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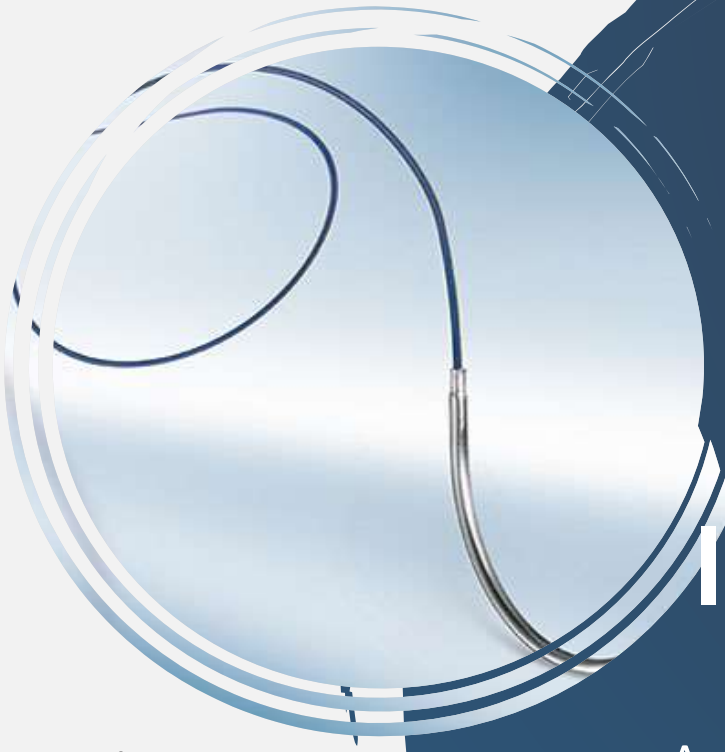


INTRODUCTION

Most traumatic and surgical wounds require some kind of closure. The use of surgical sutures and needles are the most common methods of primary closure.

A proper understanding of sutures and the principles underlying their choice can help the surgeon achieve optimal results.

Definition

Surgical Sutures and Needles

- A suture is any strand of material used to ligate blood vessels and approximate tissues, maintaining their tensile strength until adequate healing is achieved. They are generally applied using a needle with an attached length of thread.
- A surgical needle is a needle designed to carry sutures when applying stitches to tissues.

HISTORICAL BACKGROUND

Ancient Times

- Egyptians used plant materials like hemp, cotton or animal material such as tendons, silk, and arteries to suture wounds as early as 3000BC.
- Blood vessels ligated in East Africa with tendon strips and wounds approximated with acacia thorns held firmly with vegetable strands wound around them in a figure of eight.
- South American tribes apposed wounds by having large ants bite edges together like clips before twisting their bodies off.

HISTORICAL BACKGROUND

1000BC-CE

- Indian surgeons used horsehair, cotton and leather sutures.
- Linen and silk sutures and metal clips called “fibulae” used in Rome to close gladiatorial wounds.

End of 19th Century

- Advances in textile industry led to use of silk and catgut as sutures. In 1860’s, Lister advocated for tanning of catgut with chromic to increase durability in tissues. His technique for catgut sterilization was finally perfected in 1906.

SUTURES

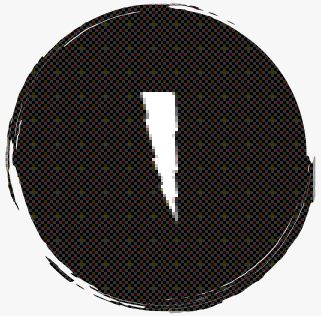
CHARACTERISTICS

CLASSIFICATIONS

CLINICAL CONSIDERATIONS

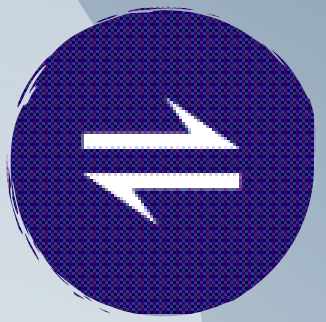
CHARACTERISTICS

The Ideal Suture



Strong

Have and maintain adequate tensile strength until its purpose is served. It should not shrink in the tissues.



Inert

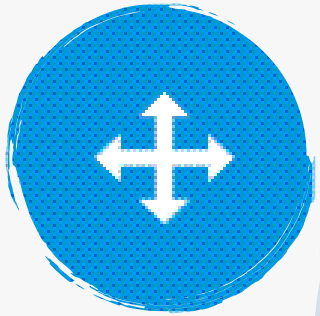
It should stimulate minimal tissue reaction and should not create a situation favourable to bacterial growth.

Safe

It should be non-electrolytic, non-capillary, non-allergenic, non-carcinogenic and non-thrombogenic (in vascular surgery).

CHARACTERISTICS

The Ideal Suture



Pliable

The material should handle comfortably and naturally by the surgeon and a knot should hold securely without fraying or cutting.

Cheap

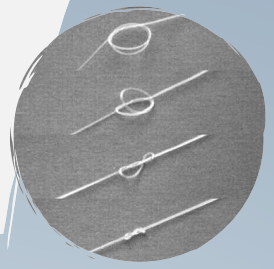
It should be inexpensive and easily sterilized.

CLASSIFICATION

Sutures are generally classified according to the following characteristics.

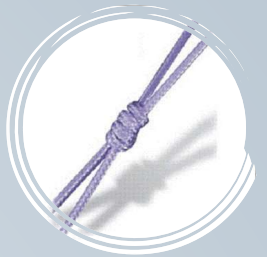
Physical Structure

Monofilament, Braided



Tensile Behaviour

Elastic, Plastic

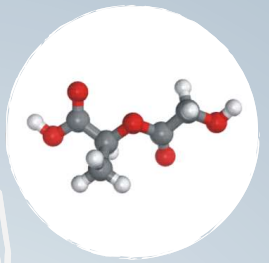


Tensile Strength

High, Low

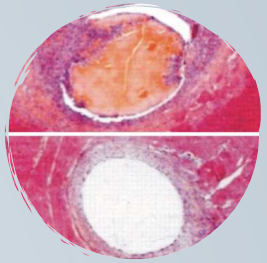
Absorbability

Absorbable, Non-absorbable



Origin

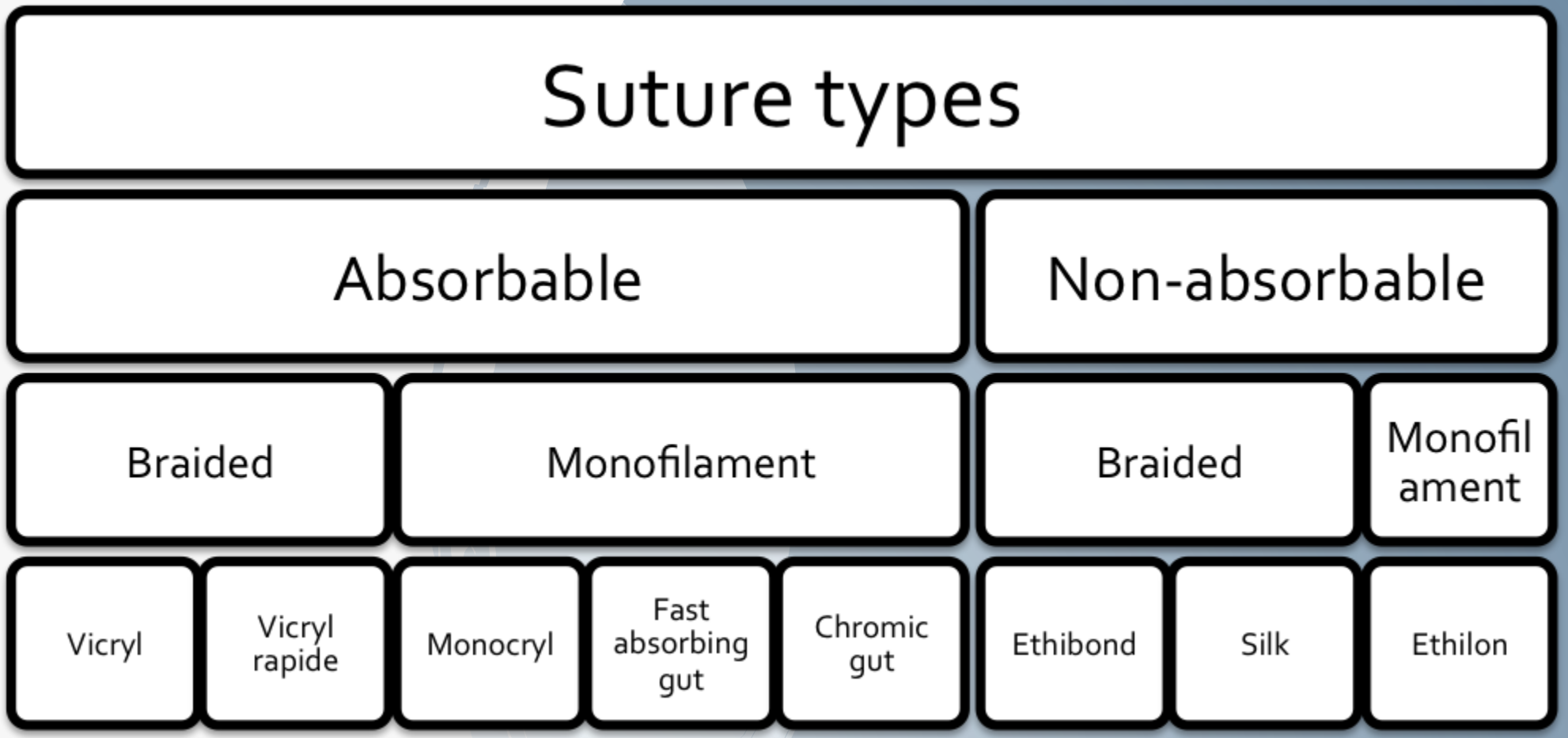
Natural, Synthetic



Biological Behaviour

Proteolytic, Hydrolytic

CLASSIFICATION



Physical Structure

Monofilament, Braided

- This refers to the texture of the suture derived from it being a single strand of material (monofilament), or a weave of several strands (multifilament or braided).

Physical Structure

	Monofilament	Multifilament
Advantages	1. Less tissue drag – resistance when pulled through tissues 2. Minimal tissue trauma – less sawing action 3. Minimal scarring	1. Greater tensile strength 2. Easier handling – flexibility and pliability 3. Better knot security – fewer knots needed
Disadvantages	1. Easy to damage from forceps grip 2. Less knot security 3. Difficult handling 4. Less tensile strength	1. More tissue drag, trauma and scarring except when coated 2. Capillary action, interstices – more likely microbial infection and sinus formation

Tensile Behaviour

Plastic, Elastic

- Sutures can be classified according to tensile behaviour into elastic (high-memory) and plastic (low-memory).
- Memory is defined as the ability of a suture to return to its original strength and coil once any tension acting on it is released.
- Synthetic sutures have more tendency to demonstrate memory.
- The greater the memory of a suture, the lesser its knot security.

Tensile Strength

- This is expressed as the force required to break a suture when its two ends are pulled apart. This is a useful approximation of its strength in the tissues (strength in vivo). It depends on:
  - Time in vivo
  - Caliber
  - Material

Tensile Strength

Time in Vivo

- Non-absorbable sutures retain their tensile strength in vivo much longer than absorbable sutures. Most non-absorbable sutures however, do not maintain their tensile strength indefinitely and may degrade or fracture with time.

Caliber

- The tensile strength of any given suture material would fall with a decrease in caliber.
- Caliber is classified according to diameter in tenths of a millimeter.

Metric (EurPh)	Diameter Range (mm)	USP
1	0.100-0.149	5-0
1.5	0.150-0.199	4-0
2	0.200-0.249	3-0
3	0.300-0.349	2-0
3.5	0.350-0.399	0
4	0.400-0.499	1
5	0.500-0.599	2

Tensile Strength

Material

- The tensile strength of sutures vary from one material to the other.
- And the tensile strength of various materials degrade at different rates in vivo.
- Absorbable sutures lose their tensile strength faster when exposed to digestive enzymes in the gut.

Absorbability

Absorbable, Non-absorbable

- Absorbable sutures are sutures that undergo rapid degradation in tissues, losing their tensile strength within 60 days.
- Non-absorbable sutures generally maintain their tensile strength in tissues for longer than 60 days.

Absorbability

Absorbable, Non-absorbable

- Absorbable sutures are made from collagen fibers of healthy mammals (natural) or biodegradable chemical polymers (synthetic).
- Absorbable sutures are degraded by tissue enzymes while non-absorbable are encapsulated and walled off by tissue fibroblasts.

Absorbability

Absorbable, Non-absorbable

- Factors that affect absorbability of a suture include
  - Origin – natural or synthetic
  - Exposure to digestive enzymes in the gut
  - Exposure to fluid – in vitro or in vivo e.g. pus, urine
  - Fever or infection
  - Protein deficiency

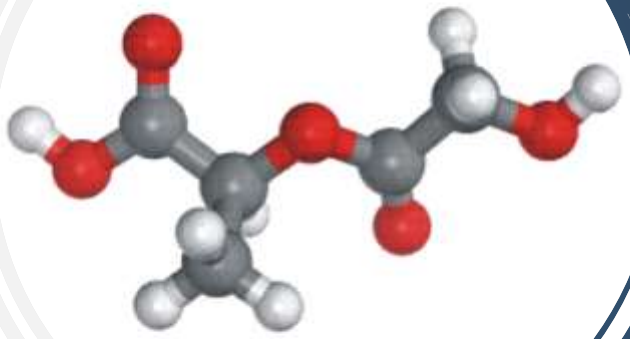
Absorbability

	Absorbable	Non-absorbable
Advantages	1. No residual foreign body left in vivo 2. Useful in fast-healing tissue	1. Prolonged wound support time
Disadvantage	1. Short tissue support time	1. Foreign body left 2. Cost and trauma of suture removal 3. May stick out and/or lead to sinus formation

Absorbability

Tensile strength and absorbability of sutures

Suture	Tensile Strength Loss	Absorption in Tissue
Catgut	15 days	60 days
Chromic Catgut	30 days	80-120 days
Polyglyconic acid (Dexon)	30 days	90 days
Polyglactin (Vicryl)	32 days	70 days
Irradiated Polyglactin (Vicryl Rapide)	14-21 days	56-70 days
Polydioxanone	56 days	180 days
Nylon	25% in 2 years	–
Prolene	Indefinite	–
Dacron	Indefinite	–



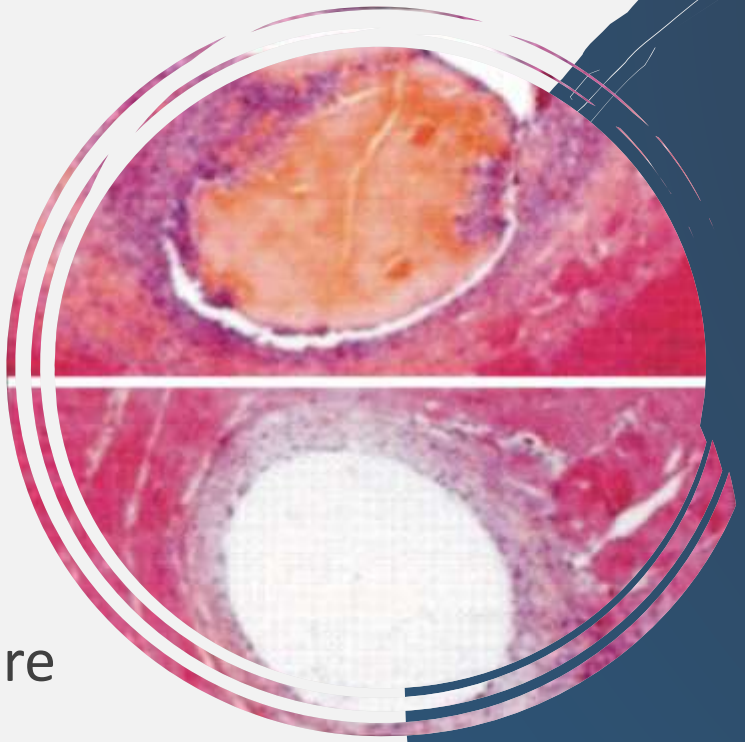
Origin

Natural, Synthetic

- Sutures can be classified based on their origin into natural and synthetic.
- Natural sutures have biological origins while synthetic sutures come from chemical polymers.

Origin

	Natural	Synthetic
Advantages	1. Better handling and knot security 2. Rapid absorption of natural absorbable sutures – suitable for apposition of rapidly healing tissues and ligation of superficial vessels	1. Absorption by hydrolysis – provokes less inflammatory response 2. Synthetic absorbable sutures have predictable rate of absorption
Disadvantages	1. Natural absorbable sutures provoke a worse tissue reaction 2. They fray during knot construction 3. More variability in tensile strength in vivo	1. Poor handling – monofilament



Biological Behaviour

Proteolytic, Hydrolytic

- This refers to the behaviour of suture materials within tissues.
- Natural sutures such as catgut are degraded by **proteolysis** which involves and entirely unpredictable process and can cause varying severity of tissue irritation. Hence, catgut is seldom used.
- Synthetic polymers are degraded by **hydrolysis**. Their in vivo degradation process is more predictable.

Biological Behaviour

Proteolytic, Hydrolytic

- Evidence indicates that cancer cells migrate to sites where sutures persist therefore synthetic sutures may be less carcinogenic on account of more predictability and less tissue reaction.
- Catgut has been banned in Europe and Japan on account of fears that it may transmit bovine spongiform encephalopathy.

CLINICAL CONSIDERATIONS

Choosing Your Sutures

- Monofilament absorbable sutures – when there is a risk of infection.
- Thin monofilament absorbable sutures – running intradermal sutures.
- The smallest suture usable – suturing cosmetically sensitive skin. (Trials show no major difference between absorbable and non-absorbable sutures in cosmesis, complications or scarring).
- Sutures with longer absorption time – if using absorbable sutures for areas where more strength is required.

CLINICAL CONSIDERATIONS

Choosing Your Sutures

- Non-absorbable or slow absorbing sutures – for slow healing tissues or where prolonged tension is required for adequate healing like fascia, tendons, ligaments and bones.
- Absorbable sutures – fast healing tissues like stomach, colon, and bladder.
- Absorbable sutures – for ligatures.
- Natural sutures are not advisable within the gut due to digestion.
- Synthetic absorbable sutures – tracts prone to stone formation e.g. urinary and bilary.
- Non-absorbable sutures – vascular surgery.

CLINICAL CONSIDERATIONS

Size, type and intervals for removal of skin sutures

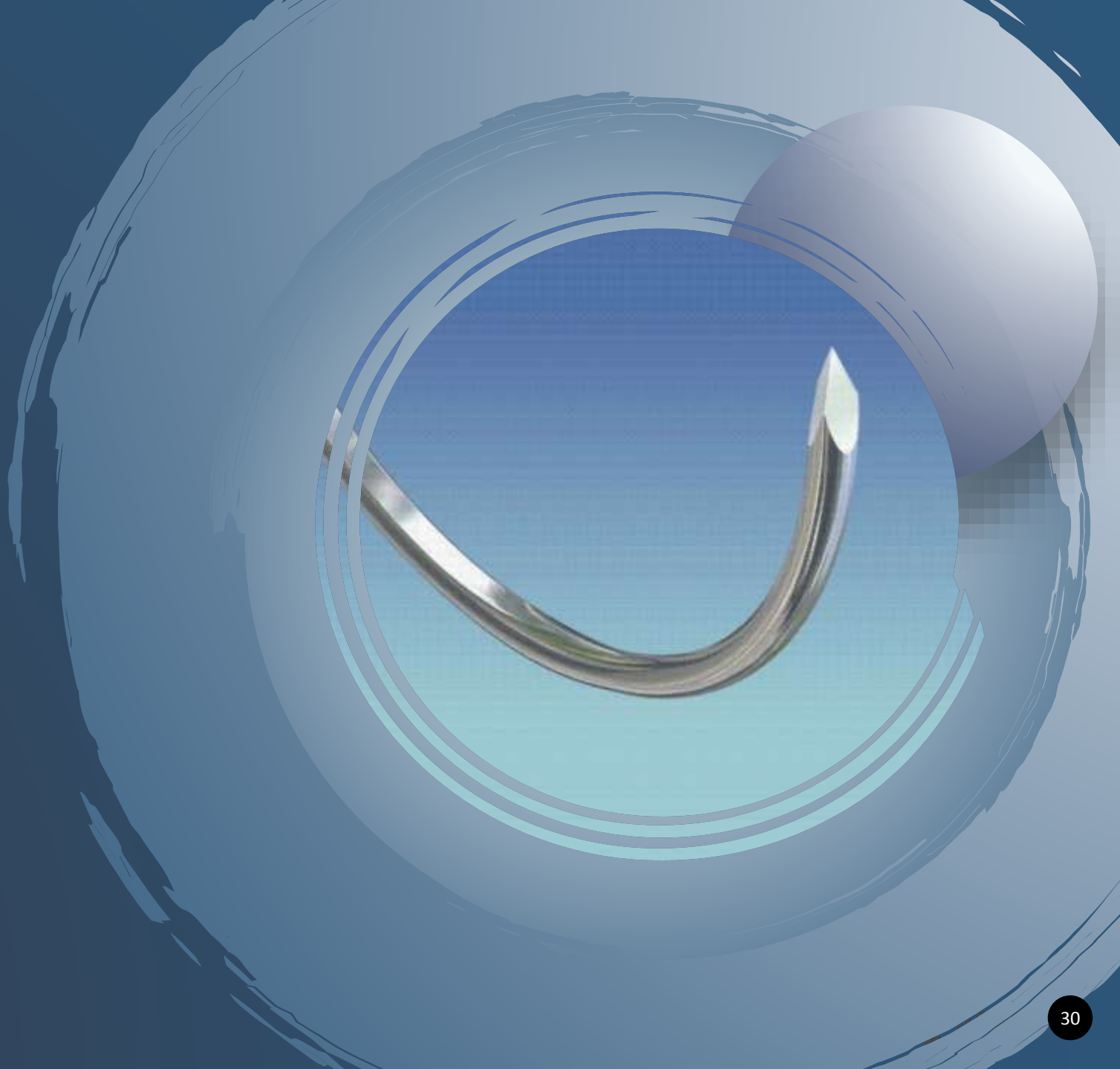
Area	Size	Type	Days to Removal
Scalp	4-0 or 5-0	non absorbable	7
Ear	6-0	non absorbable	5-7
Eyelid	6-0 or 7-0	absorbable or nonabsorbable	5-7
Eyebrow	5-0 or 6-0	absorbable or nonabsorbable	5-7
Nose	6-0	absorbable or nonabsorbable	5-7
Lip	6-0	absorbable	NA
Oral mucosa	5-0	absorbable	NA
Other face / forehead	6-0	absorbable or nonabsorbable	5
Chest/abdomen	4-0 or 5-0	non absorbable	12-14
Back	4-0 or 5-0	non absorbable	7-10
Extremities	4-0 or 5-0	non absobrable	7-10
Hand	5-0	non absorbable	7-10
Foot / Sole	3-0 or 4-0	non absorbable	12-14
Joint (Extensor)	4-0	non absorbable	10-14
Joint (Flexor)	4-0	non absorbable	7-10

NEEDLES

CHARACTERISTICS

ANATOMY

CLINICAL CONSIDERATIONS



CHARACTERISTICS

Characteristics of the ideal surgical needle

- It is made of high-quality stainless steel
- It has the smallest diameter possible
- It is stable in the grasp of the needle holder
- It is capable of implanting suture material through tissue with minimal trauma
- It is sharp enough to penetrate tissue with minimal resistance
- It is sterile and corrosion-resistant to prevent introduction of microorganisms or foreign materials into the wound

ANATOMY

Basic Design

Specifications

Shapes

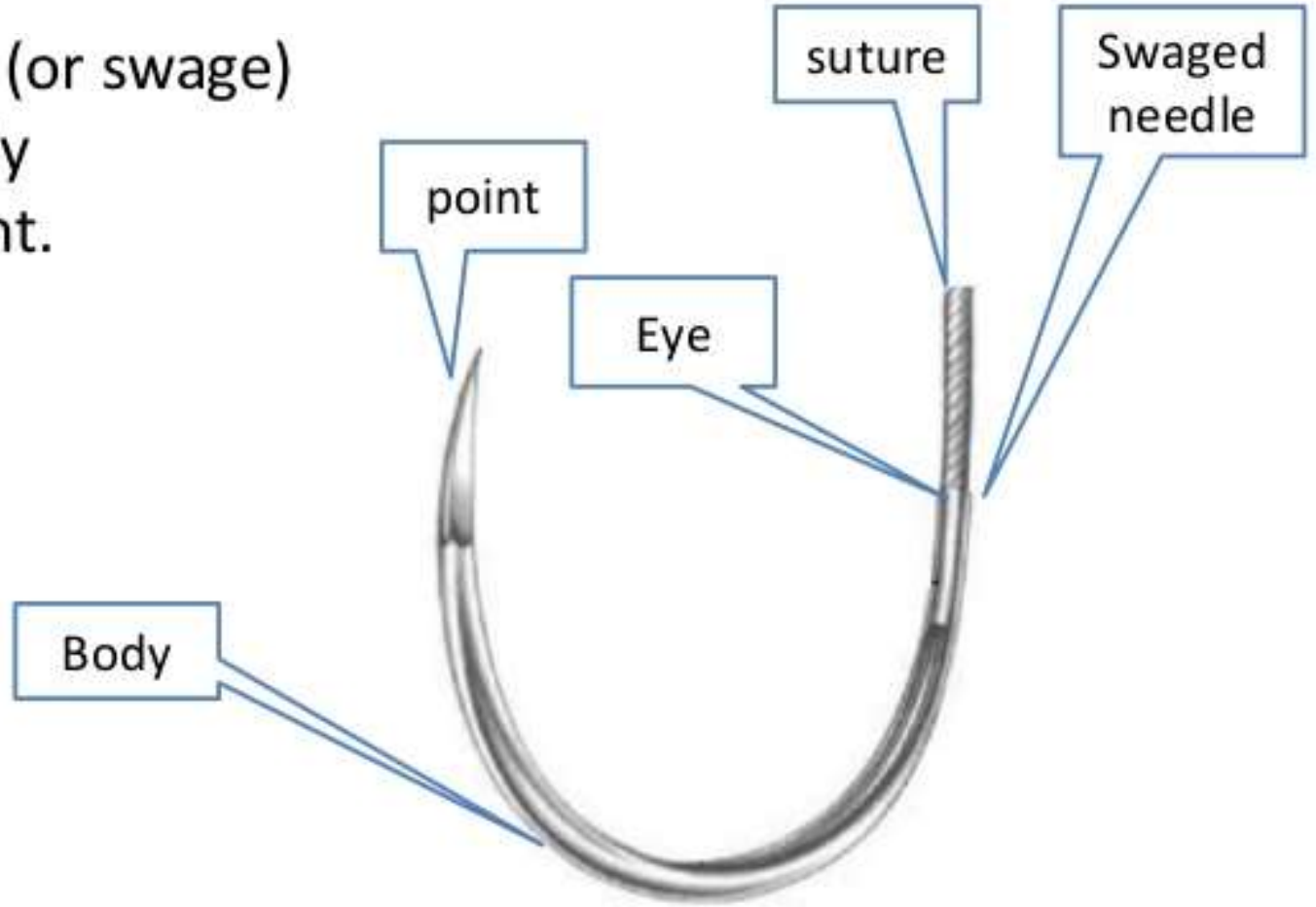
Butt: Eye or Swage

Body and Tip

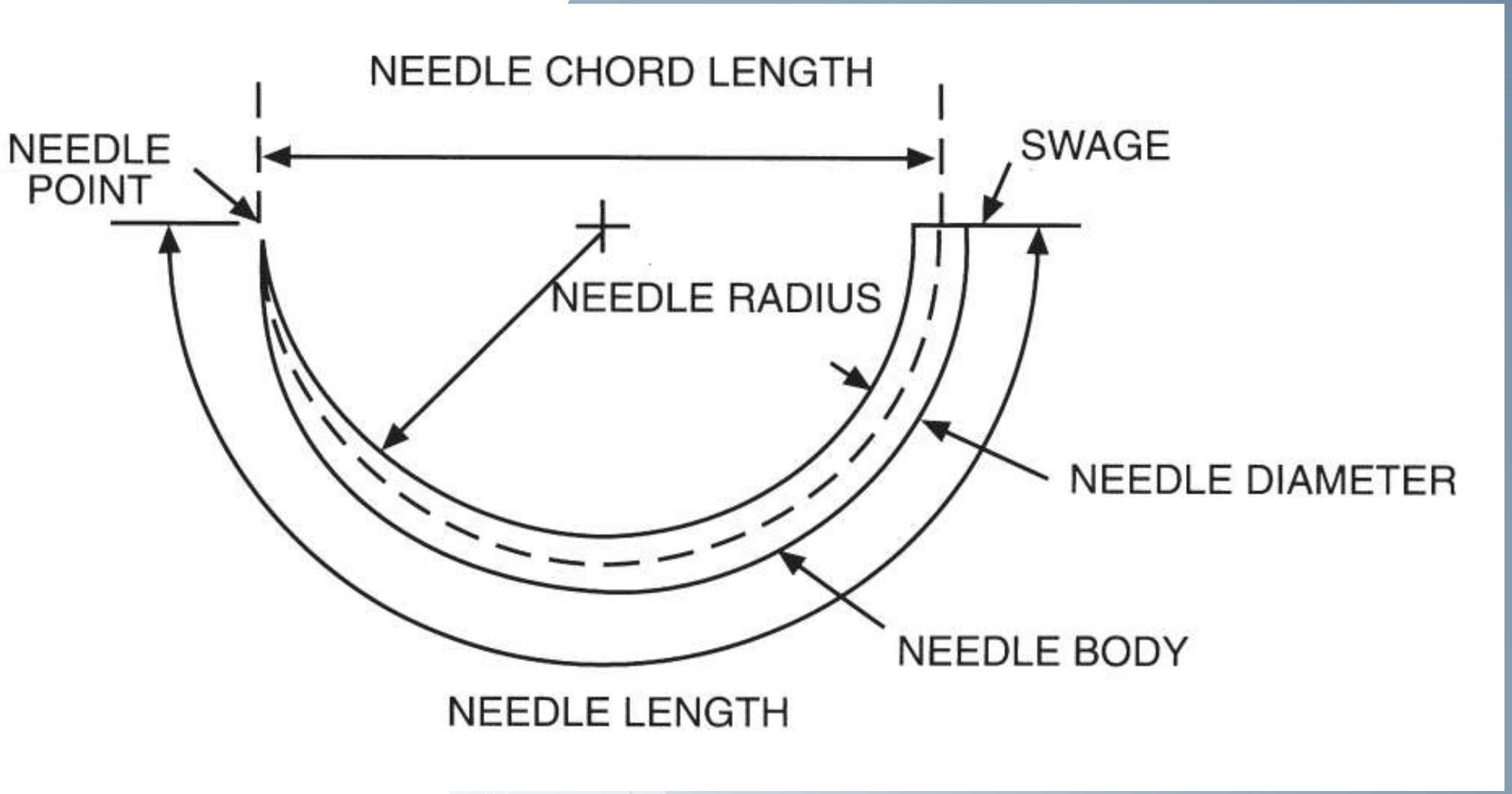
Basic Design

All surgical needles have three basic components:

1. eye (or swage)
2. body
3. point.



Specifications



Shapes

1/4 Circle

- Eye
- Microsurgery

Straight

- Nasal cavity
- Nerve
- Skin
- Tendon

3/8 Circle

- Dura
- Eye
- Fascia
- Nerve

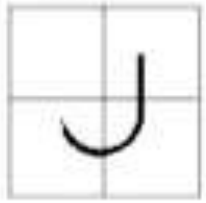
Compound Curve

- Eye (Anterior segment)

1/2 Circle

- Muscle
- Eye
- Skin
- Peritoneum

J Shape



- Laparoscopy

5/8 Circle

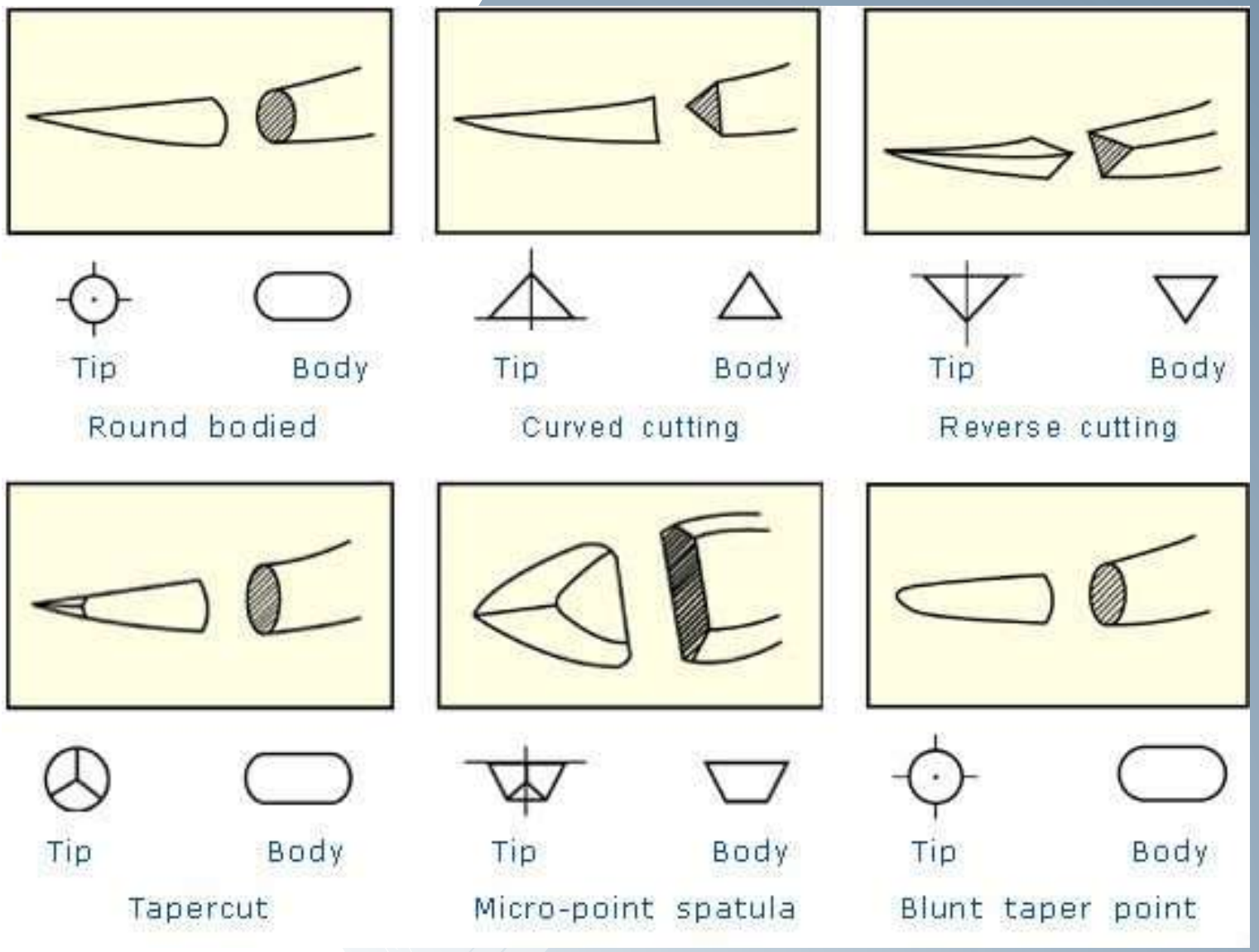
- Cardiovascular
- Oral
- Pelvis
- Urogenital tract

Butt: Eye or Swage

Disadvantages of eyed to swaged needles

- Time consuming
- Traumatic – tissue disruption
- Repeated use

Body and Tip


Tip
Body
Round bodied
Tip
Body
Curved cutting
Tip
Body
Reverse cutting
Tip
Body
Tapercut
Tip
Body
Micro-point spatula
Tip
Body
Blunt taper point

CLINICAL CONSIDERATIONS

Choosing Your Needles: Shapes

- Straight needles are used by hand on easily accessible tissues like skin, nerves and blood vessels.
- Needles with shallower curvatures like ¼ and ⅜ are useful in superficial procedures and on easily accessible convex surfaces. Examples include subcuticular skin closure and eye surgeries.
- Needles with deeper curvatures like ½ and ⅝ are ideal for operating in confined spaces and deep cavities like the pelvis.
- J-shaped and half-curved needles are used for laparoscopic procedures while compound needles are ideal for anterior segment eye surgeries.

CLINICAL CONSIDERATIONS

Choosing Your Needles: Body and Tip

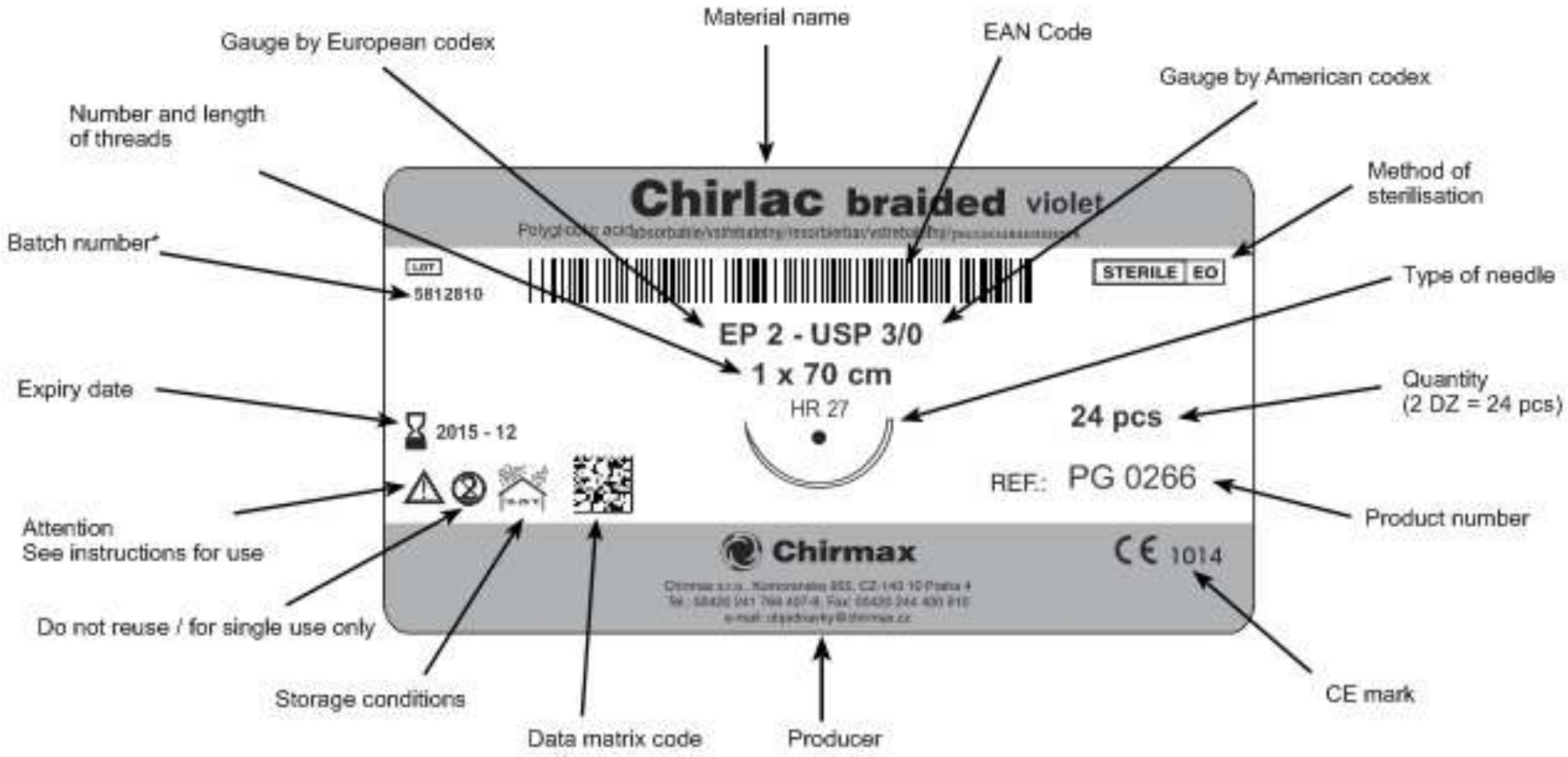
- Cutting needles are used in tough tissues like skin and tendons. They are also ideal for cosmetic and ophthalmic surgery where minimal trauma is paramount. Reverse-cutting needles serve the same functions but are stronger and less likely to cut through tissues.
- Round-bodied needles spread tissues apart as they pass through with minimal cutting and are ideal for easily penetrated tissues like abdominal viscera and peritoneum. They are also less likely to cause leakage of needle tracks after internal anastomoses.
- Blunt tipped needles are ideal for easily pliable tissues like liver and kidneys.
- The spatula needle used in ophthalmic surgeries to penetrate between corneal and scleral layers without tissue disruption.

CLINICAL CONSIDERATIONS

Using Your Needles

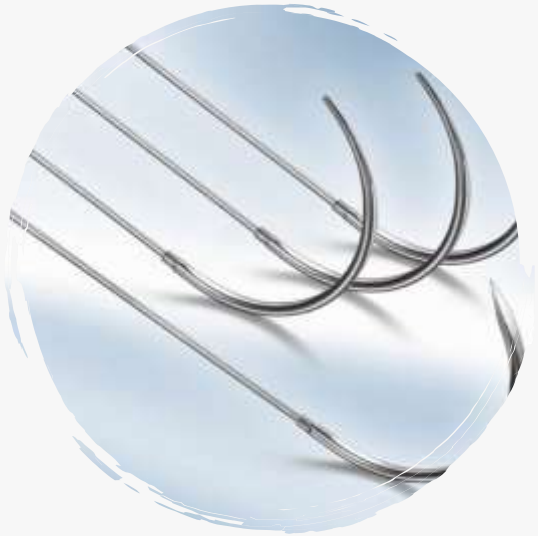
- Grip the needle with optimal force using a needle holder selected to match its size and strength to avoid damage and distortion of its curvature.
- Needle holders with worn, nicked or defective jaws can cause needle instability and subsequent tissue trauma.
- Do not grip the needle at its tip to avoid bluntness, or at its butt to avoid instability. It is best to place your grip one-third the length of the needle from the butt.

PACKAGING


Material name
Gauge by European codex
EAN Code
Gauge by American codex
Number and length of threads
Method of sterilisation
Batch number
Type of needle
Expiry date
Quantity (2 DZ = 24 pcs)
Attention See instructions for use
Product number
Do not reuse / for single use only
Storage conditions
Data matrix code
Producer
CE mark
Chirlac braided violet
LOT
5812810
STERILE EO
EP 2 - USP 3/0
1 x 70 cm
HR 27
24 pcs
2015 - 12
REF: PG 0266
Chirmax
CE 1014

ALTERNATIVES

Alternatives to traditional sutures include the following.

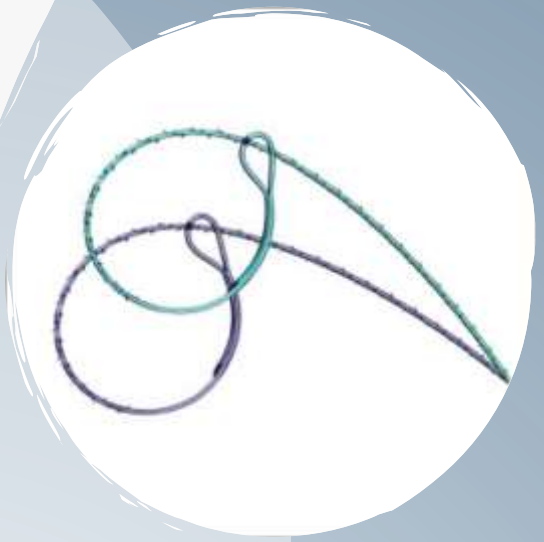


Metallic Sutures

Stainless steel, aluminum, silver etc

Advantages: Inert. High tensile strength for longer period. Aluminum sutures cause rapidly increasing wound tensile strength even after removal of sutures. Silver has antibiotic properties.

Disadvantages: Difficult to knot, pain when sutures fracture in vivo.



Barbed Sutures

Knotless sutures

Advantages: Tissue passage in only one direction. Distributes tension uniformly along length of wound. Does not need knots and therefore reduces length of surgery and mass of foreign body in vivo.

Disadvantages: Cutting barbs into a suture reduces its functional diameter and consequently, its tensile strength.

Surgical Staples

Skin staples

Advantages: Useful in apposition of wounds under tension. Quick placement. Minimal tissue reaction. Absorbable staples useful in laparoscopic surgeries.

Disadvantages: Cost. Less precise wound edge alignment

ALTERNATIVES

Surgical Clips

Advantages: Essential in laparoscopic surgery. Good residual vascular length of grafts in transplant surgery.

Disadvantages: Cost. Metallic clips may interfere with CT and erode into tissues.

Skin Tapes

Sutureless skin closure

Advantages: Prevents tension across wound, avoids post-operative scarring. Reduces time of surgery.

Disadvantages: Loss of adhesiveness may lead to wound dehiscence. Difficulty ensuring accurate skin edge apposition. Effectiveness depends largely on skill of operator.

Skin Adhesives

Acrylate superglues

Advantages: Rapid, painless application. Good cosmesis – no suture marks. Blocks pin point skin haemorrhages. Bacteriostatic.

Disadvantages: Less tensile strength. High cost.

CONCLUSION

The use of sutures and needles for primary closure and ligature is of utmost importance in surgery. There is a great variety of these suited for different procedures and operations. The surgeon now has options to work with and by an in-depth understanding, will achieve the best outcomes.

THANK YOU