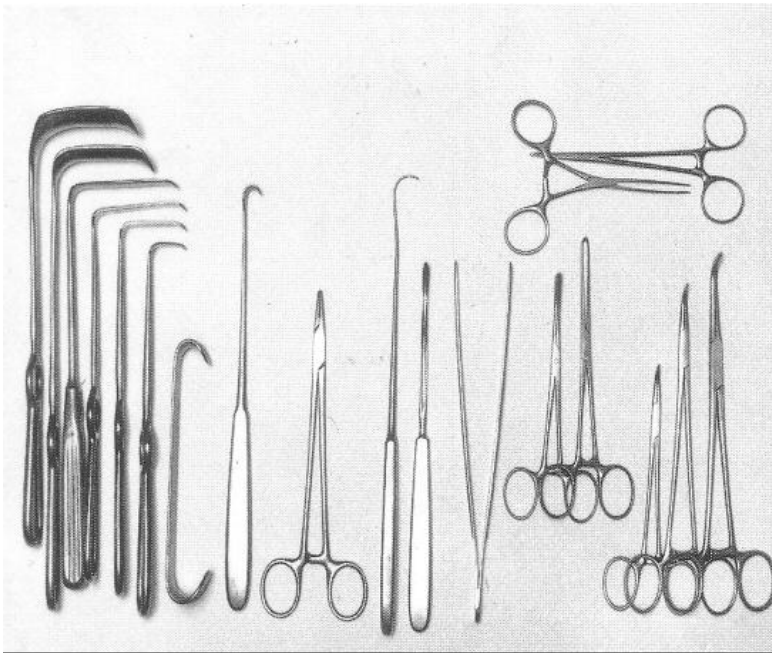
WFHSS ÖGSV

VII

Fundamentals of Instrumentation



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1 Introduction

The history of instrument production dates back to antiquity when man used natural materials such as bone and stones as “instruments”.

In subsequent centuries instruments were then made of bronze, brass, copper and iron.

Today, stainless (non-rusting) steel is used to manufacture instruments.

But other materials are also used to make instruments, e.g.:

- plastics for various handles
- copper
- brass for instrument handles
- silver, e.g. for probes
- tin also for special probes

The surfaces of instruments can also differ greatly, e.g.:

- highly polished or
- dull polished,
- nickel-plated e.g. suturing needles
- silver-plated, e.g. eye instruments
- gold-plated instruments e.g. the rings of scissors or needle holders (= an international designation for hard metal inserts – these scissors have a particularly long service life)
- blackened instruments, with the advantage that they do not give rise to any glare during surgery.

2 Designation and classification of instruments:

Instruments can be classified according to different criteria, e.g.:

2.1 Designation based on persons, e.g.:

Doctors, instrument makers, engineers or other persons who either designed the instruments, influenced their development or publicized them, e.g.:

- **Pean** clamp
- **Lexter** chisel
- **Kocher** grooved probe
- **Gigli** saw

2.2 Designation based on function, e.g.:

- **Elevator**
- **Chisel**
- **Drill**
- **Thread cutter**
- **Needle holder**

2.3 Designation based on characteristics, e.g.:

- **Sharp** hook
- **Grasping** forceps
- **Probing** hook
- **Atraumatic** tweezers
- **Soft** clamp

2.4 Designation based on shape, e.g.:

- **Button** cannula
- **Bullet** forceps
- **Bayonet** tweezers

2.5 Designation based on organs, e.g.:

- **Gallbladder** forceps
- **Vascular** scissors
- **Meniscus** retractor
- **Kidney** dish
- **Intestinal** clamp

2.6 Classification of instruments as per surgical specialism

General surgery instruments

- **Basic instruments:** scissors, tweezers, clamps, needle holders, wound hooks, etc.
- **Gastrointestinal instruments:** intestinal clamps, clip suture apparatus, staplers, tissue grasping forceps, Allis clamps, etc.
    - **Endoscopic instruments**

Instruments for paediatric surgery

All instruments as used in general surgery, only of smaller design

Instruments for gynaecology and obstetrics

Vaginal specula, Hegar dilators, grasping forceps, hooked forceps, Museux, suction and biopsy curettes, uterine probes, weights, parametrium scissors, parametrium clamps, microinstruments, PE forceps, uterine scoops, instruments for hysterosapingography, endoscopic instruments, etc.

Instruments for urology

Kidney stone forceps, kidney fistula forceps, cystoscopes, prostate hooks, urinary bladder wound retractors, urinary bladder spatulas, dilatation bougies, otis f. urethral fissure, catheter placement instruments, etc.

Instruments for cardiovascular surgery

Chest separators, aorta clamps, arterial clamps, atraumatic tweezers, Cooley clamps, Satinsky clamps, atrium hooks, Bulldog clamps, valve sizers, microinstruments, dissectors, Pott-Smith scissors, vascular needle holders, coronary suction devices, haemoclip applicators, wire-needle holders, clamps and scissors, etc.

Instruments for chest surgery

Rib separators with different valves, raspatories, Bailey rib contractors, Duval lung grasping forceps, sternum saws, sternum scissors, Brunner and Sauerbruch rib scissors, lung spatulas, bronchus clamps, sternum chisels and hammers, etc.

Instruments for bone surgery, accident surgery, orthopaedics

Various drive machines, hammers, chisels, raspatories, bone punches, hollow chisels, drills, drill adapters, AO instruments, bone files, elevators

Instruments for neurosurgery

Trepanation instruments, Gigli saws, dura separators, dura scissors, elevators, punches, microinstruments, special wound retractors, Mayfield head support, brain spatula, AO instruments for different types of plating, bayonet-shaped curettes, enucleators, various aneurysm clips and application forceps, scalp clamps and clips (Raney clips), etc.

Instruments for maxillofacial surgery

Tooth extraction instruments, repositioning instruments, diverse mouth gags, self-retaining lip retractors, tongue depressors and spatula, tongue forceps, intraoral retractors, progenia hooks, raspatories, Ahlen, mobilization hooks, AO instruments, etc.

Instruments for eye surgery

Eyelid retractors, eyelid ?, microinstruments, special tweezers (sclera tweezers), iridectomy scissors, keratomy scissors, Sato knives, special punches, drills, repositioning hooks for lenses, iris spatula, corneal scissors, etc.

Instruments for ear, nose and throat surgery

Nasal specula, ear specula, laryngoscopes, ear forceps, scooped forceps, ear scissors, special knives, paracentesis needles, various hooks, dissectors, measuring probes, raspatories.

2.7 Classification of instruments as per intended use:

- Tissue dissecting instruments
- Tissue grasping instruments
- Tissue retracting instruments
- Tissue protecting instruments
- Tissue probing instruments
- Special instruments

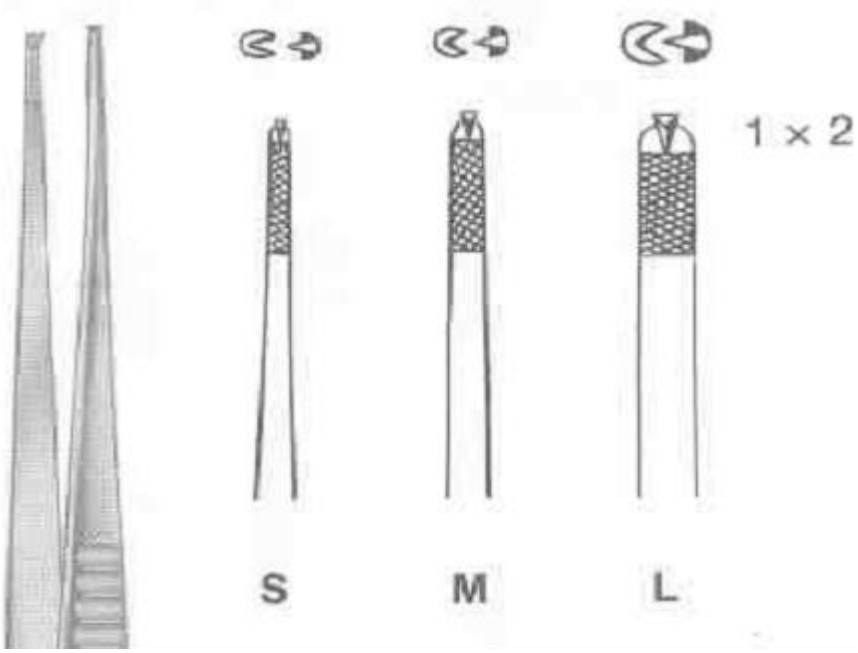
3 Typical characteristics of surgical, anatomical and atraumatic instruments

3.1 Jaw surfaces of instruments

Surgical jaw surfaces:

These jaw surfaces have teeth (serration) and hooks at the functional ends, permitting firm grasping of tissue. The number of teeth is given as follows.

1 : 2 teeth or 1 x 2 teeth, this means that at one end of the jaws there is one tooth and two on the opposite side.



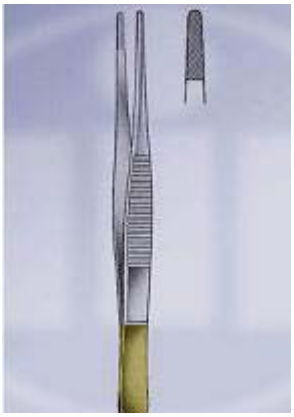
Surgical jaw surfaces

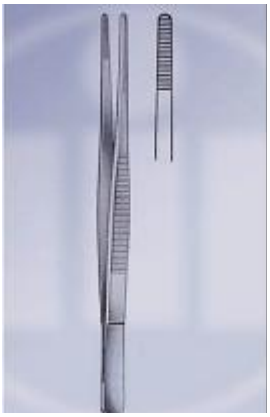
Anatomical jaw surfaces:

Instruments with anatomical jaw surfaces are used in areas where there is a risk that the teeth of surgical jaw surfaces could damage tissues, e.g. the mucous membranes of the stomach or intestines.

Anatomical jaw surfaces are available in different designs.

Here the most common designs:

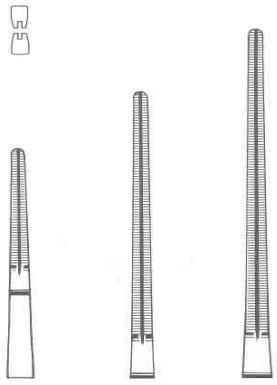




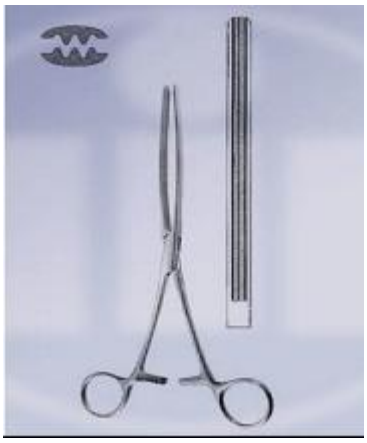
Anatomical jaw surfaces

Atraumatic jaw surfaces:

These are instruments whose jaw surfaces have a special serrated (toothed) profile. The particular type of serration and arrangement of the teeth prevent damage to tissues or organs when the jaws close.



Cooley atraumatic jaw surfaces .....



DeBakey double serration

A distinction is made between single and double serration.

3.2 Hard metal inserts

Designation:

Instruments with hard metal inserts are designated by means of gold rings in clamps, scissors and needle holders by a gold spring in tweezers.

Advantages:

These hard metal inserts prolong the service life of instruments, and manufacturers generally give a 3-year warranty for these inserts. The hard metal inserts can be replaced.

3.3 Ratchets

Ratchets are used to fix the shanks of an instrument in a particular position.

The following ratchet devices are in use:

- toothed rack (locking bar)
- 2 toothed racks
- spring
- one ratchet
- spring and outer ratchet
- threaded ratchet
- spring shanks

3.4 Scalpels and knives

Scalpel with replaceable blade:

The blade recesses and connections for the scalpel handles are standardized As such, blades and handles of different manufacture can be combined.

The sterile disposable blades are mainly packed individually in aluminium foil.

4 Tissue dissecting instruments

4.1 Scissors

Scissors configuration:

Blades:

The functional end of a scissor is composed of the blades and cutting edges. The blades are situated opposite the cutting edges. The blade length and width as well as the shape come in different designs

Closing region

Here, both halves of the scissor are pivotally connected,

Shanks with rings:

The shanks are the part of the scissor situated between the closing region and the rings. To accommodate the fingers, the rings close on the shanks. A distinction is made between similar and dissimilar as well as closed and open rings.

Scissor shapes:

Surgical scissors are straight or equally curved and/or angled at the blades, functional ends, in the closing region, at the shanks or at several parts of the scissor. To determine whether the scissor is curved or angled upwards or downwards, towards the right or towards the left, it is placed on a table such that the screw head of the closing region is visible.

Vascular scissors:

The functional parts of several scissors are angled towards the right or left. The angle is specified in degrees: 25, 45, 60, 90 and 125 degrees

Blade types:

1. Sharp / blunt

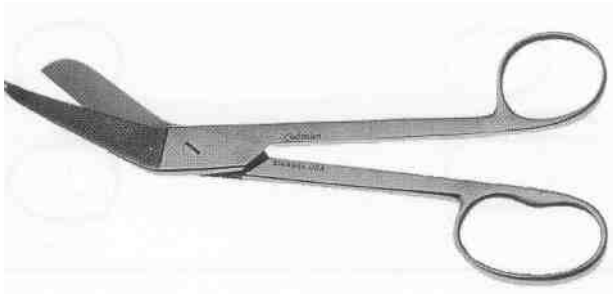
   Standard scissors used for tissue and medial accessories.

2. Sharp / sharp

   Iris and microscissors

3. Blunt / blunt scissors with half-blunt blade ends

   These are used as preparation scissors as well as in vascular surgery



Bandage scissor

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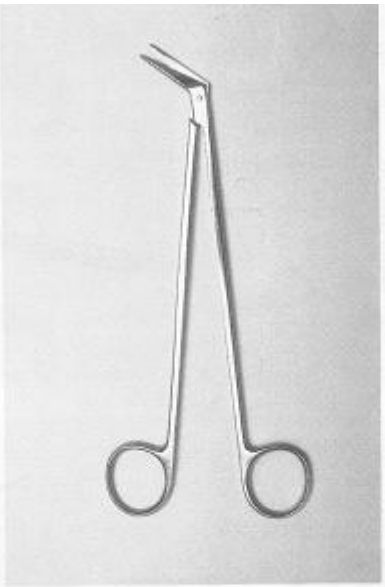

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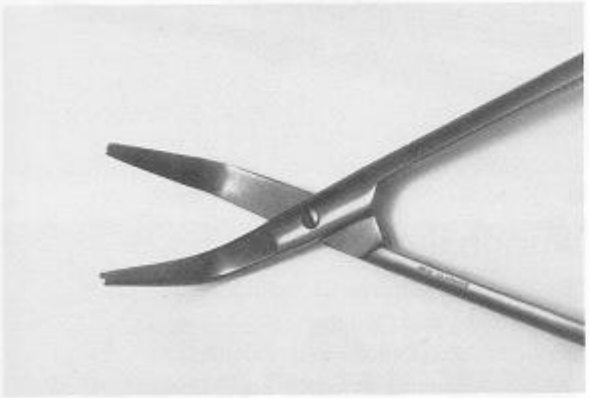

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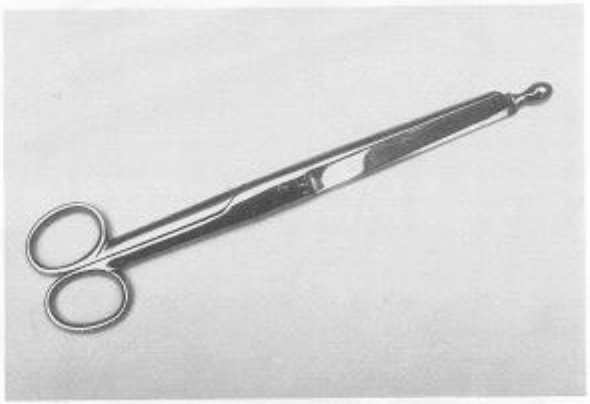

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45 Standard, straight and Lexer-Fino scissors

46 Potts-Smith scissor

47 Hösel scissor

48 Hösel, Detail knee scissor

49 Organ scissor

Spring scissors:

Surgical scissors also include some delicate and very fragile spring scissors. The name spring scissors derives from the leaf springs found at the closing ends of the shanks.

This type of design permits tactile and uniform cutting action. The blades are curved / angled upwards or sideways. The shanks are straight or shaped like a bayonet. They have precision-polished cutting edges.

Spring scissor

4.2 Chisels

Intended use:

Chisels are used to separate bones or to remove bone material.

A distinction is made between hollow and flat chisels.

This instrument consists of a:

- blade
- shaft
- handle

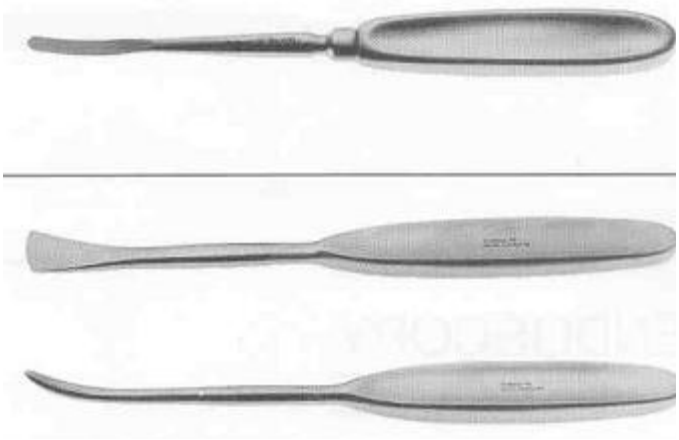
The handle is made of

- plastic
- metal or
- wood

but wooden handles are no longer made because of the risk of splinters.

Hollow chisels:

They consist of a blade, shaft and handle (generally made of plastic).



Different chisels

5.3. Rasparatories

Intended use:

The term raspatory comes from the Latin “raspare” – to grate or scrape. This instrument is used to scrape bone.

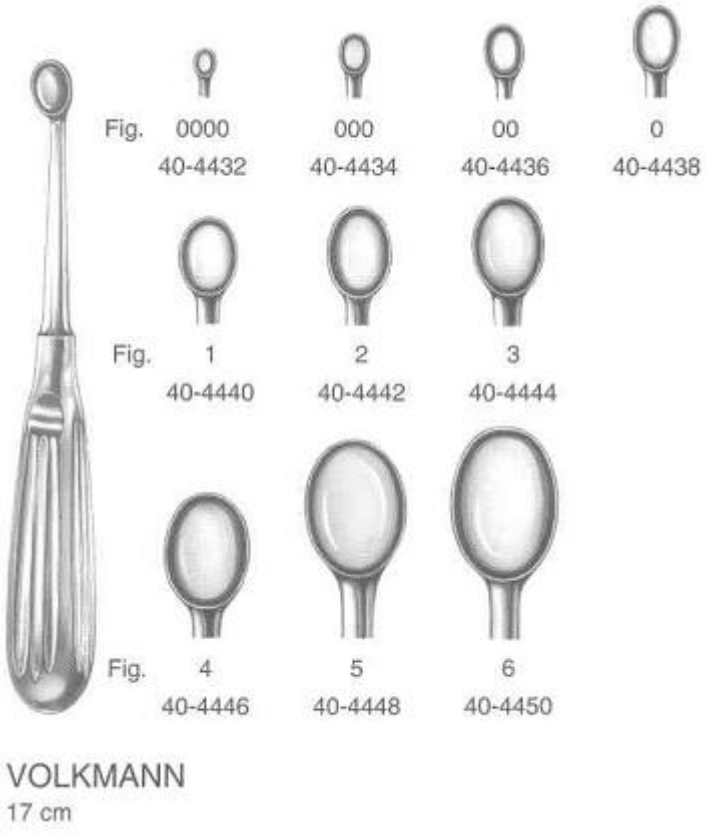
Rasparatories

3.4. Scoops

These are spoon-shaped instruments with sharp spoonlike margins.

Intended use:

This instrument is used to scoop out abscesses and /or bone cavities.



Volkmann sharp scoop:

3.5. Dissectors

Intended use:

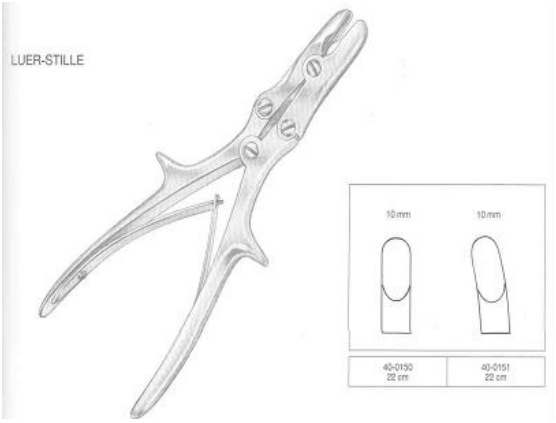
The term dissector derives from the Latin “dissectio” – separation, cutting through.

Dissectors have an oval end, which can be blunt, sharp or serrated.

3.6. Hollow chisel forceps, bone splitting forceps, bone punches

These instruments are used to remove bone parts and are being marketed in various designs

Luer–Stille hollow chisel forcep:



Hollow chisel forcep

Liston bone splitting forcep

Richter, Schlesinger laminectomy punch

90 degree upward or downward cutting action, various jaw widths;

40 degree upward cutting action, also various shank lengths

5 Tissue grasping instruments

5.1 Tweezers

General design of tweezers:

1. Jaws:

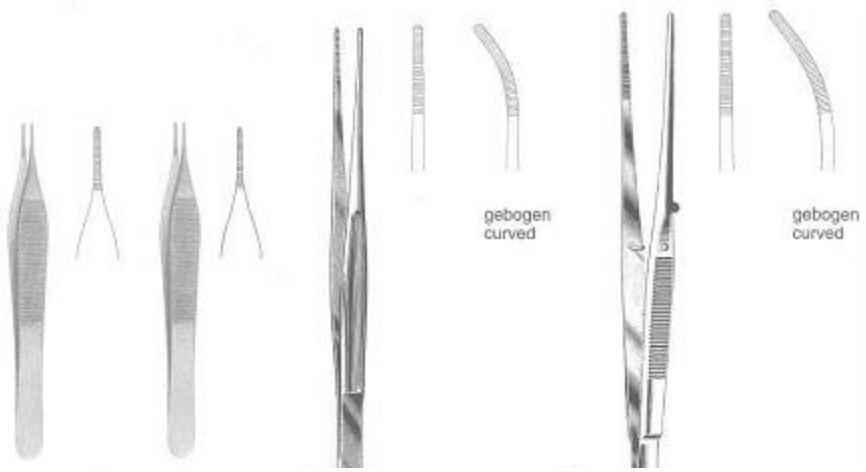
   Their shape determines the intended use.

2. The jaw surfaces can be **anatomical, surgical, atraumatic**
3. The gripping surfaces are mainly cross-grooved, and it is here that the instrument is grasped
4. The mirror generally features designations, e.g. owner's symbol, manufacturer's symbol or order number
5. The spring part confers the necessary flexibility to the instrument or shanks

Anatomical tweezers:

The standard model has straight, rounded jaw tips, cross-grooved jaw surfaces and the handle surfaces are cross-grooved.

However, there are also special designs, e.g. curved or bayonet shaped anatomical tweezers.



Various anatomical tweezers

Anatomical tweezers with guide pin:

The role of the guide pin is to prevent the jaws being pushed sideways when they are pressed together.

Surgical tweezers:

Standard model with 1 to 2 teeth:

Straight, interlocking teeth at jaw tips and cross-grooved handle surfaces.

Surgical tweezers

Special features and fields of application of bayonet-shaped tweezers:

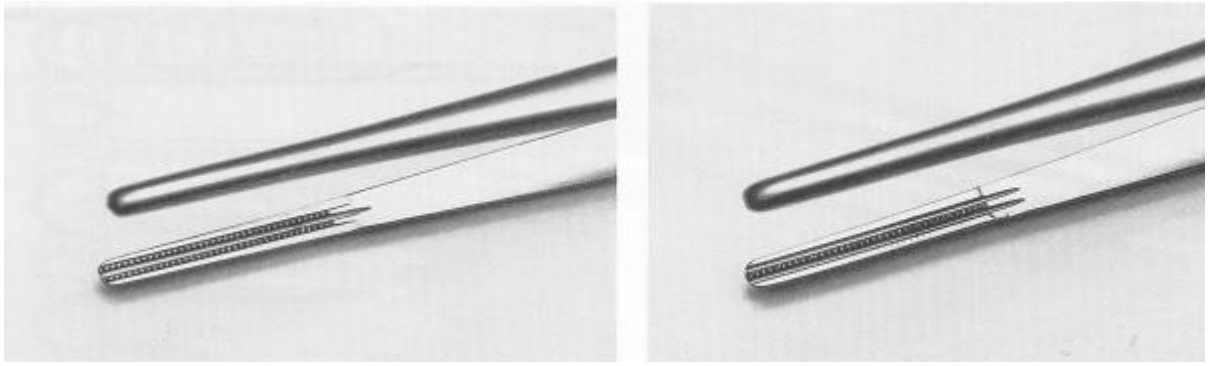
Bayonet-shaped, curved and knee-curved tweezers are mainly known as nasal and ear tweezers, but they are also used for other purposes. For example, they are used as anatomical, surgical, vascular, coagulation, micro- and tumour tweezers.

If they are more than 150 mm, they are classified as nasal tweezers.

The jaw surfaces are smooth, grooved or fitted in front with 1 : 2 interlocking teeth.

Atraumatic tweezers:

Atraumatic tweezers have special serration that prevents tissue contusion (bruising) and are used mainly in intestinal and vascular surgery.

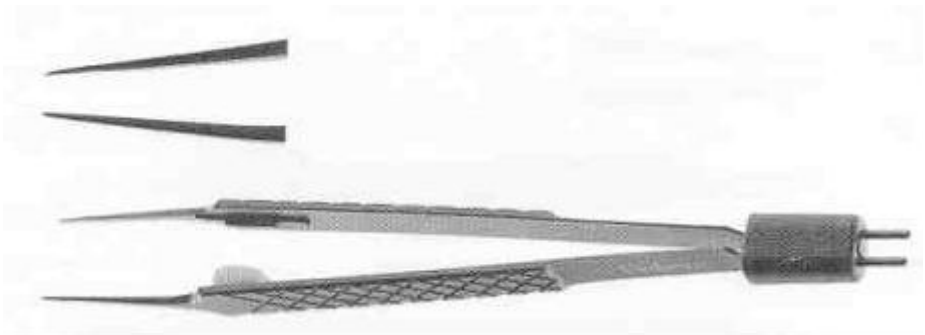


Atraumatic tweezers

Design of bipolar coagulation tweezers:

At the end of the tweezers is a connector for connecting to a power supply cable.

Coagulation tweezers have in some cases jaw tips similar to microtweezers and can, in general, be subjected to steam sterilization.



Bipolar coagulation tweezers

5.2 Clamps

Classification of clamps:

- Atraumatic clamps:

These are instruments whose jaw surfaces have special serration. The particular type of teeth and their arrangement prevent damage (traumatization) to tissue or organs when the jaws are closed.

- Gently grasping clamps:

In these clamps the jaws are made of flexible steel. This ensures that the materials to be grasped or held, e.g. the intestines, stomach, are hardly, or not at all, injured.

- Firmly grasping clamps:

The jaws of these instruments are not flexible or very elastic. The materials grasped with these clamps are grasped firmly and hard and can even be bruised.

Clamp jaw types:

In terms of jaw types, a distinction is made between:

1. Short jaws
2. Long jaws

Clamps with short jaws include e.g. Mikulicz peritoneal clamp

Clamps with long jaws include e.g. Rummel, Fuchsig ligature and preparation clamps

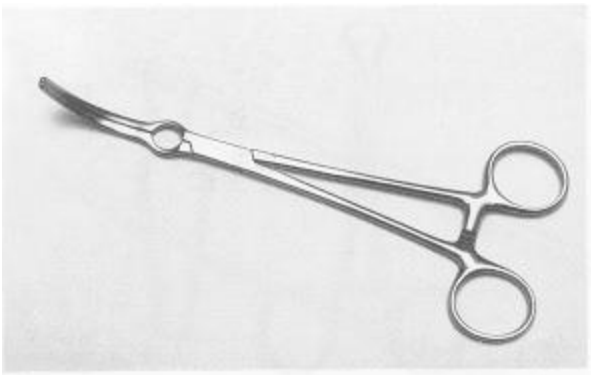
Fields of application for atraumatic clamps:

DeBakey vascular clamps:

The DeBakey atraumatic clamps have special serration of the jaw surfaces which prevents bruising of the tissue, hence they are used mainly for clamping blood vessels.

Depending on the width of the jaws and the intended use, the appropriate serration is fitted.

Cooley and DeBakey vascular clamps:



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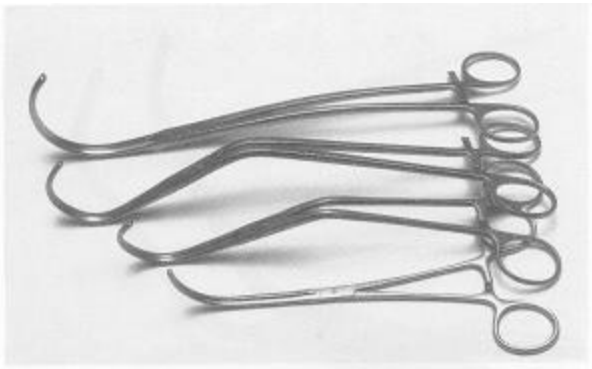

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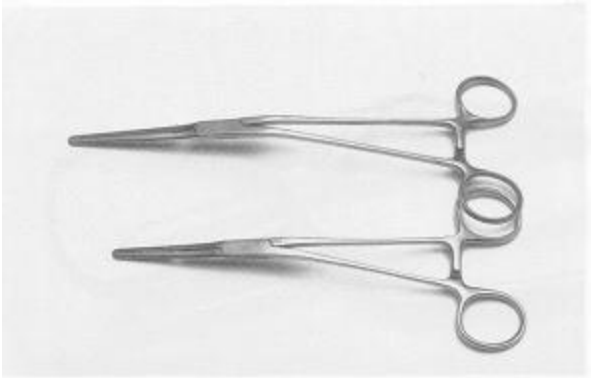

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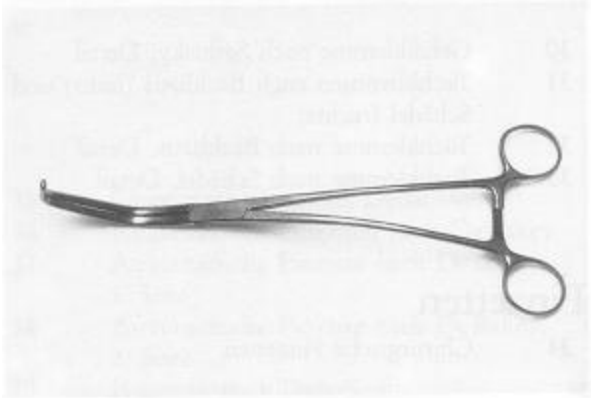

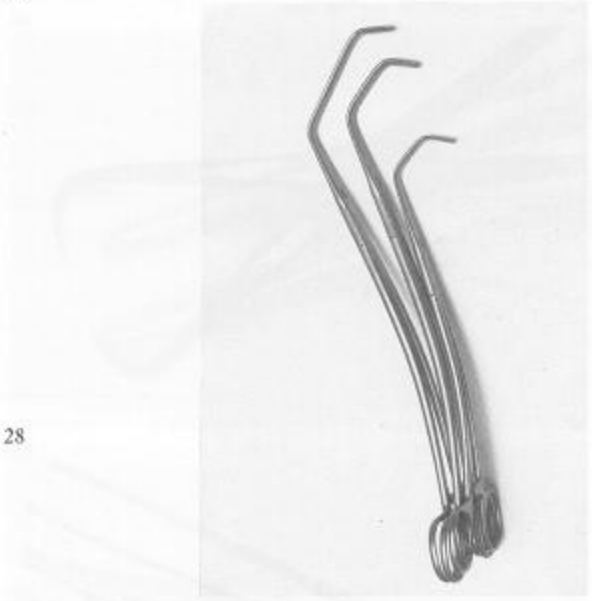

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29

25 DeBakey clamp
26 Derra and DeBakey vascular clamps
27 Cooley vascular clamps
28 Satinsky atraumatic vascular clamp
29 Satinsky vascular clamps

DeBakey bulldog clamp:

This is a slim clamp with DeBakey serrated jaw surfaces (also called “alligator clamp “).

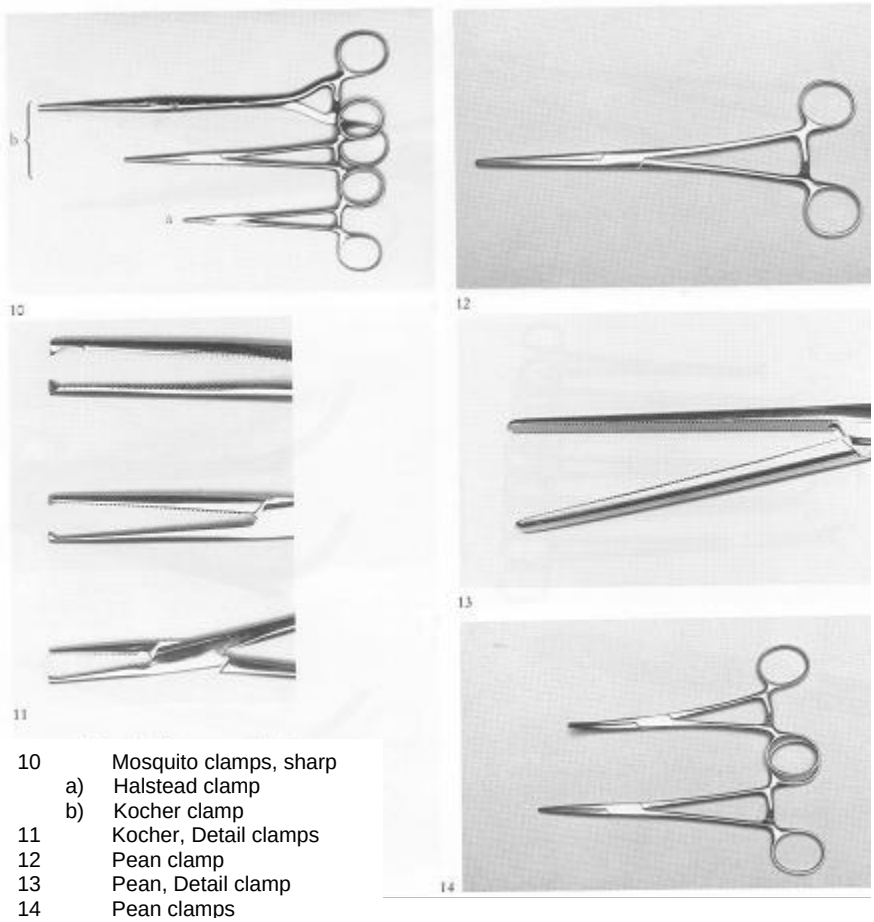
The jaws can be straight or curved.

Intestinal clamps:

These have long, gently grasping and flexible jaws. To protect delicate tissue while, nonetheless, assuring a firm grip, the jaws have an additional fabric covering.

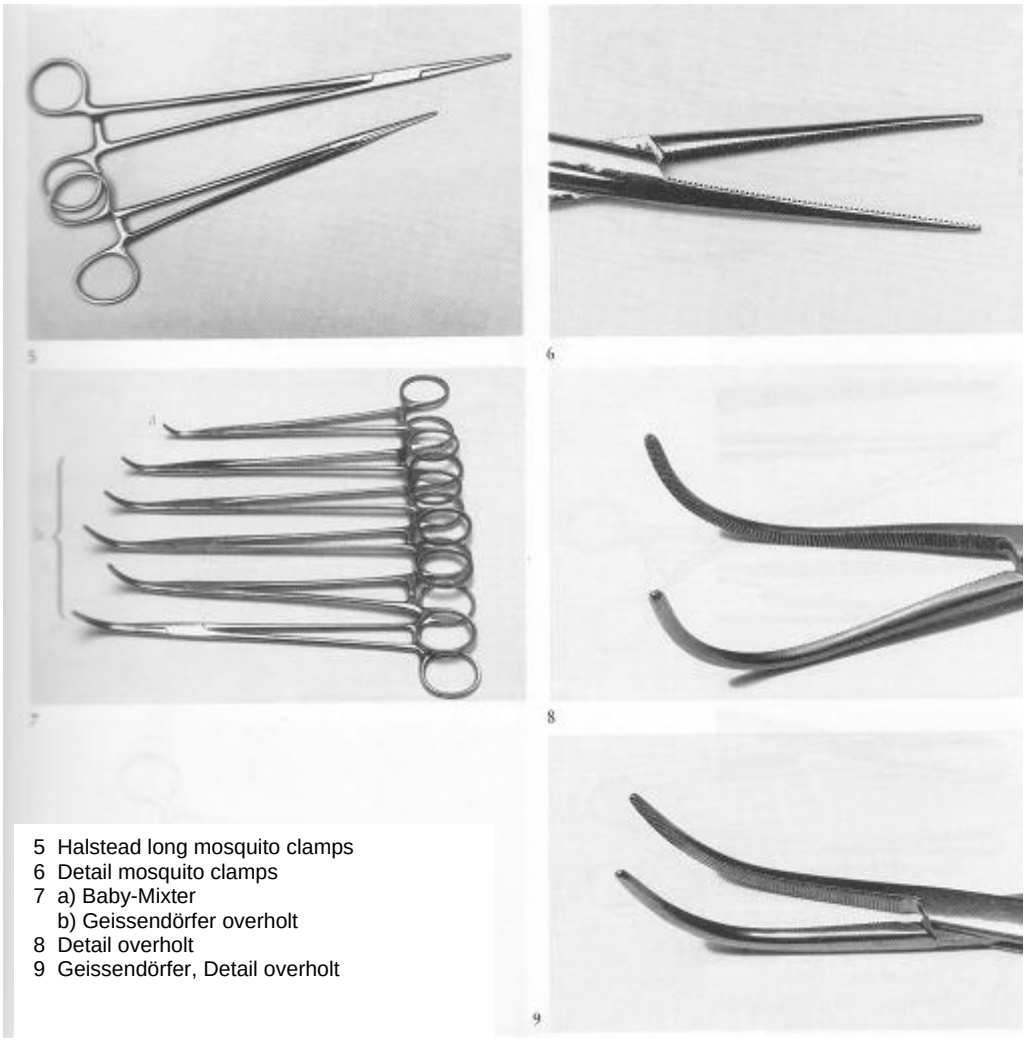
Intestinal clamps

Straight or curved arterial clamps



10 Mosquito clamps, sharp
a) Halstead clamp
b) Kocher clamp
11 Kocher, Detail clamps
12 Pean clamp
13 Pean, Detail clamp
14 Pean clamps

Arterial clamps



5 Halstead long mosquito clamps
6 Detail mosquito clamps
7 a) Baby-Mixter
b) Geissendörfer overholt
8 Detail overholt
9 Geissendörfer, Detail overholt

Firmly grasping clamps:

Mikulicz arterial clamp

With 1 to 1 serration for firm grasping of tissue segments.

Surgical clamp

5.3 Forceps

The grasping forceps include:

- Dressing / swab grasping forceps
- Organ / tissue grasping forceps
- Bone grasping or holding forceps

Organ / tissue grasping forceps:

Martin, Pozzi or Schröder hooks or bullet forceps. This is mainly used as uterine forceps.

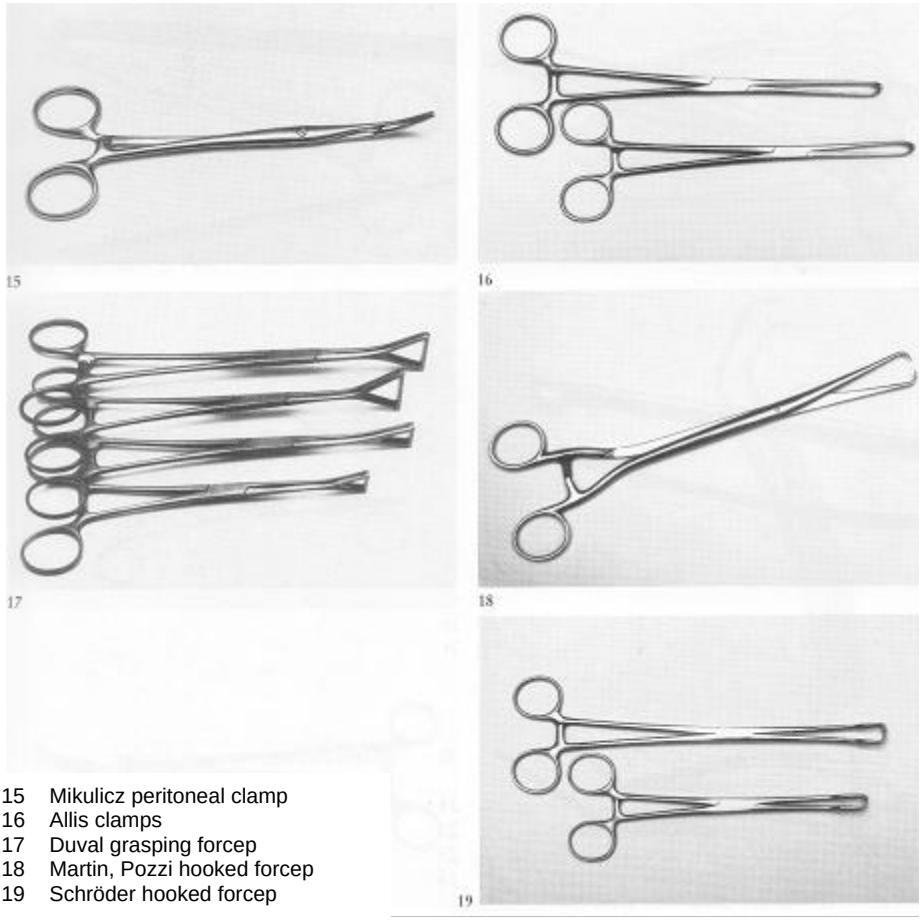
Museux hooked forceps

With 2 to 2 or 3 to 3 sharp interlocking serration.

It is used e.g. also as uterine forceps.

Allis intestinal and tissue grasping forceps

Wide at the jaw tips, 5 to 6 sharp interlocking teeth



15 Mikulicz peritoneal clamp
16 Allis clamps
17 Duval grasping forcep
18 Martin, Pozzi hooked forcep
19 Schröder hooked forcep

Grasping forceps

6 Tissue retracting instruments

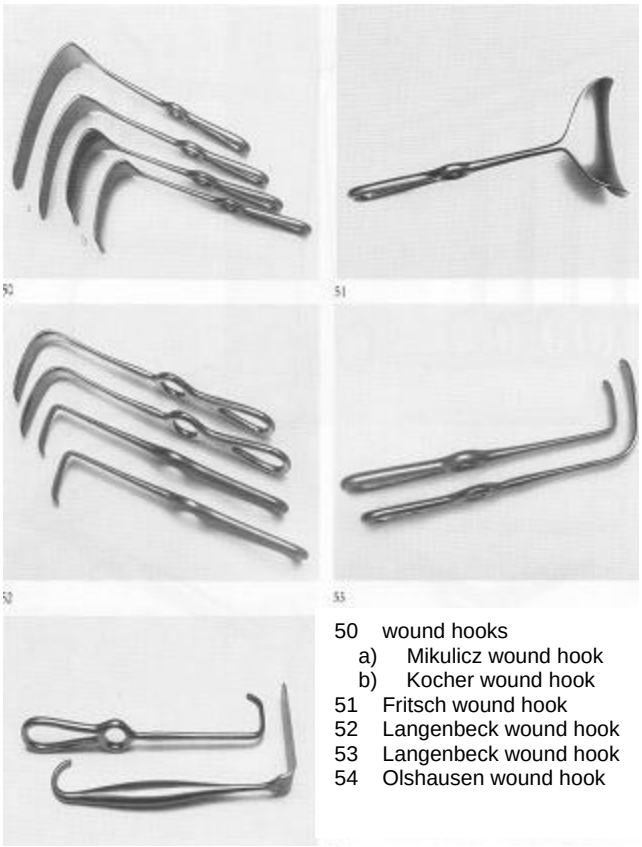
This group includes:

- wound retractors
- abdominal wall holders (frame)
- extractors (retractors)
- bone elevators
- specula
- spatulas
- nerve and vascular hooklets

6.1 Wound hooks and wound retractors

Wound hooks and wound retractors can be classified in four groups:

1. Blunt wound hooks
2. Blunt wound retractors
3. Sharp hooks
4. Sharp wound retractors



50 wound hooks
a) Mikulicz wound hook
b) Kocher wound hook
51 Fritsch wound hook
52 Langenbeck wound hook
53 Langenbeck wound hook
54 Olshausen wound hook

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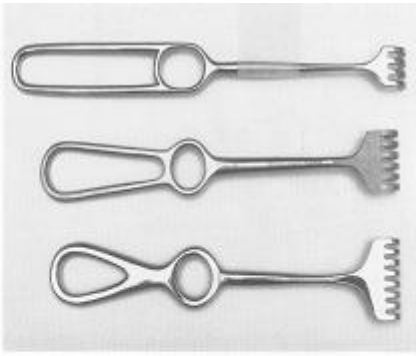

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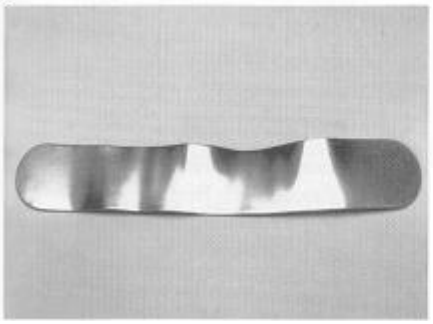

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Wound hooks
55 Roux wound hooks
56 Sharp wound hooks, 4 to 5 prongs
57 Detail deep sharp wound hook
58 Self-retaining wound retractor
59 Abdominal spatula

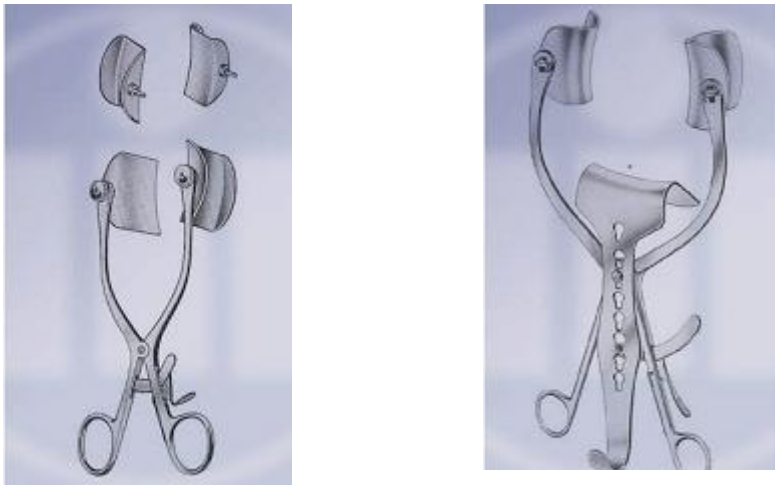
Allison lung spatula Rehn wound hook Doyen wound hook

Abdominal wall retractors:

These have been conceived to maximize exposure of the entire abdominal cavity and alleviate the tasks of assistants. Abdominal wall retractors are available in several designs.

They consist either of:

- a frame and in addition several, mainly saddle-shaped curved hooks that can be inserted into the frame.
- a guide bar with mobile or stationary arms and corresponding hooks.



Abdominal wall retractor

Sharp wound retractors:

Wound retractors are also used to hold the margins of the wound apart. They are kept in an open position by means of special ratchets.

Wound and laminectomy retractors

Weitlaner wound retractor

Laminectomy retractor

Gelpi retractor

7 Tissue apposing instruments

Tissue apposing instruments are used for grasping, holding tissue, bones and medical accessories as well as for driving surgical suture needles and needle / thread combinations when suturing.

Typical instruments of this group include:

- Needle holders
- Needles
- Repositioning forceps, etc.

7.1 Needle holders

Intended use:

Needle holders are normally divided into jaws, closing part and shanks (with or without a spring or ratchet) and rings.

The instruments are similar to ring forceps and clamps.

The jaw surfaces generally have hard metal inserts. As already stated, such needle holders can be recognized from the gold-plated rings

Hegar needle holders:

The shank ends feature rings and a ratchet. The jaw surfaces are cross-grooved and have hard metal inserts.

Hegar needle holder

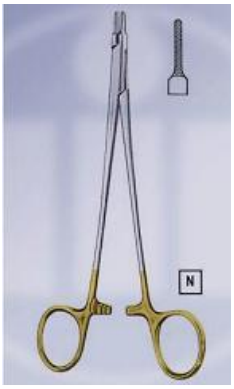
Bozemann double-angled needle holders:

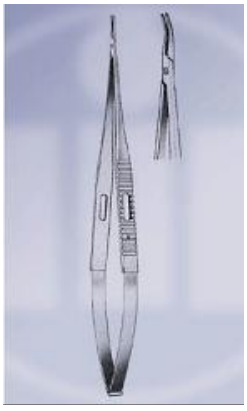
The jaw surfaces are cross-grooved and have hard metal inserts. The shanks are curved at the front and back. The instrument has rings and a ratchet and is often used in gynaecology.

Bozemann double-angled needle holders:

Microneedle holders are special needle holders used in microsurgery.

Microsurgery is understood to mean surgical operations that can be conducted only with the aid of special optical equipment, e.g. telescopic /magnifying spectacles or surgical microscope, Microsurgery is used for eye, vascular and cosmetic surgery.





Needle holders

8 Tissue protecting instruments

Tissue protecting instruments are used to protect tissues, organs, bones, etc.

Typical instruments of this group include:

- Hollow probes
- Tissue protecting sheaths
- Tissue protecting plates
- Etc.

9 Tissue probing instruments

Tissue probing instruments are used to probe and dilate hollow organs, tissue and body orifices (openings).

Typical instruments of this group include:

- probes,
- bougies,
- dilators, etc.

9.1 Probes

Probes are instruments used to palpate, measure, explore and insert into cavities. The diameter of probes is given in mm or Charrière.

Probes can be flexible, elastic or rigid

Probes with one functional end are known as *probes with a ball tip,* and probes with two functional ends as *probes with double ball tip*.

The functional ends can be tapered, spherical or olive-shaped.

Probe with ball tip (Sims uterine probe) with centimetre graduations for examining the uterus

Probe with ball tip

Cleaning probes are used to introduce cleaning solutions and/or drugs into cavities.

9.2 Bougies and dilators

Intended use:

Bougies and dilators are used to stretch and/or expand narrow sections of organs and body cavities. They are used mainly in urology and gynaecology departments to dilate the urethra or uterus.

Characteristics:

The functional ends are blunt and rounded. These instruments come in a set with different diameters. The diameter sizes are given mainly in Charrière.

Hegar uterus dilator:

Lightly curved, rounded, short, tapered tip, flattened gripping end

Other dilators include:

- Bile duct dilators, lacrimal duct dilators, vascular dilators, etc.

10 Implantation instruments

For osteosynthesis

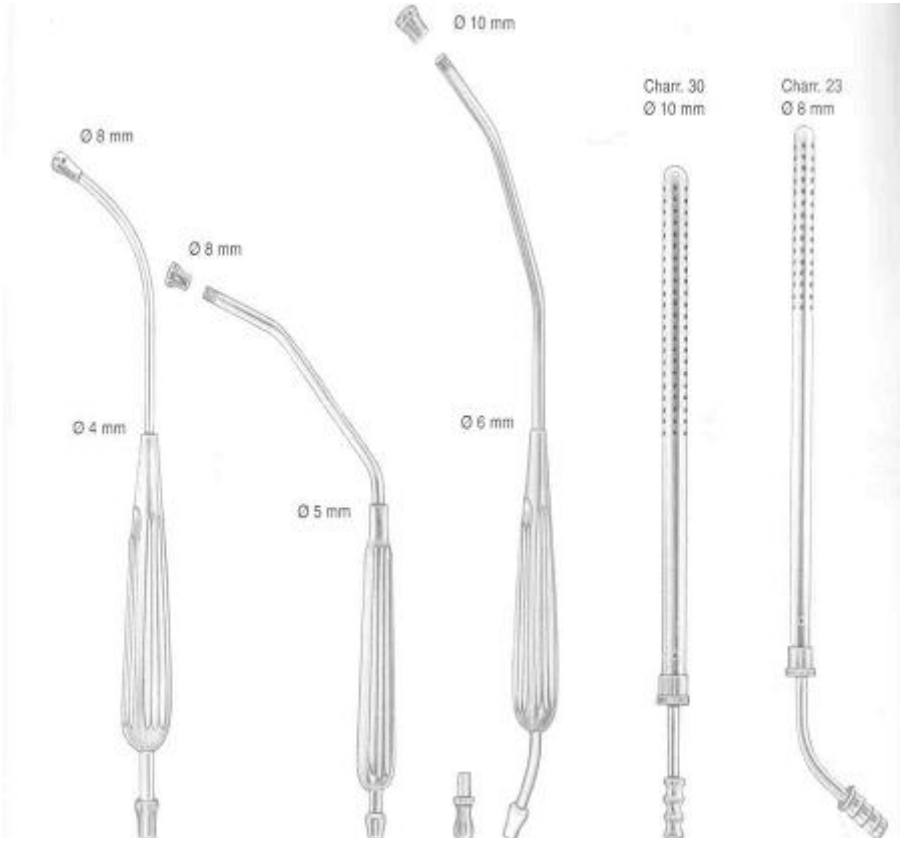
- Measuring gauges
- Screw measuring devices
- Deep measuring devices
- Drill gauges
- Nail gauges
- Screwdrivers
- Guide pins

For implantation of hip and knee joint prostheses

- Shaft rasps
- Drill gauges
- Calipers
- Holding instruments
- Hammers
- Etc.

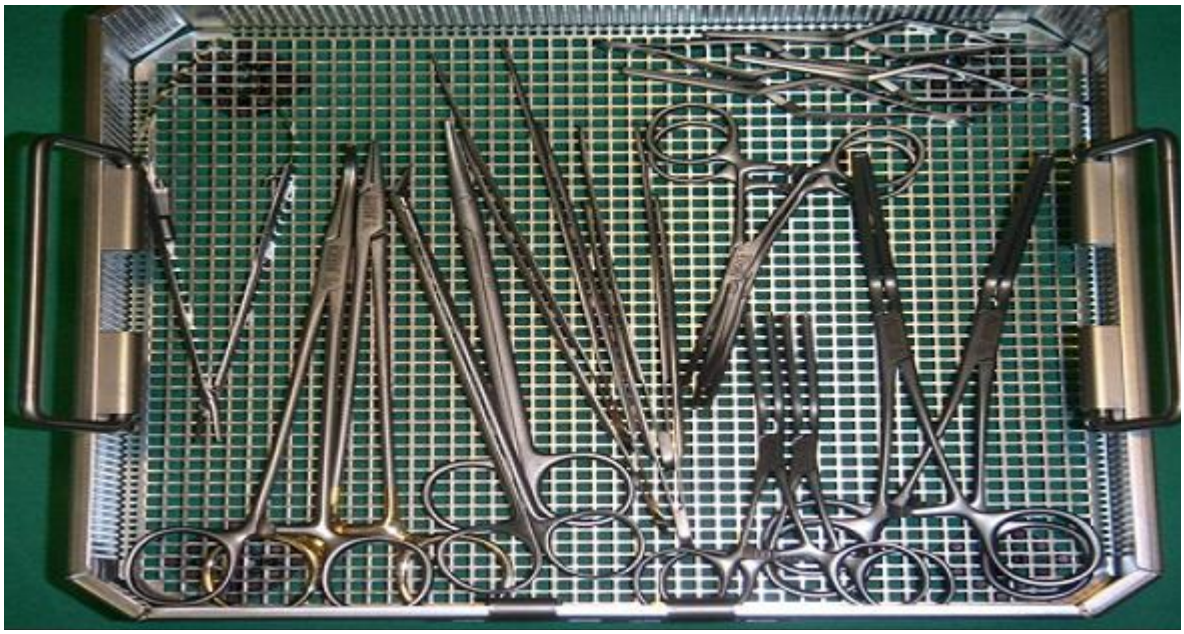
10. Special instruments

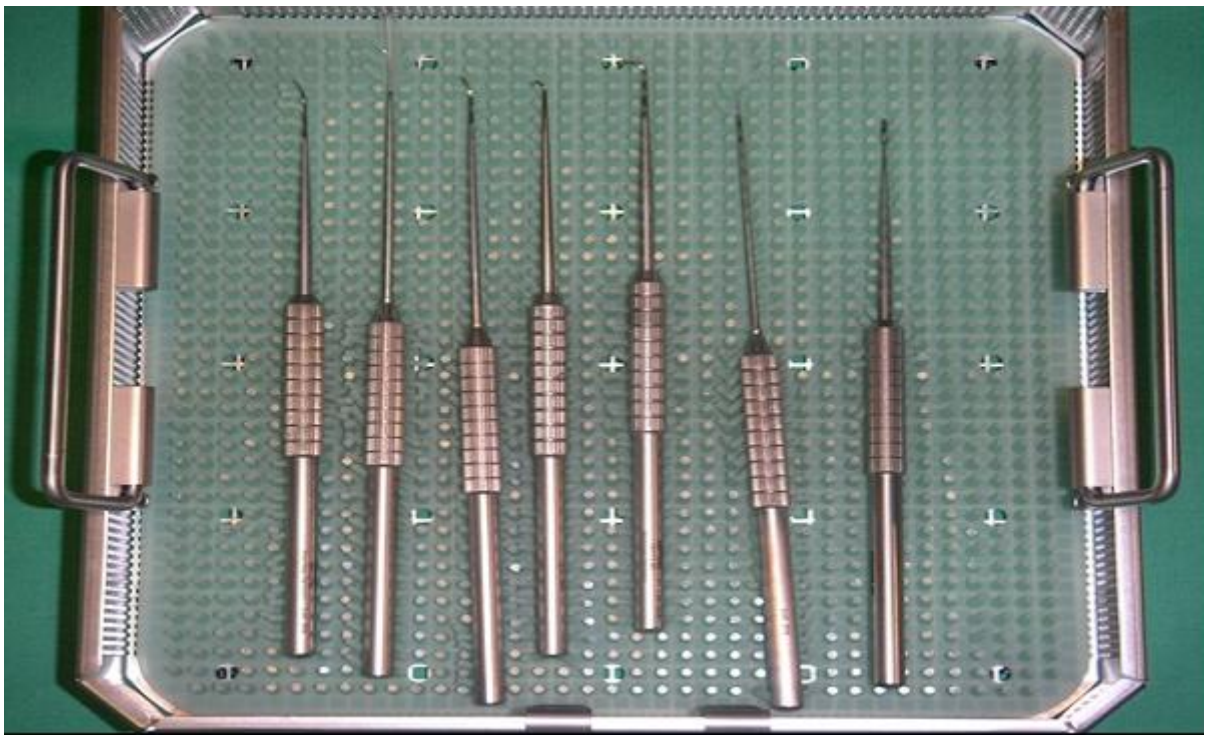
10.1 Suctions devices

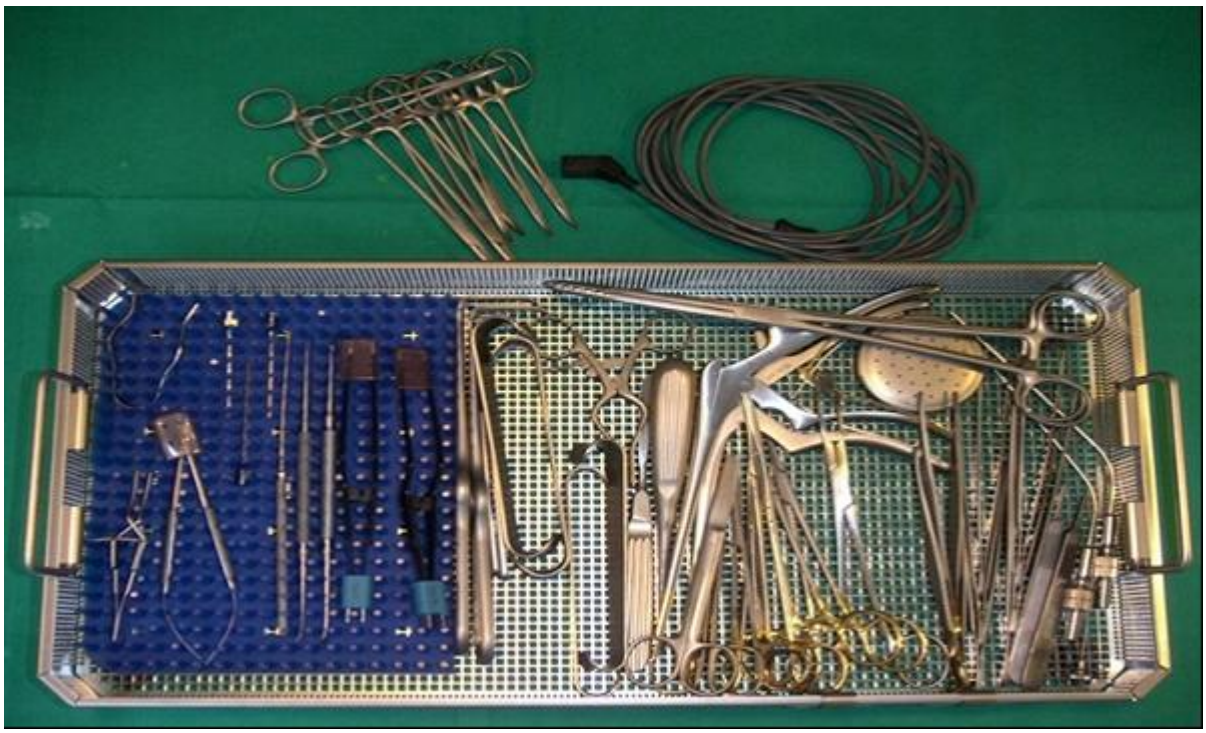


Various suction devices

11 Some examples of instrument trays








stryker
Universal
1.2 UPPER-FACE
MICRO FIXATION MODULE
Plates/Screws

12 Testing and caring for instruments

12.1 Testing instruments

After cleaning all instruments must be carefully inspected for ***cleanliness, stain formation, corrosion a***nd ***functionality***.

12.1.1 Cleanliness

After cleaning all instruments must be absolutely clean, i.e. free of visible protein residues and other contaminants.

Soil residues, tissue residues or bone splinters can remain in the grooves or jaws despite cleaning and disinfection.

The following in particular must be inspected:

- Instruments with atraumatic serration
- All Instruments with joints
- Bone splitting forceps, bone punches, hollow chisel forceps – there may still be bone residues in these!
- Cleaning channels, suction devices, etc.
- Worn and rusty instruments must be removed
- Damaged instruments (hair cracks in the closing section, hard metal inserts in needle holder may be broken, etc.) must also be removed

Particularly delicate instruments (e.g. eye instruments) must be inspected using a magnifying glass or binoculars!

Residual soils on instruments become fixed during sterilization and are then very difficult to remove from the instruments, if at all!

Furthermore, residual soils can adversely affect sterilization results (because they make it harder for the sterilant to reach the surfaces). This is particularly critical in the case of low-temperature sterilization processes!

Note:

Soiled instruments must definitely be cleaned once again!!!!

12.1.2 Stain formation

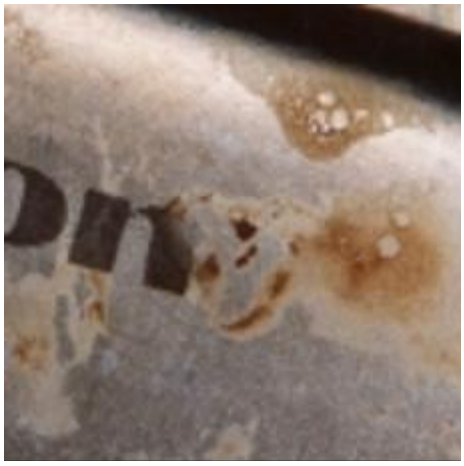
Stained instruments are mainly the result of poor cleaning and disinfection.

Possible reasons for this:

- Inadequate automated or manual cleaning
- Inappropriate detergents, disinfectants or care products
- Incorrect dosage of detergents and disinfectants
- Residues of detergents (entrainment)
- Effects of water e.g. iron or silicate
- Already damaged instruments must be removed (e.g. rusty instruments cause rust to also become deposited on intact instruments (extraneous rust)
- Drug residues
- Etc.

Surface changes can occur in all types of instruments, regardless of material. This is true in particular in the case of “removable residues” that can be removed by thoroughly recleaning.

Often yellow-brown to dark-brown discolorations can be misinterpreted as rust.



Instrument discolorations

12.1.3 Corrosion

Instruments are subjected to arduous demands because of exposure to chemical and thermal influences:

- Blood and secretions
- Ringer's solution
- Disinfectants and detergents
- Sterilization

In the event of discoloration one should check whether there are possibly any low quality instruments in the tray.

Fretting corrosion

Pitting corrosion

12.1.4 Functionality

The various instruments are tailored to their intended use. Therefore functional checks must be conducted to ensure that any instruments that do not meet the requirements will be removed.

- Instruments with moveable parts (scissors, clamps, etc) must be allowed to cool down before a functional check to avoid metallic friction
- Worn, damaged and rusty instruments must be removed
- The manufacturer’s instructions must absolutely be observed!

12.2 Caring for instruments

All instruments with a joint or closure (clamps, scissors, etc.) need special care after cleaning. Just as every mechanical component that rotates needs “lubrication”, so instruments must also be well oiled to assure their long-term performance.

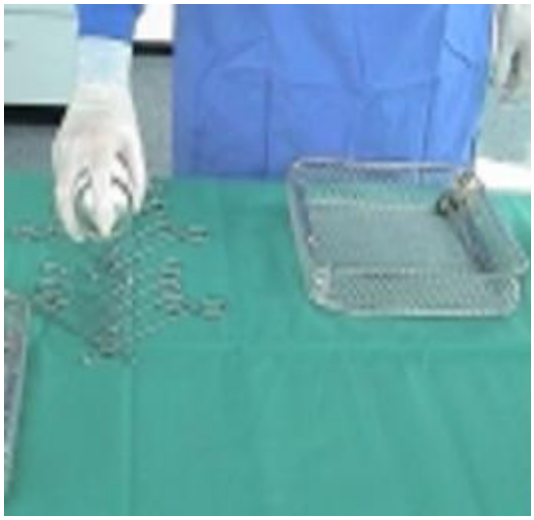
Paraffin-oil based care products that tolerate steam sterilization must be used.

These care products prevent metallic friction and thus assure good operation of the instruments i.e. the instrument is easier to open and close.

Fretting corrosion (= damage to the surface which, in turn, can give rise to rust) is thus prevented.

Method:

* ***When caring for instruments one must ensure that oil is applied only to those sites at which friction occurs.***
* ***It is not advisable to spray the instrument surfaces with oil since when use in this way the oil will not gain access to the delicate jointed regions.***
* ***Any excess oil should be removed from the surface with a non-linting cloth.***
* ***Instrument spray oil is the agent of choice for inaccessible sites.***



Carrying out care routines

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