SURGICAL INSTRUMENTATION

SECOND EDITION

Nancymarie Phillips

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RN, PhD, BA, BSN, MEd, RNFA, CNOR(E)

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***Surgical Instrumentation,* Second Edition**
Nancymarie Phillips

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PREFACE

This text, *Surgical Instrumentation, Second Edition,* is designed for perioperative personnel in all surgical disciplines. Surgeons, nurses, technologists, and technicians will find the design and collections in this book informative and user friendly. Books about surgical instrumentation have been in print for more than 100 years. However, none have offered comprehensive collections of instruments used with foundation sets for multiple specialties. They feature individual instruments without providing guidance for establishing or streamlining the set creation process.

THE DEVELOPMENT OF THIS TEXT

The four foundation sets described in this text are designed to be base units for use during procedures that meet the needed instrument weight, length, gauge, shape, and material necessary for a safe, efficient surgical procedure. The additional instrument groupings, such as those specific to a particular organ or region of the body, can be established as "add-on" sets to be used in combination with the appropriate foundation set.

Every perioperative nurse or surgical technologist who scrubs has encountered sets with instruments that have not been used for many years, yet the items continue to be packed into the tray for no apparent reason. This book may serve as a guide for establishing standardized instrument sets that will facilitate the count process and ease the burden of inventory control.

ORGANIZATION OF THE TEXT

This text is divided into 16 chapters. Images of the surgical instrumentation are displayed in table form with descriptions and sizes listed.

- *History of Surgical Instrumentation.* The first chapter describes the history of surgical instrumentation and provides background information about the philosophy and contributions of different cultures to the discipline of surgery.
- *Anatomy and Physiology of Surgical Instrumentation.* The materials and characteristics of surgical instruments are explored, as well as the design from handle to tip.
- *Categories of Surgical Instrumentation.* Surgical instruments are designed for specific functions and are grouped into functional categories that define the purpose for each instrument. Specific groupings make it easier to learn the instruments.
- *Considerations for Instrument Set Assembly.* Trays and containers for packaging instruments are described in this chapter. Accountability is a team effort that begins with the construction and assembly of each set.
- *Soft Tissue Foundation Sets.* The foundation sets are designed to meet specific needs for a procedure at a basic level by grouping instruments by category and function.
- *Plastic Surgery Instrumentation.* Instruments specific to the type of plastic surgery procedure are described in combination with foundation sets.
- *General Surgery Instrumentation.* Functional instruments that are added to foundation sets for general surgery are described by organ system and body location.
- *Gynecologic Instrumentation.* Specialty instrumentation specific to the needs for surgery of the female reproductive tract is described.
- *Urologic Instrumentation.* Instrumentation specific to genitourinary procedures of the urethra and kidney is included in this chapter.

- *Basic Bone and Joint Instrumentation.* Many specialties utilize instrumentation to debulk, dissect, or repair bony tissue throughout the body. The bone instruments are used in combination with soft tissue foundation sets according to the location on the body.
- *Head and Neck Procedure Instrumentation.* Upper airway and otorhinolaryngology procedures require specialty instrumentation designed for narrow passages and the soft tissues of the anterior neck and throat.
- *Neurosurgery Instrumentation.* Procedures of the brain and spinal cord use a unique blend of soft tissue sets, compact tissue sets, and microsurgical sets. Instrumentation for procedures of the cranium and spine is described.
- *Cardiothoracic and Vascular Instrumentation.* Instrumentation used for surgical procedures of the lungs, heart, and vascular system is described.
- *Microsurgery Instrumentation.* Microsurgery is usually performed on soft tissues. These sets can be used in combination with foundation sets or as stand-alone sets.
- *Endoscopic Instrumentation.* The application of endoscopic techniques to multiple specialties is described. Percutaneous and natural orifice endoscopy is described in functional terms.
- *Decontamination and Sterilization.* A critical component in a complete understanding of surgical instrumentation is understanding decontamination and sterilization of the instruments. This new chapter includes information on cleaning (manual and mechanical), inspection, disinfection, sterilization, and packaging.

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Chapter 4: Considerations for Instrument Set Assembly

Chapter 5: Soft Tissue Foundation Sets

Chapter 9: Urologic Instrumentation

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CHAPTER 1

HISTORY OF SURGICAL INSTRUMENTATION

OBJECTIVES

After reading this chapter the learner should be able to:

1. Describe several historic findings that indicate ancient humans used surgical instruments.
2. Discuss the countries that contributed ideas to the surgical armamentarium.
3. List several materials that comprised early surgical instruments.

INTRODUCTION

Since the beginning of time, man has sought to appease the gods and remedy the failings of the human body with the medical and surgical arts. Each culture has historically approached medicine and surgery in a different way and has lent a societal touch to the evolution of surgical practice.

HISTORIC SURGICAL INSTRUMENTATION

Forms of early surgical practice encompassed tending injuries and wounds associated with animal encounters or battles. Some Neolithic tribes were known to have practiced amputation for serious injury, tumors, or infection. Relics of surgical instruments, such as sharpened flints and natural substances like shells, have been found wherever civilizations have been uncovered. Scientists have speculated dates ranging from 10,000 BC for early incisions to 2500 BC for suturing with horsehair or animal tendons.

Hindus developed the earliest known organized practice of surgery (shastrakarma), which is one of the eight branches of Ayurveda (Indian medicine). Shushruta (circa 800 BC), a medical practitioner from Benares, India, wrote the *Samhita*. In this text he described the need for cleanliness and precision in surgical treatment. His writings were captioned under seven topics: esya (exploration), ahrya (extraction), chedya (excision), lekhya (scarification), vedhya (puncturing), vsraya (evacuation), and sivya (suturing). He based his methods of surgery on his studies of anatomy using dead bodies. Shushruta developed 121 separate surgical instruments of natural materials, such as bone, ivory, mussel shell, and stone. He also advocated the use of hypnosis and wine as anesthetics.

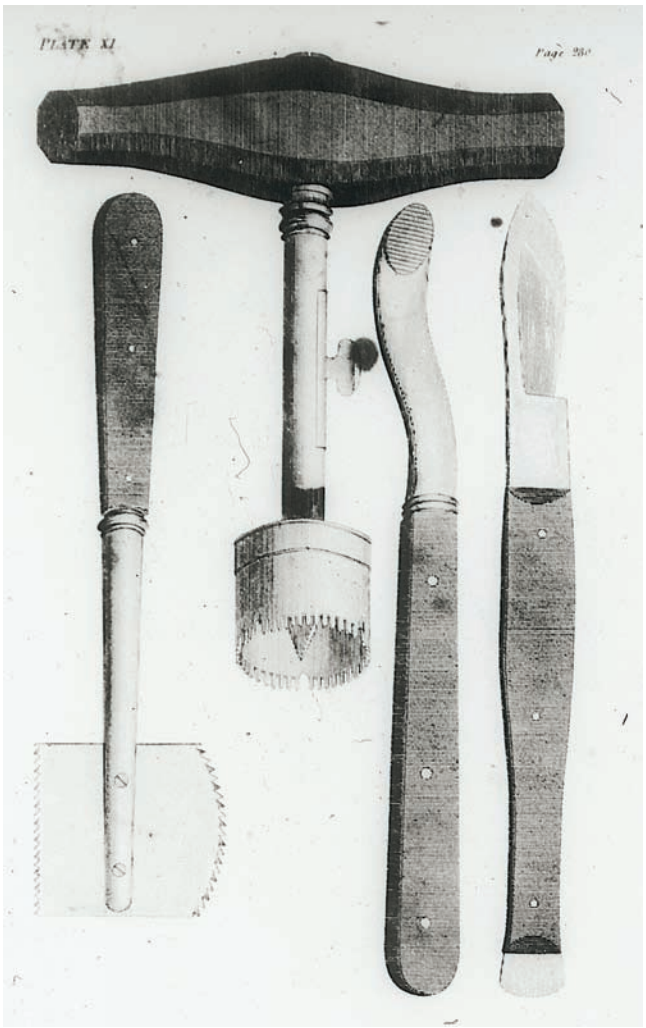
CHAPTER OUTLINE

RITUAL AND MAGIC

Prehistoric man performed documented incisional procedures as early as 6000 BC. Scientists speculate that some procedures, such as opening holes into the skull (known as trepanation), were performed for ritualistic or magic reasons. Significant numbers of skulls have been found that indicate the patients lived for many years after the procedure, as new bone growth was identified around the cut edges of the bony holes. Figure 1-1 depicts trepanation instruments used for opening skull bone.

The ancient Egyptians did not feature cutting as a primary medical treatment. Egyptian temple and tomb art indicates that most of the anatomic study involved the embalming of bodies for burial. The religious sects were guardians of physical knowledge and held the internal anatomy sacred. Archeologists discovered papyri that described medical care during this period. In 1862, American Edwin Smith purchased a 22-page papyrus, dating from 1500 BC that contained many treatments performed during ancient times. It was later deciphered by James Henry Breasted. German Egyptologist George Ebers purchased a similar papyrus in 1872 that consisted of 110 pages that dated back to the First Dynasty in 3000 BC. A later papyrus was written as a guide for midwives and those who cared for female patients. These papyri contained medical and surgical references intermingled with magical spells for protection against supernatural forces.

Cataract surgery, known as couching in many ancient lands, was a common procedure between 1345 and 1200 BC. This surgery was performed by using a rodlike tool with a blunt end to tap the eye, causing the lens to shift away from the pupil. This allowed light to enter. Later methods of performing this procedure included inserting a needle into the eye to dislodge the natural lens (Figure 1-2).



Courtesy of the National Library of Medicine

Figure 1-1 Ancient trepanation instruments.

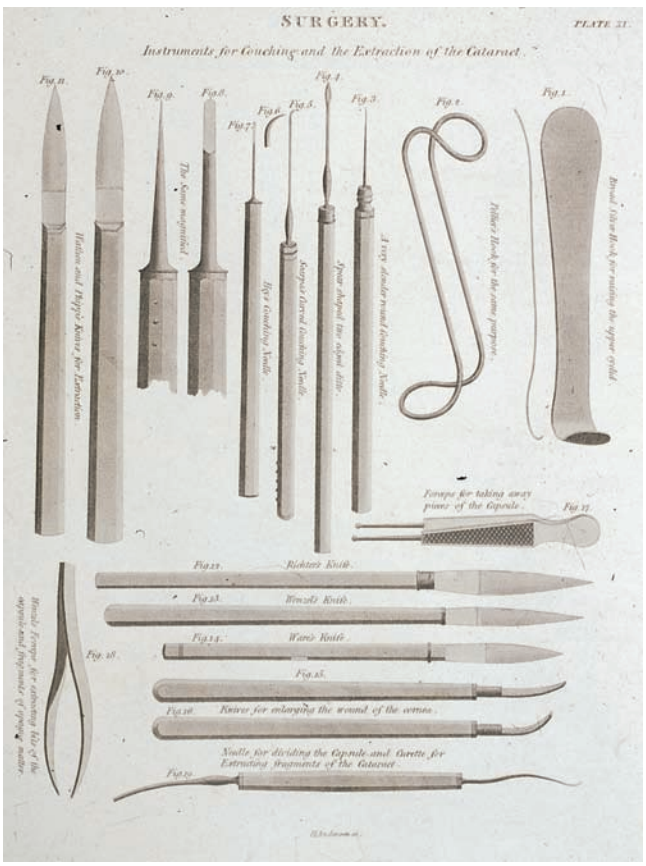


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Figure 1-2 Instruments used historically for cataract surgery.

Mesopotamian society (circa 3500 BC) exercised generalized laws and rules governing conduct. They had a concept of comparative worth concerning human life and believed in medical training before commencing practice. The physicians in Mesopotamia identified specific procedures, named each drug used in medical care, and kept records of medical and surgical activities by carving cuneiform figures into clay tablets. Over 20,000 such tablets have been discovered.

Ancient Babylonians (modern-day Iraq) were led by the great King Hammurabi (1795–1750 BC). He established the first known major metropolis and set forth the law that bears his name. The law was clear with regard to medical treatment. A surgeon who successfully treated his nobleman patient would be paid 10 shekels for his labor. If he treated a slave, he was paid 2 shekels, and for treatment of a freeman, he would be paid 5 shekels. If the nobleman or freeman patient died, the surgeon could lose a hand. If a slave died, the surgeon had to repay the cost of the slave to his master. The law was carved in black diorite stone that stood 8 feet tall and was designed like a monument for display in a public location in the city until it was taken by warring tribes as a trophy. It was discovered in Persia in 1901. The entire code of Hammurabi has been translated into English and is available online.

Greek civilization gave rise to more organized written texts on medicine and health. The Greeks encouraged a scholarly approach and established formal schools. Most of the surgery performed dealt with war wounds and orthopedic injury. The Greeks used palm bark and wood bound by moist clay and linen strips like splints to stabilize broken bones. Hippocrates (460–377 BC) used instruments of hardened iron, copper, bronze, and brass. His surgical armamentarium consisted of more than 200 types of surgical instruments. Although physicians were trained in medical and surgical treatments, the main focus of healthcare dealt with diet and exercise.

The early Romans had knowledge of steel. The ancient ruins of Pompeii (circa 310 BC to 79 AD) revealed an instrument manufacturer's place of business with preserved bundles of surgical tools made of several metals wrapped in protective fabric. Homes of physicians revealed beautifully carved boxes for instrument storage. Most of the surgical practice was borrowed from other cultures. Couching was performed as a necessity to displace cataracts. Surgery was considered manual labor, and the ancient Roman physicians contributed very little to surgical knowledge. In fact, artists frequently had a greater knowledge of the human body than physicians because they studied corpses during postmortem dissection.

Arabian surgeons established a school for brain surgery in Islam in 800 AD. Other surgical procedures were also performed, such as couching. However, little was known of human anatomy because human dissection was banned by the Koran. During this era, Andalusia (Moorish Spain) was part of the Islamic Empire. A famous skilled Moorish surgeon of the time, El Zahrawi (940–1013 AD), wrote an encyclopedia of 30 volumes referred to as the At-Tasrif to record methods of medical and surgical treatment. He taught his students to treat each patient as an individual and to practice within ethical limits. His writings guided the development of most surgical textbooks in European universities between the 12th and 17th centuries AD. Many of the surgical instruments used during that period were designed by El Zahrawi himself, who personally drew the 200 illustrations for his texts. He is also credited with being the first to use ligatures for hemostasis in surgery. The history and images of El Zahrawi and other Muslim physicians are available online at http://www.muslimheritage.com/surgery.

The Chinese practiced acupuncture and acupressure for at least 2000 years of recorded history. The central belief of these practices is that there is a mind–body–spirit connection to health and wellness associated with the ch'i, or life force. The main focus of health and wellness was not based in surgical procedures, but in a pharmacopoeia of 1800 medicinal herbs, biologic materials, and chemicals.

The ancient Aztec civilization left little written history, but significant evidence of successful surgery has been unearthed in archeological explorations. They had a strong knowledge of human anatomy because their culture practiced human dissection on their enemies. They felt that they captured the essence of the life force if they cut the beating heart from the chest of their captives. Blood sacrifice was a daily event. The main feature of their surgical armamentarium was sharp dissection of bone and soft tissues.

SUMMARY

Throughout history, physicians have devised and modified available materials for use in surgical procedures. As scientists contributed new knowledge of metals and eventually synthetics, such as plastics, instrumentation became more functional, incorporating the principles of physics. The increasing knowledge base concerning human anatomy and physiology led physicians to create new tools for exploration and treatment of body regions never surgically treated before. With each successive era, the sophistication of surgical instrumentation has improved significantly.

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CHAPTER 2

ANATOMY OF SURGICAL INSTRUMENTATION

OBJECTIVES

After reading this chapter the learner should be able to:

1. Discuss the evolution of ancient surgical instruments into designs in current use.
2. Describe the ergonomics of instrument design.
3. List the three essential design components of every surgical instrument.
4. List the common metals used in modern surgical instrumentation.

INTRODUCTION

Surgical instrumentation is one of the essential elements of a safe and efficient operating room. Even in the most skilled hands of a surgeon, the instruments must be in good condition and function as intended to prevent potential tissue damage. Surgical procedures require the use of a variety of instruments of different sizes, shapes, and chemical compositions in order to achieve a safe and optimal outcome for the patient. This chapter explores the broad range of unique design specifications of surgical instrumentation used to perform invasive procedures on all types of tissues and anatomic structures.

EVOLUTION OF MODERN SURGICAL INSTRUMENTATION

As discussed in Chapter 1, civilization has evolved and so, too, have surgical instruments and procedures. Conversely, human anatomy has not changed significantly over the centuries; however, the practice of surgical intervention has become increasingly complex in its goal to treat disease while minimizing tissue trauma, pain, and recovery time for patients.

CHAPTER OUTLINE

Despite these changes, much of our basic modern instrumentation has been modeled after long-standing styles with modifications for contemporary surgical procedures.

ANATOMY OF A SURGICAL INSTRUMENT

Basic design specifications are generally standardized according to the required function of the instrument. Modifications in size, shape, and design are made to accommodate the variety of human anatomic structures. Instruments can be classified by their use and function, which then determine the unique designs and shapes. A simple form of instrument anatomy is depicted by the small mosquito hemostat shown in Figure 2-1. It has all the standard design components, such as jaws, box locks, shanks, and handles. The essential standardized design components include the following:

- The handle or other form of hand grip held by the surgical practitioner
- The functional or connecting joint mechanism that allows the instrument sides to stay together in order to perform its task
- The tips and jaws are the working ends that come into contact with the patient's tissues and may be sharp, blunt, smooth, toothed, serrated, crushing, or noncrushing, also known as atraumatic.

Keeping these components in mind, the design possibilities are nearly limitless. Surgical instruments can be as simple as a flat sheet of metal or a single rod, or as complex as having up to 15 to 20 parts and pieces. Newer energized instrumentation can make contact with the patient's tissues through electrical current, radio frequencies, or collimated laser light waves.

Handle Styles

Handles are designed to optimize the operator's functional grip and dexterity. The working parts of an

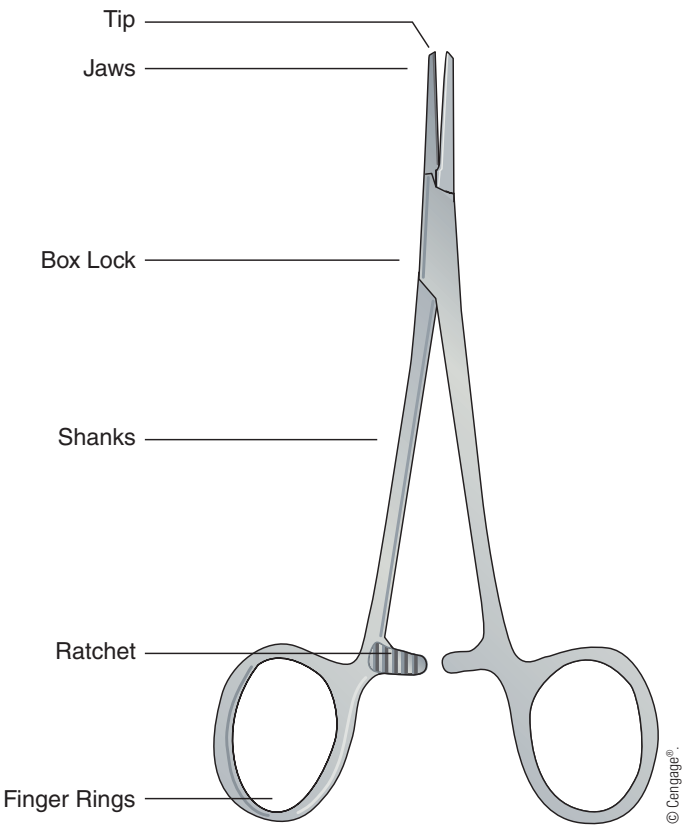

Figure 2-1 Basic anatomy of a surgical instrument (Halsted mosquito clamp).

instrument's jaws determine the style of the handle. Controlled and precise actions such as cutting, dissecting, and clamping require steady and secure manipulation as provided by ring handles and compression grips (Figure 2-2). Compression handles are pressure sensitive for precision closing power on heavy or firm tissues such as bone, cartilage, or fascia. Spring handles are preferred for microsurgery because activation of the jaws requires only minute motion to effect action on delicate tissues (Figure 2-3). Ratchets are used to lock and keep constant pressure from both sides of the instrument to occlude flow, provide traction, or hold structures together (Figure 2-4). Pistol grip handles provide additional leverage for instruments with longer shafts used in narrow anatomic spaces or small incisions such as in open nasal or spinal procedures and in laparoscopic instruments, which must be inserted through percutaneous trocar cannulas (Figure 2-5).

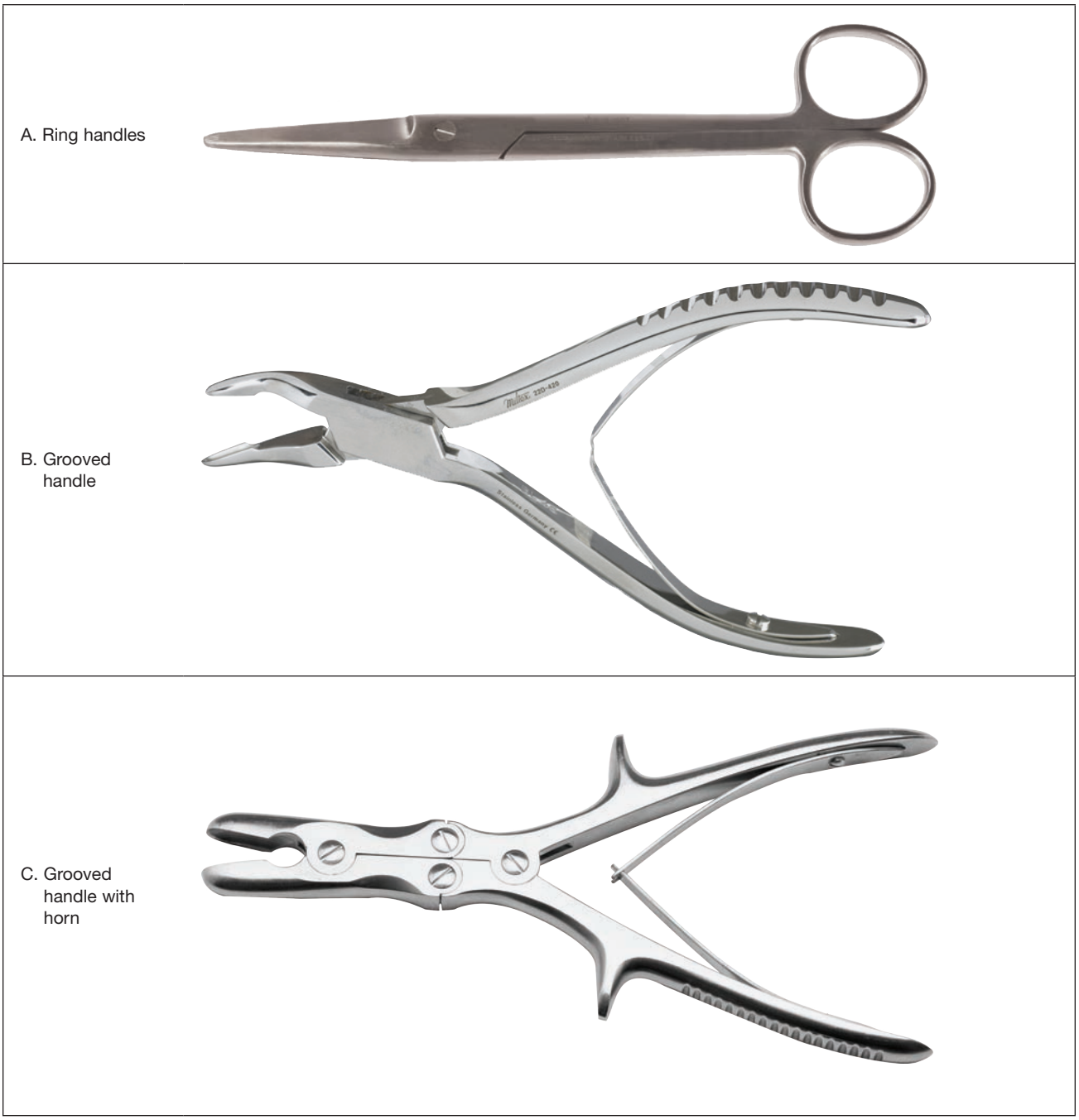

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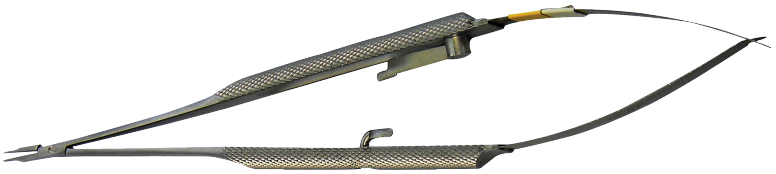
Figure 2-2 Ring handles and compression handle grips.

A. Double-leaf spring

B. Double-leaf locking spring



C. Cam ratchet

D. Bar and locking nut

E. Bar ratchet

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Figure 2-3 Spring handles and locking handle grips.

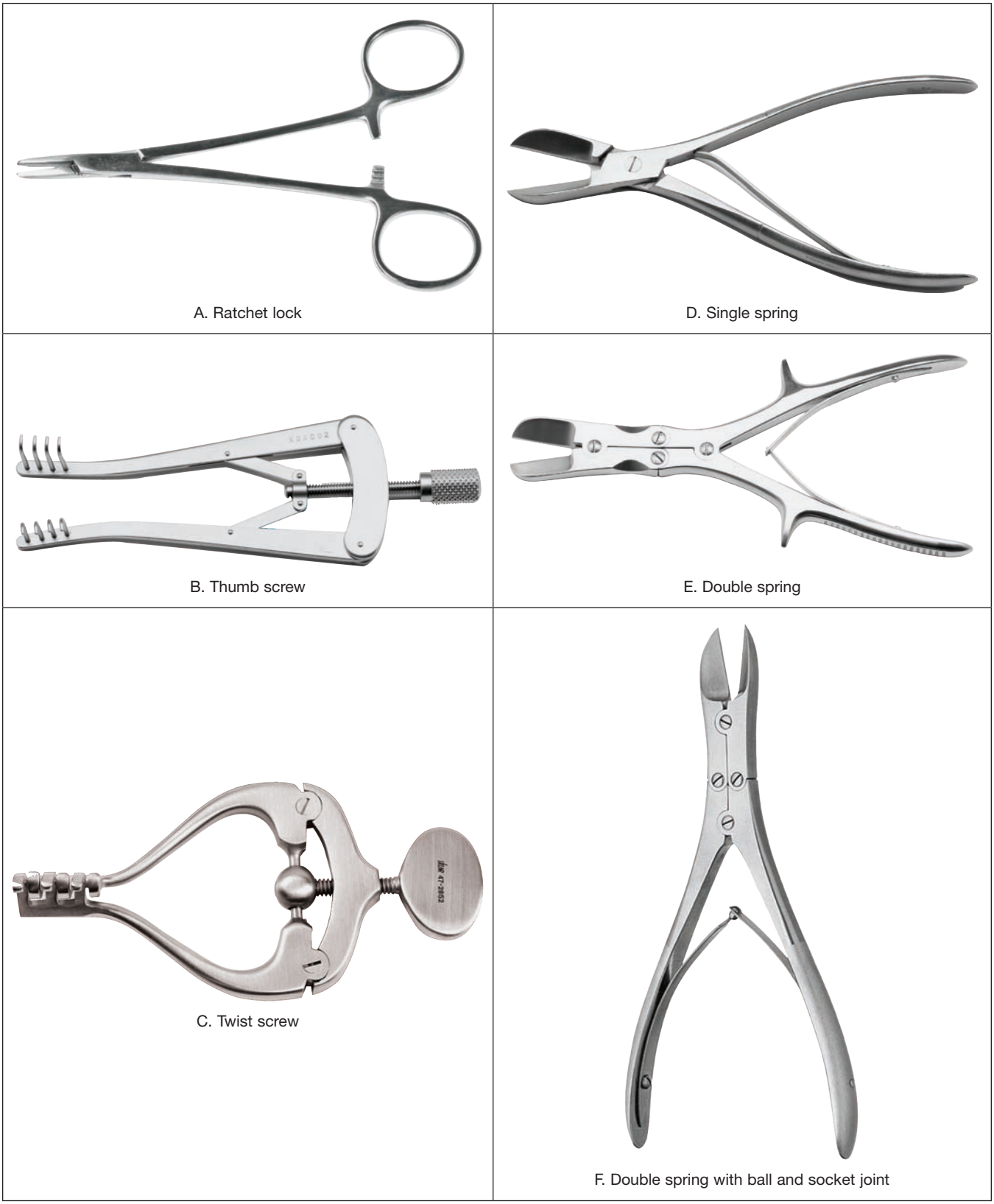

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Figure 2-4 Locking and opposition handle system.