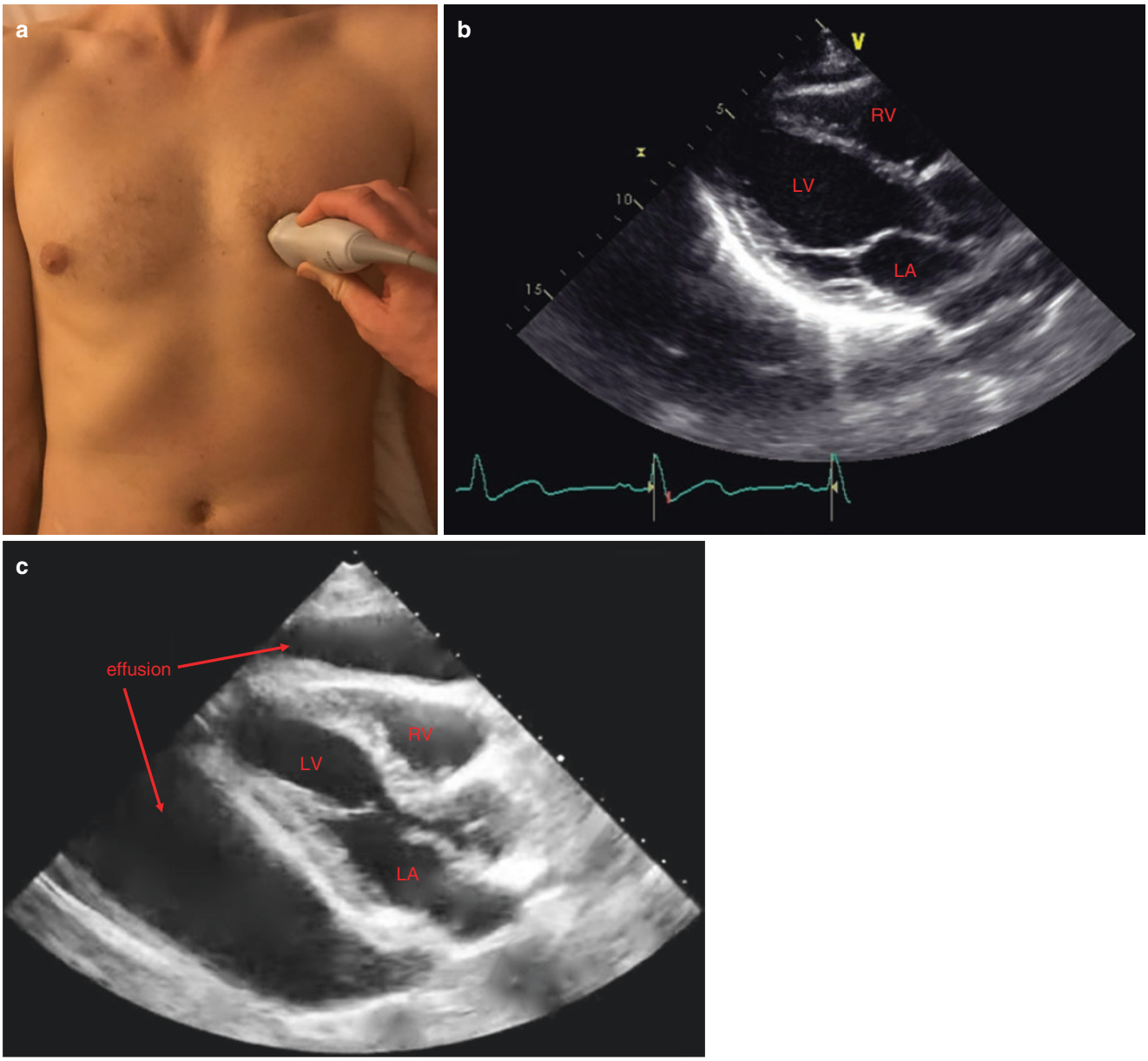

Fig. 16.5 (**a**) Parasternal probe position (long axis). (**b**) Normal ultrasound image parasternal (long axis) view. (**c**) Parasternal view with pericardial effusion

16.2 General Principles

- A pericardial effusion is an abnormal accumulation of fluid in the pericardial cavity. If it develops over a chronic period of time, the pericardium can dilate to accommodate the fluid. However, if it occurs acutely, rapid hemodynamic compromise ensues due to cardiac compression.
- Common causes of pericardial effusion include:
  - Acute: trauma, cardiac rupture, or iatrogenic injury
  - Subacute: uremia, infectious, or pericarditis
  - Chronic: autoimmune, inflammatory, and neoplastic process
- Indications for pericardiocentesis include:
  - Therapeutic: pericardial effusion with hemodynamic compromise/cardiac tamponade
  - Diagnostic
  - Palliative
- Consent from the patient or family member should be obtained whenever possible. Risks include:
  - Arterial or ventricular puncture
  - Liver injury
  - Gastric perforation
  - Pleural effusion
  - Pneumothorax
- Elective procedures should be performed under full sterile precautions, including full-body draping, gown, mask, and sterile gloves. Skin disinfection with chlorhexidine is superior to alcohol or Betadine. The ultrasound probe should be covered with a sterile probe cover. The skin entry site should be covered with dry gauze or transparent breathable dressing.
- Patients should be on supplemental oxygen and telemetry during placement.
- The operator should ensure appropriate intravenous access prior to the procedure (if the patient is hemodynamically stable).
- Nasogastric decompression is recommended, when possible, to decrease the likelihood of gastric perforation.
- Ultrasound guidance should be considered the standard of care. Determine the most superficial and largest pocket of fluid for aspiration.

16.3 Instruments

- Commercially available kits exist for pericardiocentesis/drainage. The operator should ensure familiarity with the specific product prior to use.
- General contents of a kit include (Fig. 16.6):
  - 18–20 gauge spinal or alternate needle
  - 60 cc syringe
  - Three-way stopcock
  - Flexible guidewire
  - Dilator
  - 6–8 Fr silastic drainage catheter
- Additional equipment which may not be included in the kits:
  - Chlorhexidine prep
  - Sterile drapes, gloves, mask, and gown
  - Local anesthetic
  - Appropriately sized needles
  - Additional syringes
  - Sterile saline
  - Resuscitation equipment (“code cart”)
- Ultrasound equipment
  - Phased array cardiac or low-frequency (2–4 MHz) probe for optimal resolution of structures
  - Sterile probe cover

Fig. 16.6 Commercially available pericardiocentesis kit

16.4 Positioning

- Semi-recumbent positioning with head of bed 30–45° upright is preferred, because it increases dependent pooling of fluid and brings the heart closer to the chest wall.
- Patients experiencing dyspnea due to tamponade may require more upright positioning for comfort.
- The procedure can be performed in supine position if full spinal precautions are indicated.

16.5 Technique

- The procedure should be performed under full sterile conditions, as described above, whenever possible.
- Bedside ultrasonography is used to identify the effusion (Figs. 16.3, 16.4, and 16.5).
- Lidocaine is injected with a 25 gauge needle over the intended puncture site to provide local anesthesia.
- A long spinal needle is connected to a three-way stopcock (Fig. 16.7). Alternatively, a specialized needle may be provided in the pericardiocentesis kit.
  - The ultrasound probe is held with the nondominant hand. The needle is held with the dominant hand and inserted through the incision at a 45° angle from the skin (Fig. 16.8).
  - The operator should aspirate while advancing the needle.
  - The needle is slowly advanced until the tip is seen in the fluid collection. This distance is generally less than 5 cm and can also be measured on ultrasound prior to the procedure (Fig. 16.9).
- Fluid is aspirated into the syringe (Fig. 16.10). Fluid can be emptied from the syringe by attaching tubing to the three-way stopcock (Fig. 16.7), and the procedure can then be terminated by removing the needle. Alternatively, the operator can continue with placement of a drain using Seldinger technique.
- The needle is stabilized in position with the nondominant hand, while the syringe is removed from the needle.
- The guidewire is then inserted through the Seldinger needle into the pericardium (Fig. 16.11). The wire should be advanced approximately 15–20 cm. The operator will then maintain the guidewire with the nondominant hand throughout the remainder of the procedure.
- The needle is removed. An 11 blade scalpel is used to make a small stab incision in the skin surrounding the wire (Fig. 16.12).
- A dilator is then advanced with the operator's dominant hand over the wire and into the tract. The end of the guide wire is maintained by the nondominant hand while advancing the dilator (Fig. 16.13). The dilator should not be advanced more than a few millimeters and then removed.
- The catheter should be inserted over the guidewire (Fig. 16.14).
- The guidewire should then be removed from the catheter.
- The catheter is then secured to the skin with adhesive dressing (Fig. 16.15). It can be left in place for up to 24 h.
- A portable chest X-ray should be obtained to evaluate for pleural effusion or pneumothorax.

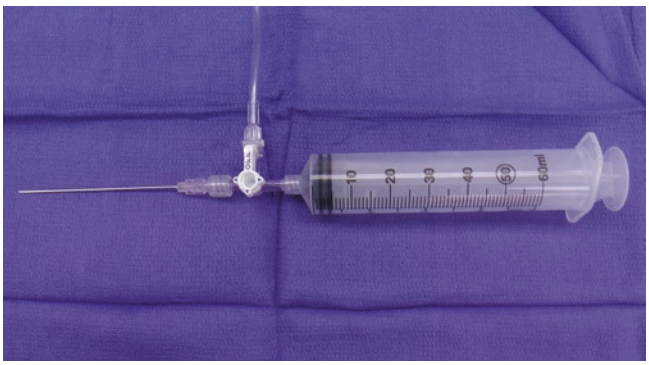

Fig. 16.7 Spinal needle/stopcock/tubing apparatus

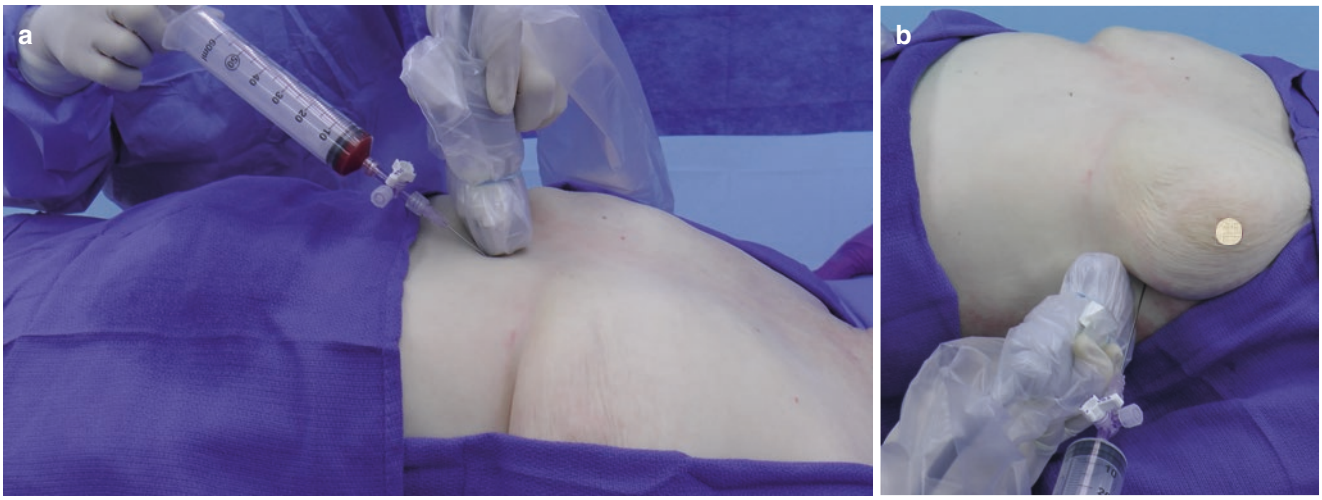

Fig. 16.8 The nondominant hand holds the ultrasound probe, while the dominant hand advances the spinal needle ((**a**) subxiphoid approach, (**b**) apical approach)

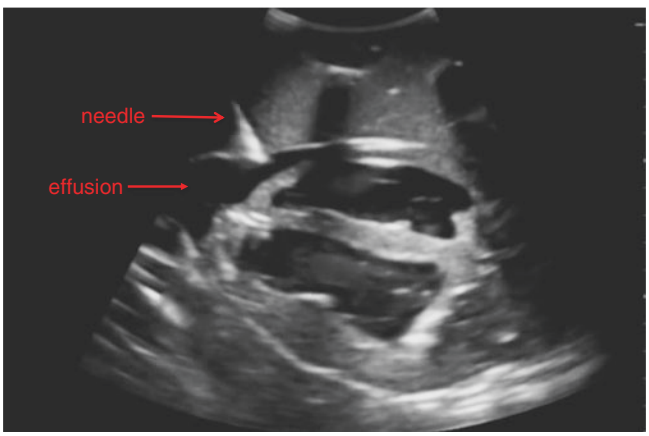

Fig. 16.9 Ultrasound view demonstrating the needle as it enters the effusion in real time. The arrow shows the tip of the needle entering the effusion

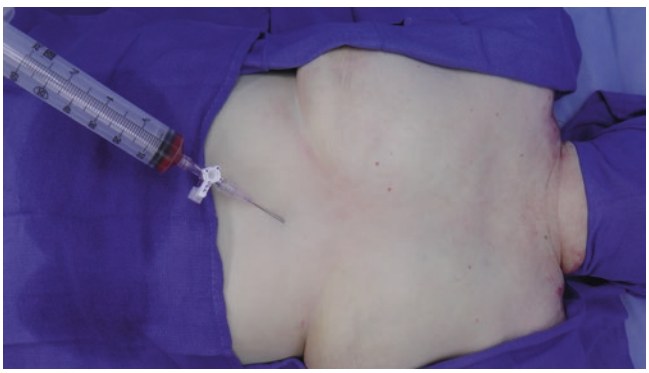

Fig. 16.10 Bloody fluid aspirated into syringe

Fig. 16.11 The wire is advanced through the Seldinger needle. The nondominant hand is used steady to the needle

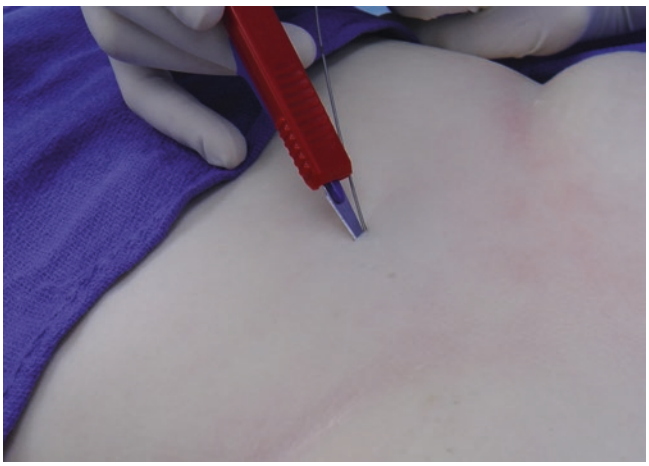

Fig. 16.12 A skin nick is made at the wire entry site

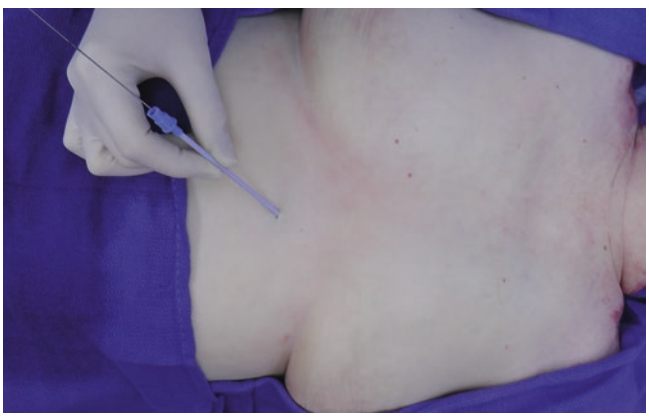

Fig. 16.13 A dilator is advanced over the guidewire. Note: the operator should maintain the end of the wire with the nondominant hand at all times

Fig. 16.14 The catheter is advanced over the guidewire to the desired length, while the free end of the wire is grasped with the nondominant hand

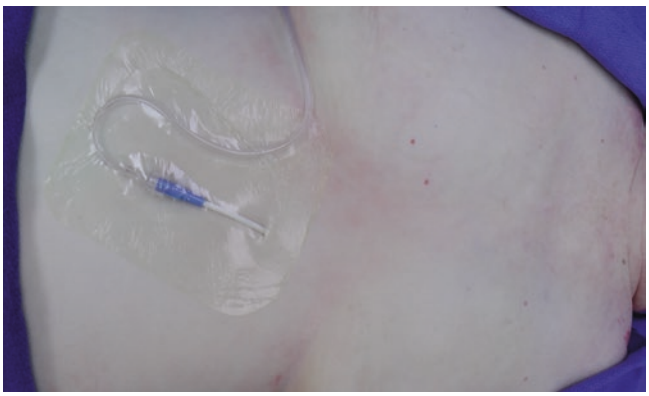

Fig. 16.15 The catheter is secured in place with an adhesive dressing

16.6 Complications

- Coronary artery or right ventricular puncture: this may be initially silent, then present with delayed hemopericardium that is poorly responsive to needle or catheter aspiration.
- Liver injury.
- Gastric perforation.
- Pleural effusion.
- Pneumothorax.
- Vasovagal response to pericardial decompression.
- Acute left or right ventricular dysfunction may be induced by successful pericardial decompression, despite no associated anatomic injury.

16.7 Tips and Pitfalls

- It is preferable to avoid the use of sedation, due to the risk for hemodynamic compromise. If sedation must be used, short-acting medications are recommended.
- Longer needles (up to 12 cm) may be required for obese patients, and shorter needles (4 cm) are appropriate for infants and small children.
- Needle tip position in the pericardial cavity can be confirmed by injection of agitated saline.
- ST elevations on telemetry during needle advancement suggest contact with the myocardium, and the needle should be slowly withdrawn.
- Relative contraindications to pericardiocentesis include myocardial rupture, aortic dissection, and severe coagulopathy (correct coagulopathy first, if possible).
- Percutaneous pericardiocentesis should not be used to evacuate frank blood or clot from around the heart, as the catheter will not allow for adequate drainage, and underlying cardiac injury cannot be addressed with this procedure. Also, removing pericardial blood may increase the driving pressure into the pericardial space.
- Loculation occurs in up to 1/3 of nontraumatic effusions. If no fluid is aspirated, the needle should be withdrawn promptly and redirected. Patient repositioning (more reverse Trendelenburg) may redistribute pericardial fluid and provide a better window for drainage. Operative intervention may be required.