Chapter 3

three

Operative Instruments

During a surgical operation, surgeons use many surgical instruments. A multiplicity of surgical instrument has been designed for different purposes. Early in his career, the surgeon should learn the specific use and proper manipulation of each instrument, such as the names and the functions of each surgical instrument, how to hold the surgical instruments and when they should be used. Some basic operative instruments will be introduced in this chapter.

Scalpel

Scalpel blade and handle

A scalpel can be divided into two parts, that is to say, it consists of scalpel handle and scalpel blade (Fig. 3-1). It is the best instrument for division of tissue. The sharp blade allows one to divide structures with minimal trauma to surrounding tissue. The blades have different shapes and sizes, each designed for a specific purpose (Fig. 3-2).

Fig. 3-1 Various kinds of scalpel

Fig. 3-2 Various types of scalpel blade

During operation, surgeon choose suitable blade according to the specific needs, for example, the smaller blade is used for plastic or delicate surgery. The scalpel handle can be used to separate tissue. They also have different shapes and sizes to suit for different blades (Fig. 3-3).

Fig. 3-3 Various types of scalpel handles

The detachable blades of the scalpels can be discarded when they become dull. To remove the blade, hold the scalpel handle in your left hand with the sharp end of blade away from you, grasp the proximal end of the blade with a needle holder in your right hand, lift the posterior edge of the blade away from the slot of the handle and free it by pushing it up

over the end of the handle (Fig. 3-4). To avoid injury, pay close attention not to break the blade.

To replace a blade reverse this procedure. Hold the scalpel in the same way, grasp the distal back of the blade with a needle holder, and pull the blade back onto the handle (Fig. 3-5). The purpose of handling the blade thus is to keep one's hand in such a position that a slip will not cut the hand.

Fig. 3-4 Remove scalpel blade

Fig. 3-5 Replace scalpel blade

How to hold the scalpel

There are four methods of holding the scalpel.

The method like holding a knife

The handle is grasped between the thumb and the third and fourth fingers, the forefinger placed over the back of the blade (Fig. 3-6). When incise tough tissue, this method may be used in order to cut it easily, such as cutting skin on the back.

The method like holding a bow

The handle is grasped between the thumb and the other fingers. The end of the handle is almost inside one's palm (Fig. 3-7). The method is just like holding the bow of a violin. This method is usually used when a longer incision is made, such as an abdominal incision.

Fig. 3-6 Method like holding a knife

Fig. 3-7 Method like holding a bow

The method like holding a pen

This method is just like holding a pen because it is more accurate. It should be used when a delicate operation or meticulous anatomical dissection is performed (Fig. 3-8).

Fig. 3-8 Method like holding a pen

The method of opposite poke

This method is also like holding a pen, but the cutting edge of the blade must be upward. We use

this method in order to prevent injury to the deep tissues, such as incising an abscess (Fig. 3-9).

Sometimes the scalpel may be hold like a fist during amputation (Fig. 3-10).

Fig. 3-9 Method of opposite poke

Fig. 3-10 Method like a fist

Scissors

Shape and function

Scissors are most commonly used to divide tissues and also used to cut sutures and dressings. They are classified into two types, tissue scissors (Fig. 3-11) and suture scissors (Fig. 3-12). Tissue scissors usually have blunt ends and can be classified to curve scissors (Fig. 3-13) and straight scissors. With such scissors there is no worry that the tips will puncture the tissues around. The suture scissors are usually straight and have sharp tips (Fig. 3-14).

How to hold the scissors

To hold the scissors the thumb and ring finger

Fig. 3-11 Curve scissors

Fig. 3-12 Scissors for removing suture

Fig. 3-13 Tissue scissors

Fig. 3-14 Suture scissors

are inserted through the rings, the middle finger is rested in front of one ring. The forefinger is set against the blades to better control and steady the instrument (Fig.3-15).

Hold all the surgical instruments with two rings like this.

When scissors should be used

Usually only the distal portion of the blade is used for cutting. That is, only use the tips, not opening them too wide when a tough structure must be cut. To avoid damage to vital structures, the scissors should never be closed unless the tips of the blades can be seen clearly. Tissue scissors are used to divide tissues. There are two types, straight scissors that are used

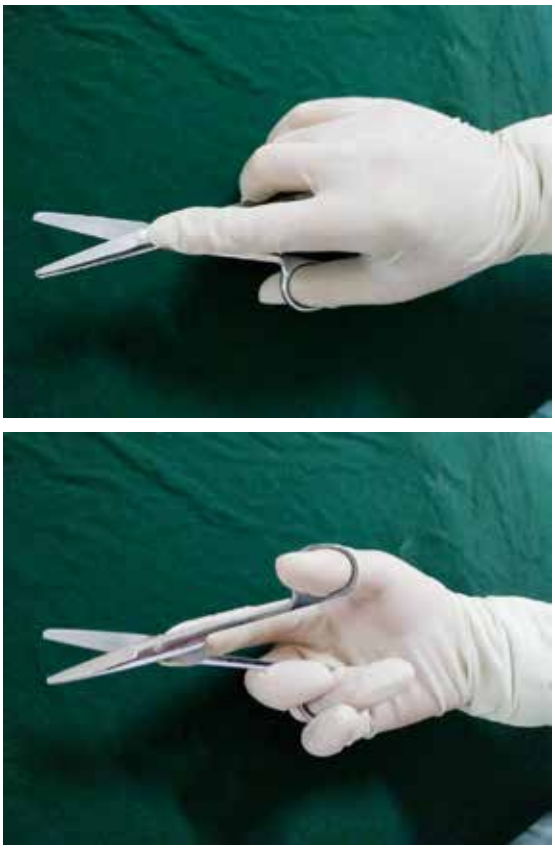

Fig. 3-15 Method of hold scissors

for work on the surface, curved scissors that are used deeper in the wound. Suture scissors are used to cut sutures and dressings. The following procedures must be done when the sutures in the tissue are cut, open suture scissors tips, lean against the suture, slipped down to the knot along the suture, turn the blade slightly about 30°–45°, and cut.

Thumb Forceps

Classification and function

A thumb forceps consists of two metal strips which joined at one end and used to pick up or to hold tissues and dressings. If the tissue is slippery such as skin, teeth forceps should be used to nip it. On the other hand, the smooth forceps which have no teeth to be used to vital structures, such as nerves, blood vessels and so on. There are two types: smooth forceps, also called tissue forceps; and teeth forceps, also called skin forceps (Fig. 3-16).

How to hold the forceps

The forceps are held between the thumb and the middle and forefingers of either hand. The

Fig. 3-16 Various kinds of thumb forceps

head of the forceps must be outside the palm (Fig. 3-17). That is to say, you must hold the forceps upright with your fingers, grasping them in the palm is wrong. During an operation, thumb forceps is commonly used with left hand to hold tissues and the right hand is used to dissect tissue with a scalpel or scissors.

Fig. 3-17 Method of hold thumb forceps

When thumb forceps should be used

Teeth forceps are always used when holding skin or tough tissue which is slippery. Smooth

forceps are used to hold viscera which might be punctured by teeth forceps. They are also used for removing dressings.

Haemostatic Forceps

When tissue is incised, there will be bleeding, in order to reduce bleeding and keep the operative field clear, haemostasis must be performed. These instruments are used to stanch bleeding during an operation. There are numerous variations (Fig. 3-18). The shape of the distal portion of the forceps are curved or straight. The sizes of haemostatic forceps are different: small, medium and large. The method of holding haemostatic forceps is just like holding scissors.

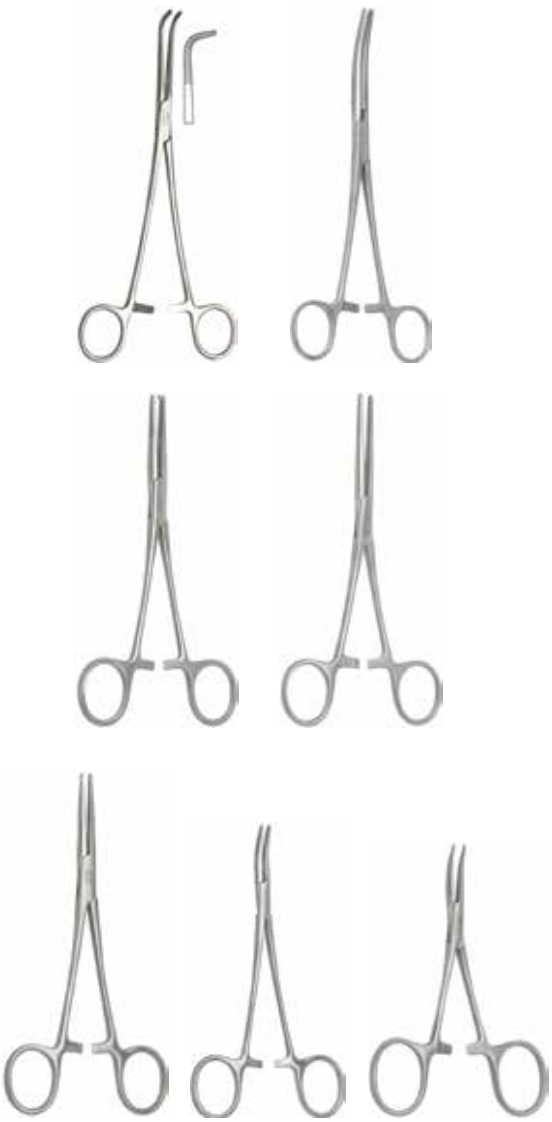

Fig. 3-18 Various kinds of haemostatic forceps

The types of haemostatic forceps

Straight clamps

They are used to stanch bleeding on surface tissue.

Kelly clamps

They have curved ends that are used to stanch bleeding in deep tissue.

Mosquito clamps

They are the smallest clamps that are used in meticulous or delicate operations, such as on the face or in the visceral organ.

Kocher's forceps

The distal portions of the forceps have transverse teeth at the tips. They have considerable grasping power and allow one to exert considerable amount of tension on tissue. They are used to stop bleeding in major blood vessels. Now they are not usually used to stanch bleeding instead of fixing the gauze pad or disinfection. Sometimes they are used on heavy fascia in order to make the tight fascia to pull free (Fig. 3-19).

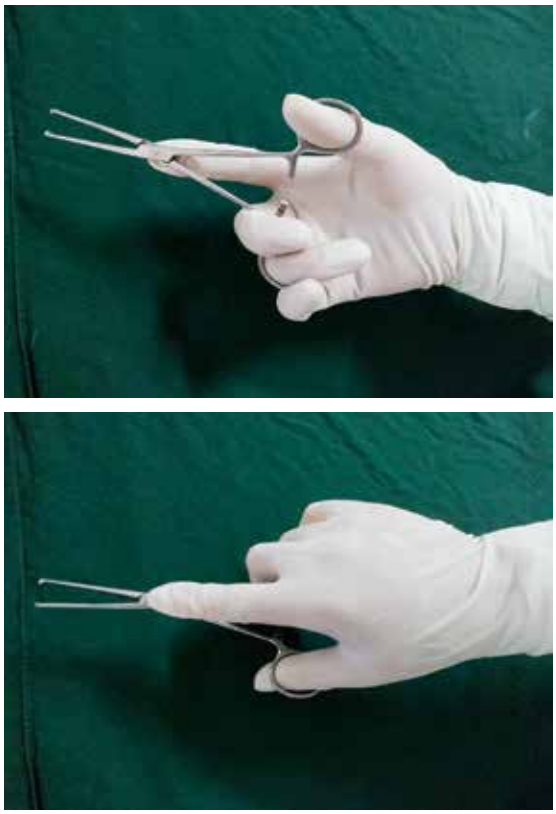

Fig. 3-19 Method of hold haemostatic forceps

How to use haemostatic forceps

If there is bleeding, apply pressure to the bleeding area with a piece of dry gauze to clear the area of blood, clamp the bleeding point with the tips of forceps, take care to clamp the least amount of tissues as possible.

Allis Forceps

Allis forceps are also called tissue forceps. The tips of tissue forceps consists of opposite serrated edges with fairly short teeth (Fig. 3-20). These forceps are used for grasping of fascia. They are not applied to the skin because skin would be caused necrosis. They are also used to hold wound drapes and dressing.

Fig. 3-20 Tissue forceps

Towel Clips

Towel clips consists of a grasping forceps with two sharp points (Fig. 3-21), which hold the edges of a towels in place to fix the four towels when draping, otherwise the towels may move away during the operation(Fig. 3-22).

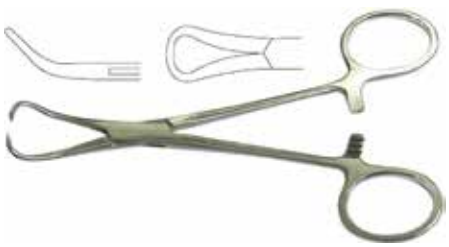

Fig. 3-21 Towel clips

Fig. 3-22 Using of towel clips

Sponge-holding forceps

Another name of sponge-holding forceps is ring forceps for there are two rings at the end of the forceps. There are two types, serrated ring forceps and smooth ring forceps (Fig. 3-23).

Fig. 3-23 Sponge-holding forceps

(1) The serrated ring forceps: The rings of the forceps have serrated opposite surfaces are commonly used to hold gauze or cotton balls when preparing the operative site.

(2) The smooth ring forceps: They do not have serrated surfaces are usually used to pull organs from body cavity.

Needle Holder

The simplest method of suture is to use straight needle, which can be held and pushed through the tissue with the fingers.

However, since much of the suturing during a surgical operation must be performed within a wound, in tissue which cannot be distorted, a curved needle must be used. Such curved needles must be manipulated with a needle holder. A needle holder has wide heads and there are different types of serration in the head (Fig. 3-24). The needle holder usually clamps the needle at one third of the length of the needle from the blunt end. The needle can be easily broken if the location of the needle holder is too near the blunt end, if the needle holder is too near its tip, it can not puncture the tissue (Fig. 3-25).

Fig. 3-24 Needle holder

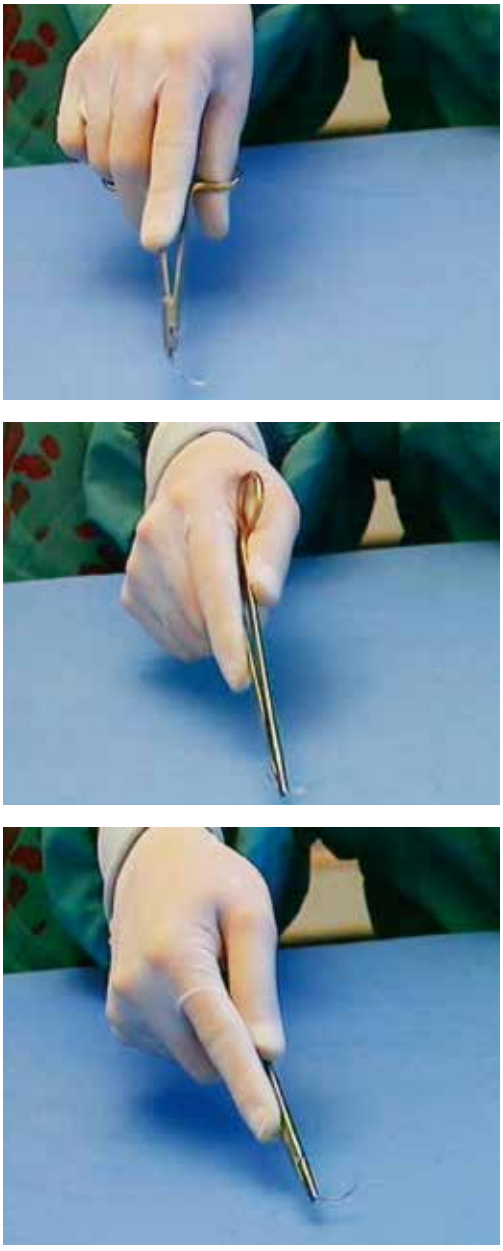

Fig. 3-25 Methods of holding needle holder

Retractors

They are used to hold superficial tissues aside in order to expose deep tissues of the operative field. There are two major types of retractors, one type with stipes which is held by an assistant (Fig. 3-26), the other type of retractors is held in position by counter pressure against opposite sides of the wounds, which are called mechanical or self-retractors, such as abdominal self-retaining retractors (Fig. 3-27). In order to protect the tissue when a retractor is used, it is necessary to interpose a piece of moist and sterile gauze pad between the retractor and tissue when retractor is used in order to protect the tissue (Fig. 3-28).

Thyroid retractor

It has two right angles at both ends, which is usually used during a neck operation and other superficial operations.

Abdominal retractor

This kind of retractors has a wide end like a saddle which is commonly used to hold back abdominal wall tissues.

Deave retractor

The retractor have a long cambered bend, it is popularly for retraction of deeper tissue in the abdominal cavity.

Rake retractors

When the retractor is used to grasp the tissue and to pull it back, it is common to use a rake retractor because it will dig into tissue rather than slide over it.

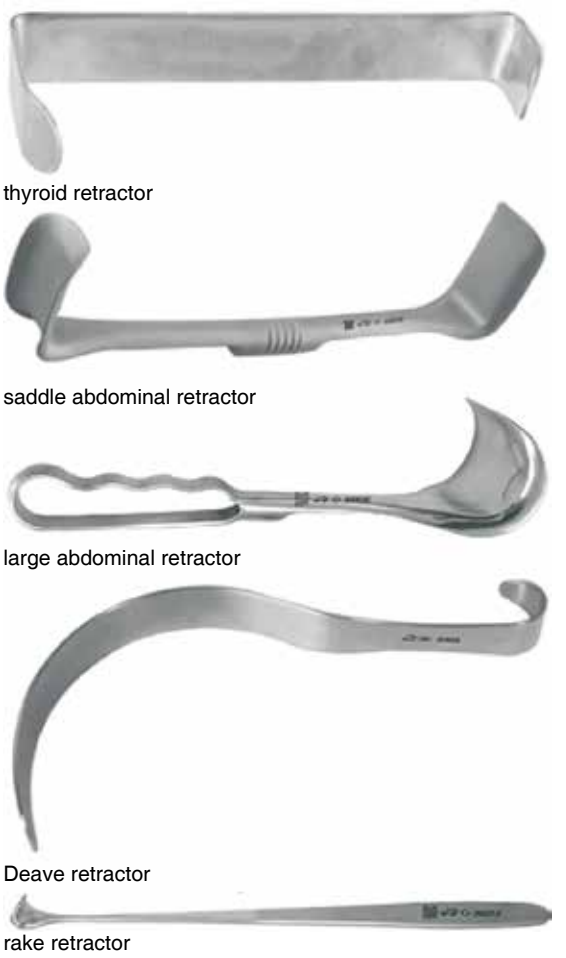

Fig. 3-26 Various kinds of retractors

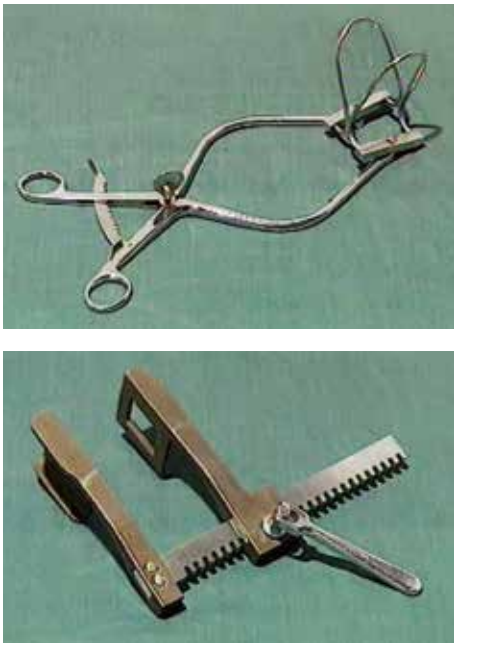

Fig. 3-27 Various kinds of self-retractor

Fig. 3-28 Using of retractors

Needle

In the history of surgery, many materials were used as the surgical needles such as fish bone and acacia thorn. Since 19th century the metallic needles have been used. An ideal needle should be made of stainless steel which has high strength and minimal tissue reaction, as much thinner as possible. For the ideal needle. ① It can be fixed in a stable manner in the needle holder. ② It can lead suture material with a suitable assurance and a minimum tissue injury. ③ It should be sharp enough to pass through the tissues. ④ It should be stiff enough to resist bending and break. ⑤ It is easily sterilized.

Conventional needle and atraumatic needle

Nowadays two basic types of needles that are used, they are conventional needle and atraumatic needle. The conventional needle have an eye to be threaded, so it causes trauma to the tissue when it pass through the tissue because it is thick with double threads.

Atraumatic needles are usually used in microsurgery. The thread is fixed at the tail portion of the needle when it is produced.

Curved needle and straight needle

Needles can be classified according to their shape.

Curved needle

It allows surgeon to work in deep cavity. A needle holder is necessary when a curved needle is used (Fig. 3-29).

Fig. 3-29 Curve needles

Straight needle

It can only be used where there is adequate exposure and the tissue can be distorted to allow the needle to pass through it (Fig. 3-30).

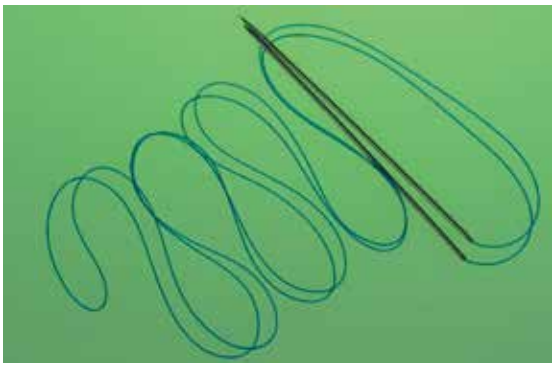

Fig. 3-30 Straight needles

Round needle and triangular needle

Needles can be classified according to the character of tips.

Round needle

The point of the needle may be tapered. It is used for suturing deeper structures and organs.

Triangular needle

The point of the needle has three sharp cutting edges. It is used for suturing skin, periosteum or perichondrium.

Suture materials

Sutures are made of many different materials. Numerous types of sutures are available, which can be divided into two types, absorbable sutures and non-absorbable sutures. Some suture materials are absorbed over a period of time and leave no material in the body, these are called absorbable suture materials. However, non-absorbable sutures will stay in their sutured position forever without any changing. The suture material is actually needed till that time when the scar tissue is formed which can replace the function of the threads is formed. Suture material should be chosen based on the wound healing properties and dynamics of the tissue or organs. The kind of suture material selected is to keep its tensile strength in the wound during this healing period.

The suture materials are made of natural or synthetic materials. Nowadays, the natural substances are not often used. Surgical threads are not all the same. The main disadvantage of the natural substances is that they contain natural proteins. It is well known that the elimination of the foreign proteins is the basic defensive function of the body. These natural substances are absorbed by the enzymatically. It means that the proteolytic enzymes released from macrophages, neutrophils, and phagocytes will digest these substances. This process leads to a strong inflammatory cellular activity as well.

Most synthetic suture materials are inert and only cause minimal reactions in the living tissues. Their absorption is done by hydrolysis. There is no need for the cellular elements and proteolytic enzymes. The molecules of these materials are simply disintegrating while H_2O is released. In this way, they cause less tissue reaction than natural materials.

The degree of tissue reaction depends on the substance of the thread. For example, the reaction of catgut and chromic catgut are very strong. The reaction of linen, silk, and polyamide are average. Teflon and polyester are moderate. Polypropylene, polyglycolic acid, polydioxanone, steel and tantalum are minimal. Suture materials made of natural substances are still used, but in surgery of the 21st century the use of the synthetic suture materials is much more common.

Non-absorbable suture material

It is the type of most commonly used suture material. In order of popularity are silk, cotton and stainless steel, followed by many synthetics material. Non-absorbable suture material has the following advantages (Fig. 3-31):

Fig. 3-31 Non-absorbable suture materials

(1) It has a known strength that will not change in a few days.

(2) It produces less tissue reaction.

(3) Knot is not slip, the least amount of suture material is left in the knot when suture is cut.

The advantages of the non-absorbable suture materials are important due to their properties, even after a prolonged time, if there is no scar formation, the materials can insure an adequate mechanical strength. Examples for this include: implantation of the cardiac prosthetic valves, implantation of the prostheses which replace the ligaments of the joint, and fixation of the vascular grafts. It is important to know that there is always a possibility for development of a severe fibrotic reaction around even the most modern and inert suture materials. This can be a bed for granulomas, micro abscesses and rejection of the sutures.

Silk

Silk is a protein filament obtained from the silkworm larva. The silk is braided, dyed and treated with polybutilate. The suture has good tensile strength, is easy to handle, and has excellent knot characteristics. Although classified as non-absorbable, silk does degrade in tissue at a variable rate and loses its tensile strength. Silk is a very comfortable suture for the patient when it is used to suture mucosa in the mouth.

Nylon

As a kind of synthetic polyamide polymer, nylon suture materials are both monofilament and multifilament. It is very strong and smooth, but extra care must be taken in tying knot to prevent knot slippage. The suture is degraded and absorbed in about 2 years. Thus, its tensile strength decreases significantly with time. Its smooth, monofilament composition ensures facile passage through tissue and minimal reaction. Nylon sutures are the most commonly used suture in cutaneous operations, both percutaneous and subcuticular.

Stainless steel

Stainless steel wire, made from low carbon iron alloy, can be monofilament or multifilament. It is the strongest and least reactive suture. However, its handling characteristics are very poor, and great care must be taken to prevent kinking and cutting through tissue. Wire is used mainly in ligament, tendon, and bone operations.

Absorbable suture material

Catgut is a type of absorbable suture material in general use in the past. It is made from strands of submucosa of the small bowel of sheep. Plain catgut is absorbed rapidly and causes a great amount of tissue reaction. All catgut swells because it is absorbed some water from the surrounding tissues. This swelling has a tendency to loosen knots and longer ends must be left in knots. Catgut also has advantages that it will be ultimately absorbed and can be used as a continuous suture. An interrupted suture using cat gut is indicated for suturing infected tissue.

With the development of modern science, many compound absorbable suture materials have

Fig. 3-32 Absorbable suture materials

become available (Fig. 3-32).

There are two types of absorption, enzymatic and hydrolysis. The enzymatic absorption is activated and done by cellular elements. It is the characteristic of the natural suture materials which contain proteins. Its results in a severe tissue reaction, activation of the inflammatory processes, formation of the micro abscess, and pathologic scar tissue. Its duration of absorption is not defined, in different structures significantly different results can be obtained from the same suture material. The hydrolysis is passive and done without participation of the cellular elements. It is the characteristic of the synthetic suture material. During hydrolysis the chemical and physical bonds which are located between the molecules of the suture material, become loose and the thread is disintegrated to such substances which are similar to the natural metabolites of the body and are excreted from the body. The duration of the absorption of these suture materials can be estimated.

Taken together, with some exceptions, the synthetic, absorbable suture materials which can be absorbed by hydrolysis are preferred in surgery.

The size of suture

The USp (United States pharmacopoeia) unit is frequently used to determine the diameter of the threads. The USp unit is grouping the suture materials according to their size. Based on this, the thinnest suture material is 11/0. Then, there are 10/0, 9/0, 8/0, 7/0, 6/0, 5/0, 4/0, 3/0, 2/0, 0, 1, 2, 3, 4, 5, 6, and 7 sizes of suture materials. The size 7 thread is the thickest one. In China, in addition there is also 12-0 (the thinnest) and 10 (the thickness). Usually, size 0 or size1 thread is often used to suture skin during most operation, size 7 thread is sometimes used in tension relaxing suture of wide wound.

Modern instruments

Today, there are many modern instruments during surgical operations. For examples, skin stapler (Fig. 3-33) has been used to suture incision of skin, digestive tract stapling instruments (Fig. 3-34) has been used to anastomosis of intestine or stomach. When an incision of stomach or intestine needs to be closed, the digestive tract closure instruments (Fig. 3-35) can perform this action. All these modern instruments save time in various suture procedures. It is hoped that there will be more instruments developed which will be used in surgical operations.

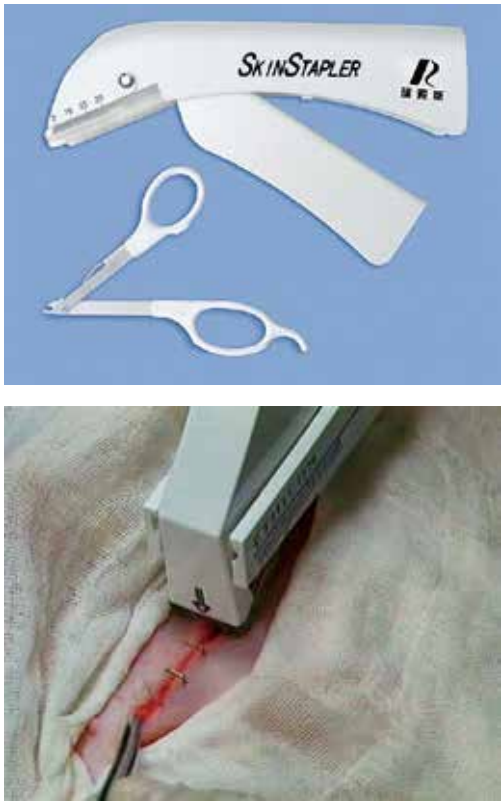

Fig. 3-33 Skin stapler

Fig. 3-34 Digestive tract stapling instruments

Fig. 3-35 Digestive tract closure instruments