The selection and positioning of the endoscopic portals are crucial portions of a thoracoscopic procedure and require forethought and careful planning. If the portals are malpositioned, the surgeon will struggle throughout the operation. If the portals are positioned appropriately, the operation is much easier to perform.

PRINCIPLES OF PORTAL POSITIONING

Several general principles are used to guide positioning of the portals. The portals should be spread far enough apart over the surface of the chest so that the surgeon’s hands are placed neither too close together nor too close to the endoscope. If the portals are clustered together too closely, the surgeon’s surface movements for manipulating the tools will be restricted. Consequently, he or she will “sword fight” or “fence” with the tools in an attempt to perform the dissection.

Because the surgeon stands anteriorly facing toward the patient’s chest during spinal thoracoscopy, the working portals for the insertion of tools, retractors, and suction devices are best positioned anterolaterally in the zone between the anterior and middle axillary lines (i.e., in the working zone, Fig. 12–1). The portal for the endoscope is best positioned posterolaterally between the middle and posterior axillary lines within the “viewing zone” for the spine. Separating the entry site of the endoscope from the area where the surgeon’s hands are actively working facilitates unencumbered, unrestricted dissection. The anterolaterally positioned working portals allow the surgeon’s hands and arms to rest in a natural, comfortable position during the dissection.

When the thoracoscope is inserted into the thoracic cavity and a 0°-angled endoscope is used, the portal must be positioned directly over the spinal segment where the pathology is located (Fig. 12–2). If a 30°-angled endoscope is used, the portal position may be offset above or below the level of the pathology and the endoscope is angled obliquely to provide a direct view of the spine. Using the 30°-angled endoscope brings the end of the endoscope camera away from the working portals, allowing the surgeon’s hands more room to work on the surface of the chest (Fig. 12–2).

The orientation and field of view of the 30°-angled endoscope can change if the telescope lens is inadvertently rotated intraoperatively. Such movement is counterproductive because the field of view is rotated away from the surgical target (Fig. 12–3). The surgeon should verify the desired orientation of the 30°-angled endoscope before inserting it into the chest and, if needed, remove the endoscope to reorient the lens properly.

The positions of the working portals are triangulated. Ideally, they should be spaced evenly rostral and caudal to the surgical target. During the dissection, the surgeon can then stand comfortably, with his or her hands at approximately equal medial trajectories (Fig. 12–4). This portal configuration has been referred to as a baseball diamond with the surgeon positioned at home plate, the target pathology at second base, and the working portals at first and third base, respectively. If the working portals are both offset above or below the target, the surgeon must twist his or her body and hold the arms in an awkward position to use the endoscopic tools (Fig. 12–4). If the working portals are positioned too posteriorly, the surgeon must elevate his or her arms in an awkward position, which is unstable and susceptible to fatigue (Fig. 12–5A). A natural, comfortable arm position for the surgeon is facilitated by placing working portals anterolaterally and rotating the patient anteriorly 30 to 40° (Fig. 12–5B).
The posterior axillary line is superficial to the thoracic vertebrae in a coronal plane over the spinal canal. The space between the middle and posterior axillary lines, the viewing zone, provides the best region to insert the endoscope for spinal thoracoscopy. The space between the anterior and middle axillary lines, the working zone, provides the best region to insert portals for tools to perform dissections of the spine. This configuration brings the surgeon's hands anteriorly away from the endoscope, allowing more space to maneuver.

**Figure 12–1.**
If a fan retractor is needed to move or hold the lung away from the spine manually, the retractor can be placed between the anterior and middle axillary lines offset rostral or caudal to the working portals. The retractor is inserted obliquely so it can retract the lung but not interfere with the surgeon's hand movements (Fig. 12–6). Once the lung is gently moved away from the spine, the patient can often be rotated anteriorly to allow gravity to keep the lung away from the spine.

**PORTAL SELECTION**

Flexible portals are used for thoracoscopy rather than rigid portals that can contuse or compress the intercostal nerves and cause intercostal neuralgia postoperatively. The portals are protective, plastic tissue sheaths that maintain the space into the chest through the intercostal spaces. Portals are needed at the site where the endoscope is inserted to keep blood and debris off the endoscope. Portals are also useful at the working sites where tools are inserted and removed from the channel repetitively. For sites where a single tool is inserted and held in position (i.e., the site for a fan retractor or suction device), a portal is probably unnecessary. The tool can be inserted directly through a small incision, through the intercostal space, and into the chest.

The diameter of the flexible thoracoscopic portal must be wide enough to contain the size of the endoscope and tools that will pass through the portal. An 11-mm or a 15-mm portal is adequate for most purposes during thoracoscopy: they fit the endoscope and most tools. A 7-mm portal can be used for a suction-irrigation tool. A 20-mm diameter portal is needed if bone grafts or screw plates will be placed (end-on) through the portal (Fig. 12–7). Large diameter objects (i.e., 16–25 mm) can also be passed by dilating the soft tissues with a speculum (Fig. 12–8) or by extending the intercostal incision to 1 to 2 inches (i.e., a mini-utility thoracotomy). The 7- and 11-mm portals have a round cross section. The 15- and 20-mm portals have an oval cross section so that they can fit into the intercostal space without compressing the intercostal nerve.

**TECHNIQUES OF PORTAL INSERTION**

Before a portal is inserted, the skin, muscle, and intercostal nerve at the sites are blocked with a local anesthetic by the local infiltration of 1% Marcaine® with epinephrine solution. The anesthetic reduces the incidence of intercostal neuralgia at the portal sites.

For insertion of the first portal, the skin and subcutaneous tissue are incised (10 to 15 mm) parallel to the superior surface of the rib to avoid the neurovascular bundle. A hemostat is passed through the intercostal muscles directly over the retracted lung field (Fig. 12–7). The hemostat is then grasped with a pair of pliers to exteriorize the endoscope and camera. A small incision is made through the skin, subcutaneous tissue, and intercostal muscle, and the hemostat is passed through the intercostal space. The endoscope and camera are then inserted through the portal (Fig. 12–8). The muscle fibers are then retracted with a hemostat to provide access to the pleural space. The hemostat is then removed, and the portal is sealed with a sealant.

**Figure 12–2.** A 0°-angled endoscope has a field of view directly ahead of the tip of the telescope. It must be placed directly over its surgical target to provide a direct view of the pathology. A 30°-angled endoscope can offer a clear view of the surgery from an oblique trajectory, which moves the camera and endoscope away from the surgeon's hands on the surface of the chest. The 30°-angled telescope provides more room for the surgeon's hand on the surface of the chest because the endoscope is positioned farther from the working portals.
Figure 12–3. (A) The lens of the 30°-angled endoscope can be rotated to view the anatomy from a new perspective. This off-axis telescope can be positioned to look around corners of the dissection site. (B) If the 30°-angled endoscope is inadvertently rotated, the target can move out of the field of view.

Figure 12–4. The working portals are ideally positioned equidistant rostral and caudal to the surgical target so that the surgeon's hands rest in a comfortable position during the dissection. (Inset) If both portals are above or below the spinal target, they can obstruct the surgical view.
Figure 12–5. (A) Positioning the working portals too posteriorly forces surgeons to elevate their arms in an awkward, unstable, fatiguing position. (B) The surgeon’s arms rest in a comfortable position when the working portals are placed near the anterior axillary line, and the patient is rotated anteriorly 30 to 40°.
Figure 12-6. The endoscope is positioned between the middle and posterior axillary lines to provide an anterolateral perspective of the thoracic spine. The working portals and retractors are placed more anteriorly. When a lung retractor is needed, its portal should be positioned so that its handle does not interfere with the surgeon’s hand movements on the chest surface.

Figure 12-7. Flexipath™ (Ethicon Endosurgery, Cincinnati, OH) flexible thoracoscopic portals are available in diameters of 20, 15, and 7 mm.

tips of the closed hemostat penetrate through the parietal pleura into the thoracic cavity. The tips of the hemostat are opened and widely spread apart to dissect the intercostal muscles from the upper edge of the rib to create a space for the trocar and portal (Fig. 12-9). The surgeon then inserts a gloved finger through the incision into the chest and feels for lung adhesions that would preclude inserting a portal at that site. The method for preparing the portal insertion site is similar to the method for inserting a chest tube, except that the trocar penetrates through the intercostal space directly beneath the skin incision (Fig. 12-10).

A rigid trocar is inserted into the flexible portal to guide the portal through the chest wall. After the surgeon excludes the presence of local pleural adhesions, the first portal and the trocar are inserted through the intercostal space into the chest (Figs. 12-9 and 12-10). The rigid trocar is removed from the portal, leaving the flexible tissue sheath within the chest wall (Fig. 12-10B). The length of the soft flexible portal can be customized to fit the individual patient. If needed, the tip of the portal can be shortened with scissors. The proximal end of the flexible portal has a cuff that can be stapled or sutured to the skin to keep the portal anchored in a stable position during the procedure (Fig. 12-11).

After the first portal is inserted, the endoscope is inserted into the chest, the extent of atelectasis is assessed, and the contents of the thoracic cavity are inspected systematically. All additional portals are inserted under direct visualization using techniques identical to those employed for the first portal. Direct endoscopic visualization is needed to prevent penetration of the diaphragm and visceral injury. Particularly when portals are inserted below T7, the surgeon must exercise caution to avoid penetrating the diaphragm. Far anterior portal placement should be avoided to prevent injury to the internal mammary artery and the mediastinal structures. The first and second intercostal spaces should be avoided to prevent injury to the subclavian artery and vein.

When present, focal pleural adhesions may be detached by sharp dissection with scissors or blunt dissection (digital separation or cotton-tipped dissectors) to mobilize the lung
fusion, pleural symphysis) usually cannot be detached endoscopically. Such adhesions preclude endoscopic access and require conversion to a thoracotomy. If adequate atelectasis was not achieved initially or if the lung was partially ventilated, the anesthesiologist should reposition the double-lumen endotracheal tube using a fiber-optic bronchoscope. As the lung is deflated, dense atelectasis is achieved. The lung may be moved gently away from the surface of the spine with a tool or retractor. Rotating the operating table 30 to 40° anteriorly reduces or eliminates the need to retract the lung. If an endoscopic fan retractor is needed for mechanical retraction of the lung, it should be opened, repositioned, and closed under direct endoscopic visualization to avoid lacerating the lung.

**PORTAL CONFIGURATIONS**

The configuration of the portals can vary depending on the surgeon's preferences, the patient's body habitus, the type of pathology, the type of spinal procedure performed, and the location of the spinal pathology (Figs. 12–13 to 12–20). Most simple spinal procedures (i.e., sympathectomy, discectomy, biopsies) can be performed with three portals (Figs. 12–13 to 12–15). Four portals (sometimes more) may be needed for more complex procedures (i.e., corpectomy, fusion) or when a lung or diaphragm retractor is needed (Figs. 12–16 to 12–22).

**Portals for Upper Thoracic Access**

T1 to T5 are accessed by inserting portals close to the inferior edge of the axillae. The arm is abducted and secured to an ether screen to provide access to the axillae and to rotate the scapula posteriorly away from the portal insertion sites. The axillary space is never entered so that the brachial plexus and axillary vessels are not injured. Likewise, neither the first nor second intercostal space is entered so that the subclavian vessels can be avoided. Working portals are inserted in the third and fifth intercostal spaces. The portal for the endoscope is inserted more posteriorly in the fourth or fifth intercostal space, anterior to the edge of the latisimus dorsi muscle (Fig. 12–13).

**Portals for Middle Thoracic Access**

T5 to T10 are the easiest levels to expose because they are centrally located in the thoracic cavity, and the diaphragm seldom must be retracted to expose the spine. The portal configurations are individually customized for the patient's surgical procedure. Three or four portals are used for most procedures; occasionally, another portal may be needed. A T-shaped portal configuration is used.
Figure 12–9. Technique for insertion of flexible portals. A small incision is made parallel to the superior surface of the rib over the intercostal space. (A) A closed hemostat penetrates through the intercostal muscles over the superior surface of the rib. (B) The hemostat is spread to dissect the muscles apart. (C) Before the first portal for the endoscope is inserted, the surgeon inserts a gloved finger to feel for lung adhesions and to ensure that the lung is deflated to prevent its injury. (D) Intraoperative photograph and (E) corresponding illustration showing the insertion of the portal and trocar.
Figure 12–9. (continued) (F) The trocar is removed, leaving the portal in place.

Figure 12–10. (A) The flexible portal and trocar are inserted into the incision in the intercostal space. (B) The trocar is removed, leaving the portal in place. The portals are sutured or stapled to the skin to anchor them into position.
Flexible portals are anchored to the skin with staples or sutures. A long needle can be inserted through one of the portals into a disc space so that the spinal level can be localized radiographically. [With permission of Barrow Neurological Institute.]
THORACOSCOPIC ACCESS STRATEGIES: PORTAL PLACEMENT TECHNIQUES AND PORTAL SELECTION

Figure 12–13. Illustration of portal placements for approaching the upper thoracic spine. This configuration is useful for sympathectomy or lesions affecting the T1 to T4 vertebrae. The working portals are positioned in the third and fifth intercostal spaces (ICS). The second ICS should not be used to avoid injuring the subclavian vessels. The viewing portal for insertion of the endoscope is positioned posterior to the working portals.

Figure 12–14. Three portals are usually used for thoracoscopic microdiscectomy. The portals are triangulated above and below the spinal target level. An additional portal may be needed in the working zone, rostral or caudal to the working portals, to insert a retractor for the lung or the diaphragm.

Portals for Lower Thoracic Access
T9 to L1 are adjacent to the diaphragm, which usually must be retracted to expose this area. The diaphragm is retracted caudally to reduce the amount of diaphragm retraction needed. For exposure of the T12 and L1 vertebral bodies, the pulmonary ligament is detached. The pleura is mobilized so that the caudal retropleural space can be entered. The crus of the diaphragm is incised and the diaphragm is retracted caudally. This strategy allows the surgeon to expose T12 and L1 transthoracically without inserting separate portals in the retroperitoneal space. If needed for reconstruction and dissection, additional retroperitoneal portals can be used for accessing the retroperitoneal space.
Figure 12–15. When three portals are needed, various positions and shapes can be used to configure the working portals and the viewing portal for a thoracoscopic microdiscectomy. (A) The working portals are spaced equidistant rostral and caudal to the target. When a 0°-angled endoscope is used, it must be positioned directly over the target. (B, C, and D) To move the endoscope away from the working portals, the endoscope portals are offset when the 30°-angled endoscope is used.
Figure 12–16. When four portals are used for thoracic microdiscectomy, corpectomy, or other procedures, the surgeon has more options to vary the positions of the portals. Retractors are inserted through offset portals so that access to the working portals is unobstructed. Typically, T- or L-shaped portal configurations are used. 0°-angled endoscope with fan retractor positioned (A), retroflexed (B), and 30° up (C), and 120° angled (D).
A common portal configuration for thoracoscopic microdiscectomy positions a 30°-angled endoscope obliquely to the target, bringing the endoscope’s camera farther away from the surface of the chest over the working portals. The working portals are positioned near the anterior axillary line, spaced equidistantly above and below the pathology.

Figure 12–17.
**Figure 12–18.** Portal configurations to access the lower thoracic spine and thoracolumbar junction. A portal is devoted to a fan retractor to retract the diaphragm caudal to the costophrenic recess to expose the spine. A reverse Trendelenburg position can be used to allow gravity to aid in the retraction of the viscera and diaphragm caudally.

**CLOSURE OF PORTAL SITES**

After the spinal dissection and hemostasis have been completed, the thorax has been irrigated and cleared of debris, and the lung surface inspected, the portals are removed from the chest wall. The endoscope is kept inside the thorax so that the portal incisions can be examined internally. A bleeding portal incision can be controlled internally using thoracoscopy or externally by inserting a speculum into the incision to identify the bleeding vessel and using bipolar cauterization to seal it. After most thorascopic procedures, chest tubes typically are inserted into the chest through the existing portal incisions and secured with heavy-gauge silk purse-string sutures. The surgeon may wish to make a separate skin stab incision to create an oblique subcutaneous tunnel through which the chest tube can be inserted into the portal site. The skin over the portal site can then be sutured directly to obtain an airtight closure. For postoperative analgesia, the subcutaneous tissues adjacent to the portal incisions are anesthetized with a 1% Marcaine® injection just before the incisions are closed. The portal incisions are then closed with separate subcutaneous and subcuticular layers of interrupted absorbable sutures to provide an airtight tissue closure.
Figure 12–19. For an anterior release of an extensive multilevel scoliotic deformity, the convex surface of the spine is approached using portals positioned linearly. Most of the portals are positioned near the anterior or middle axillary lines. This configuration allows the surgeon to view and expose the anterior longitudinal ligament and the disc spaces over multiple levels of the spine.

Figure 12–20. When a screw plate is needed for internal fixation, the portals must be positioned coaxial to the intended trajectory of the screws and bolts. The positions of the portals are evaluated fluoroscopically.
Figure 12–21. Portal positions for inserting screw plates. The bolt portals are usually positioned near or behind the posterior axillary line. The screw holes are positioned more anteriorly yet posterior to the midaxillary line.
CONCLUSIONS

Selection and positioning of the portals are crucial steps that can facilitate intraoperative access and dissection. The techniques for inserting thoracoscopic portals into the chest are relatively simple, and various strategies can be individualized to fit a patient’s pathology, the level of the spine, and the particular operative procedure being used. If the portals are malpositioned, however, surgery will be hindered.

RECOMMENDED READINGS