
Laparoscopic Abdominal Access and Prevention of Injury

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INTRODUCTION

This paper reviews the use of trocars and trocar-related injuries with abdominal surgery, covering the following areas:

- SECTION I reviews the types of trocars in use and the wounds most commonly associated with each type;
- Section II covers the most common sites and types of injury related to trocar use;
- Section III addresses the factors associated with increased risk of injury from penetration force, obesity, and adhesions; and
- Section IV examines ways physicians can prevent and manage injuries

Approximately 1 in every 1000 patients undergoing laparoscopic abdominal surgery will experience bowel or vessel perforation injury by trocars during initial access.¹ A systematic review of studies found no conclusive evidence that any one method of gaining initial access and establishing pneumoperitoneum during laparoscopic surgery is safer or more efficacious than another.² While injuries occurred with all commonly used methods, trends in the findings warrant further study. Similarly, reports reviewing injury claims submitted to the Food and Drug Administration as well as to insurers found that no single trocar is without the potential for injury.^{3,4} While neither the method nor type of trocar used appears to influence the safety of establishing laparoscopic access, factors reported to contribute significantly to visceral and vascular injuries are usage errors,⁴ inexperience,⁵ poor skill,⁶ violation of good technique,⁶ high axial force with excessive downward displacement of the abdominal wall,^{6,7} over-thrust,⁶ inadequate incision size,⁶ and previous abdominal surgery.⁷ Although infrequent, injuries and complications related to abdominal access for laparoscopic surgery concern surgeons, as they adversely affect patients and may lead to litigation.^{3,4} After a review of the trocars available for laparoscopic surgery, common injuries and key issues in injury prevention will be addressed.

SECTION I

TROCAR TYPES

Many types of trocars are manufactured for laparoscopic surgery⁷ and are used in four common methods of gaining initial access to the abdominal cavity: Veress needle insufflation followed by trocar puncture; open technique (also referred to as the Hasson technique); direct trocar puncture; and direct puncture with visualization through an optical trocar.⁸ Although the majority of surgeons use the Veress needle followed by trocar puncture, some say that the open approach is the safest method to gain entry.^{5,9,10}

Trocars can be grouped into several categories. The two major but overlapping categories are reusable and disposable. A few manufacturers make reusable trocars, which have a reusable cannula and a disposable trocar and valve component. Reusable, disposable, and reusable trocars can be further grouped according to whether they have cutting or noncutting blades. In addition, trocars with or without cutting blades may have optical devices that permit visualization of the blade and abdominal wall tissue. Generally, disposable trocars with cutting blades have retractable shields that cover the cutting tip after entering the abdominal cavity, while reusable cutting trocars do not.

CUTTING TROCAR

Trocars with cutting blades have two basic designs:

- **Pyramidal-tipped trocars** have sharp edges that cut tissues in three planes as they pass through the abdominal wall. Reusable versions of these do not have retractable shields.
- **Flat-blade trocars** have two sharp edges and cut tissue in a single plane. Disposable pyramidal-tipped and flat-blade trocars generally have retractable shields.

NONCUTTING TROCAR

Trocars without cutting blades have three basic designs:

- **Pointed conical trocars** penetrate the abdominal wall by separating tissue fibers along paths of least resistance.^{11,12}
- **Blunt conical trocars:** One version uses a blunt obturator to dilate an expandable sheath that is inserted through the abdominal wall over a Veress needle.¹³ Other blunt trocars are intended to be placed through an incised wound, such as would occur with the open technique.
- **Optical trocars** are a subset of trocars. Three devices are commercially available—one has a cutting blade and two are bladeless. Each uses a laparoscope that is inserted down the trocar's shaft to visualize tissue planes and landmarks. The bladeless optical trocars have a clear conical tip with flanges that separate fascial and muscle fibers as the trocar is pushed through the abdominal wall. The bladed trocar has a clear

Pyramidal-blade Trocars



Figure 1
Reusable



Figure 2
Disposable

Flat-blade Trocars



Figure 3
Flat-blade



Figure 4
Flat-blade

Unique Trocars



Figure 5
Conical



Figure 6
Optical-blade

Non-bladed Trocars



Figure 7



Figure 8



Figure 9

half-sphere dome that allows tissue visualization. Its blade is activated by a trigger mechanism and cuts the tissue in view, then automatically retracts.⁶

EXAMPLES OF TROCAR TYPES

Trocars can be grouped into several categories (see Figures 1–9).

WOUNDS ASSOCIATED WITH TROCAR TYPES

Studies have shown that trocars of the same diameter create defects similar in length, regardless of the trocar used, but that noncutting trocars create wounds with a smaller width than cutting trocars.^{12,14} In fact, one study found that 12-mm blunt conical (i.e., noncutting) trocars created wounds of a size similar to those of an 8-mm pyramidal (i.e., cutting) trocar.⁵

- **Pyramidal-tip trocars** cut tissue fibers in three planes; the tissue tends to retract and leave a gaping wound (Figures 10 and 11).
- **Flat-blade trocars** cut fibers in one plane; therefore, some tissue layers will be cut, while other layers will be separated as the trocar passes through the ab-

dominal wall. These wounds tend to gape less than wounds of pyramidal trocars (Figures 12 and 13).

- **Noncutting trocars** separate tissues along planes of least resistance and do not cut across fibers, minimizing wounds (Figures 14 and 15). Noncutting trocars create what is referred to as a “grid-iron incision” wound in areas of the abdominal wall having multiple layers.¹⁴ Layer overlap is most likely at paramedian sites, where there are multiple layers of muscle and fascia, rather than at midline sites, which pass through the condensed fascia of the umbilical scar. The difference in the direction of tension on different layers of tissue tends to cause the wound to close when the cannula is removed. Similarly, using the “Z”-track insertion technique exaggerates the overlap of muscle layers and reduces hernia formation. Wounds created by the open approach are linear scalpel incisions through the fascia and peritoneum and are of variable size, depending on surgeon technique.¹⁵

The following slides provide images of various wounds presented by trocar type.