UNIVERSITAS INDONESIA
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EST. 1849
FAKULTAS KEDOKTERAN

RSCM

Basic of Suturing Skills

The Science of Tissue Management

Departemen Ilmu Bedah FKUI–RSCM
Program Studi Ilmu Bedah

Three Modules

1. Suture Closure Technique
2. Suture Classification
3. Suture Selection

Module 1 : Suture Closure Technique

Module 1 : Suture Closure Technique

Learning Objectives

1. Familiar with the goals of suture closure technique
2. Familiar with the advantage and disadvantage of continuous and interrupted suture closure technique
3. Familiar with the application of continuous and interrupted suture closure technique

Closure Goals

The importance of closure technique is to optimize the outcomes:

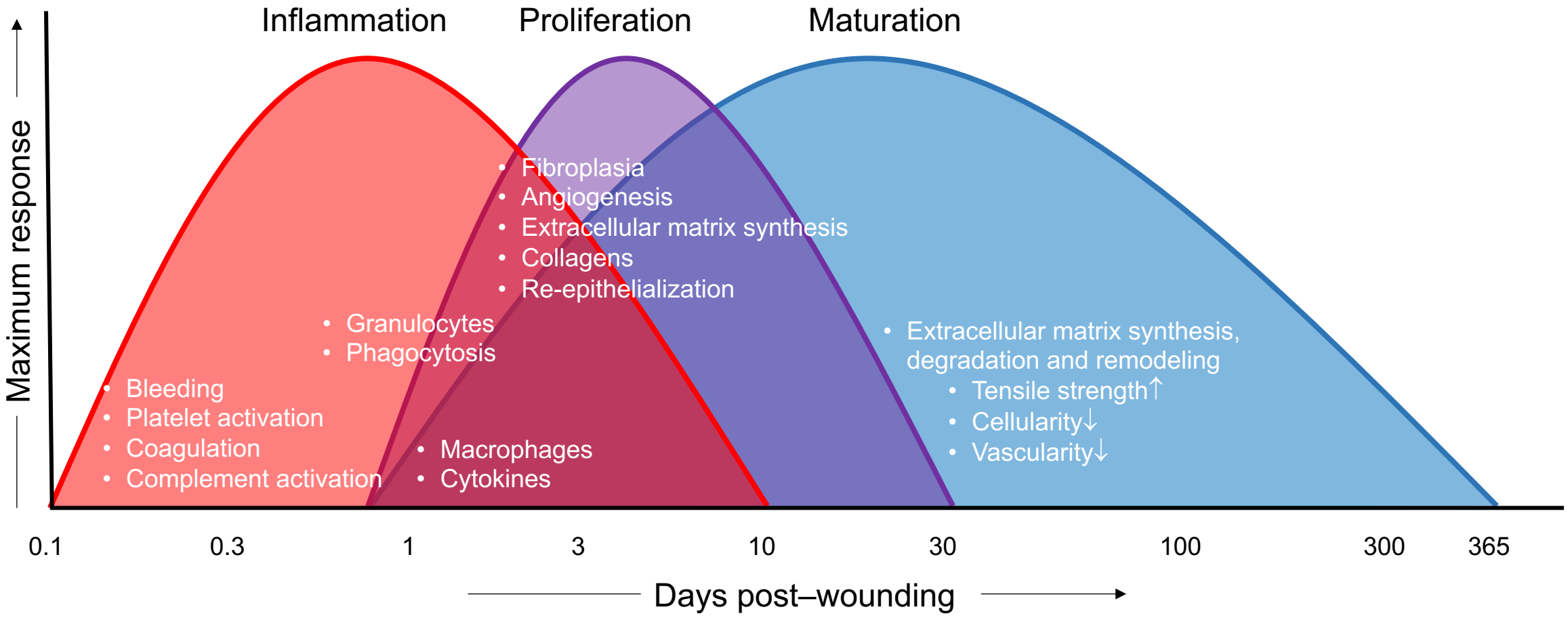
- Primary healing
  - → Wound closure: healed by 1st intention
    - Approximate the epithelial of wound edges
    - Eliminate dead space
    - Favorable/acceptable scar

Closure Goals

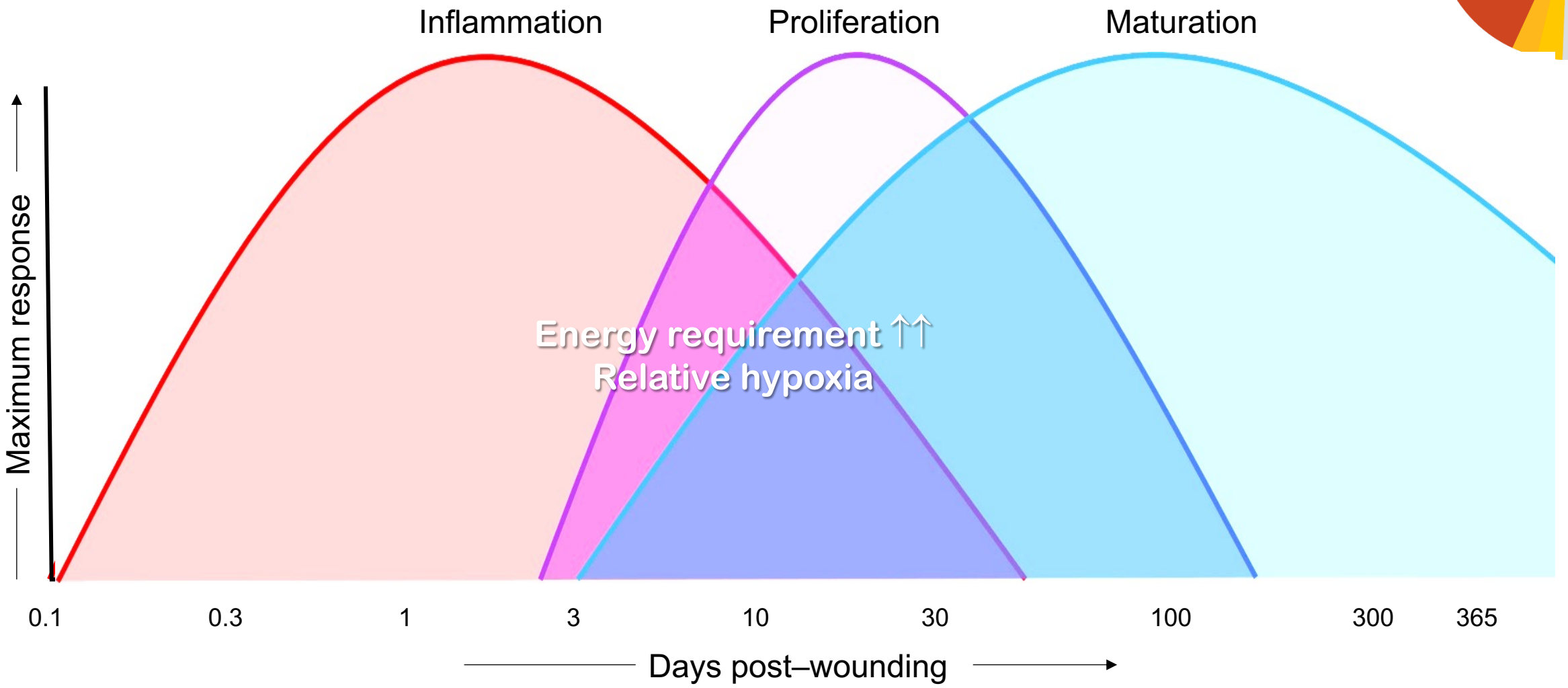
- Approximation of wound edges:

Primary healing:	Secondary healing:
Healed by 1st intention:	Healed by 2nd intention:
1. Re–epithelialization	1. Fibroplasias and angiogenesis
2. Fibroplasias and angiogenesis	2. Re–epithelialization
3. Remodeling (scar formation)	3. Remodeling (scar formation)
Re–epithelialization <10days	Re–epithelialization >21days
Unfavorable scar: 4%	Unfavorable scar: 75–80% (Fibrotic scar, contracture, hypertrophic scar and keloid)

Closure Goals

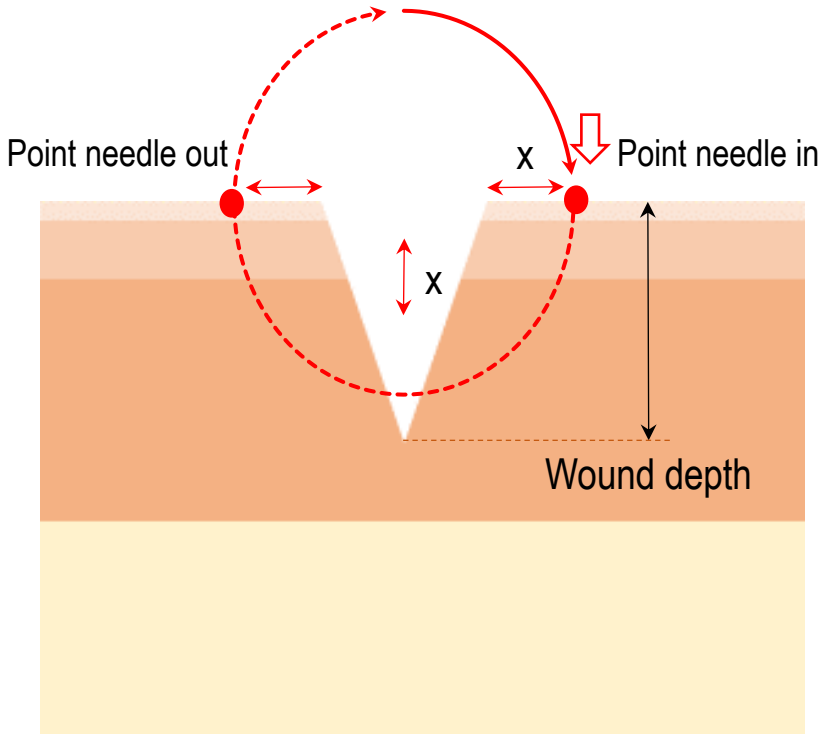


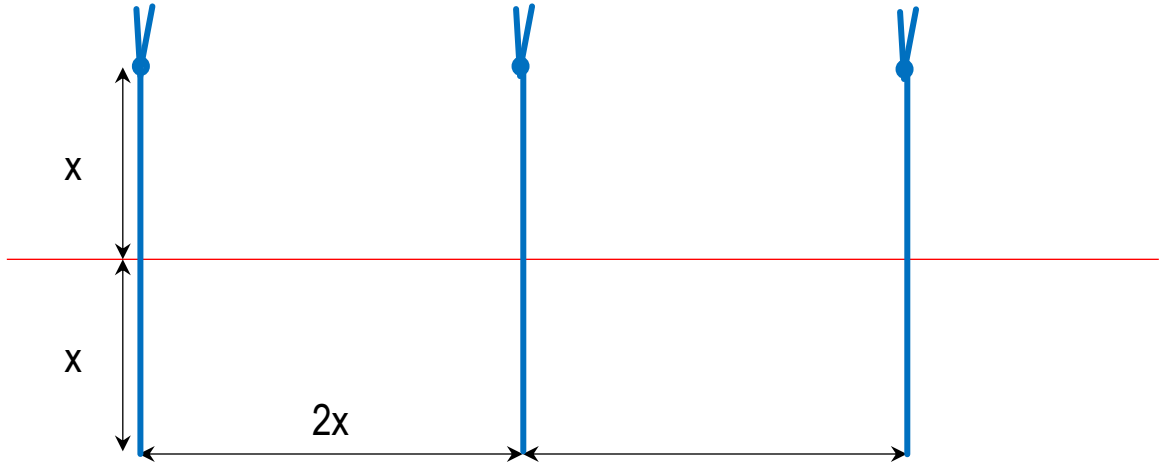
Closure Goals



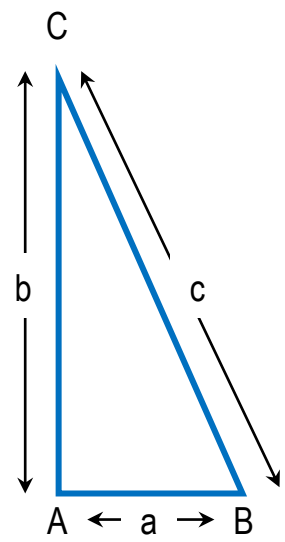
Closure Goals

- Approximation of wound edges:
  - Close–approximation [no tension, no strangulation].
  - No dead space: hematomas, seromas and infection
  - No foreign bodies.


Point needle out
x
Point needle in
x
Wound depth

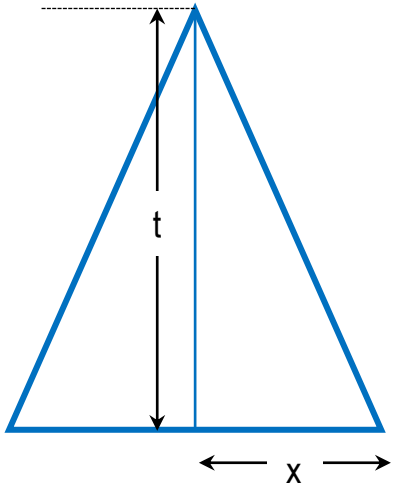

x
x
2x

Pythagoras theorem



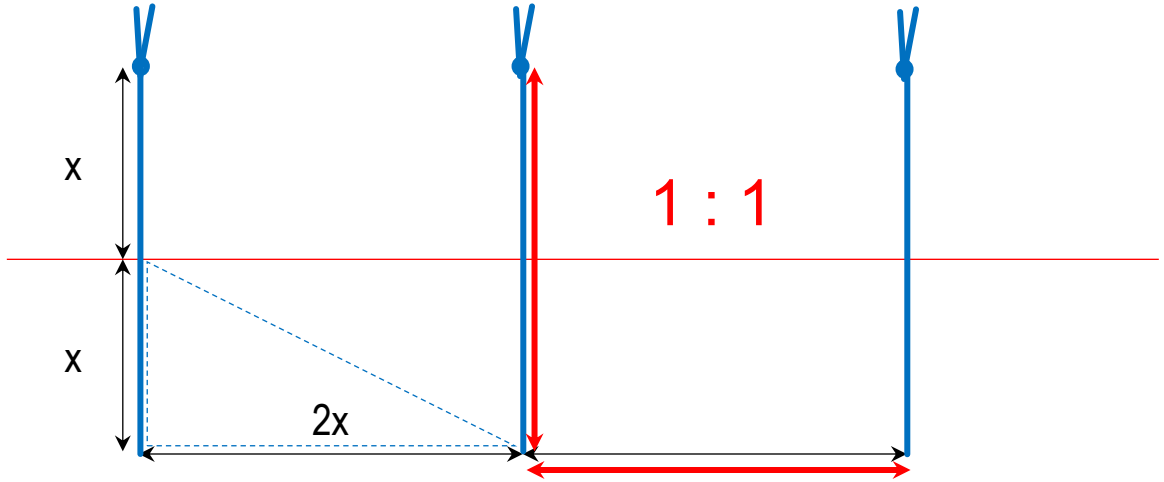
$$a^2 + b^2 = c^2$$

$$c = \sqrt{a^2 + b^2}$$



$$x = {}^1/_2 t$$

$$t = 2x$$



Closure Techniques

Types of closure technique:

- Continuous Suturing Technique, and
- Interrupted Suturing Technique

Continuous vs Interrupted

- A continuous (running–, uninterrupted–) suture: a kind of suture that after the first stitch, the suture run across the tissues over and over along the wound edges and finally knotted at its end
- An interrupted suture consists of a series of stitches where the suture across the tissues in a single loop and knotted individually. Each stitch stand independently to the others along the wound edges.

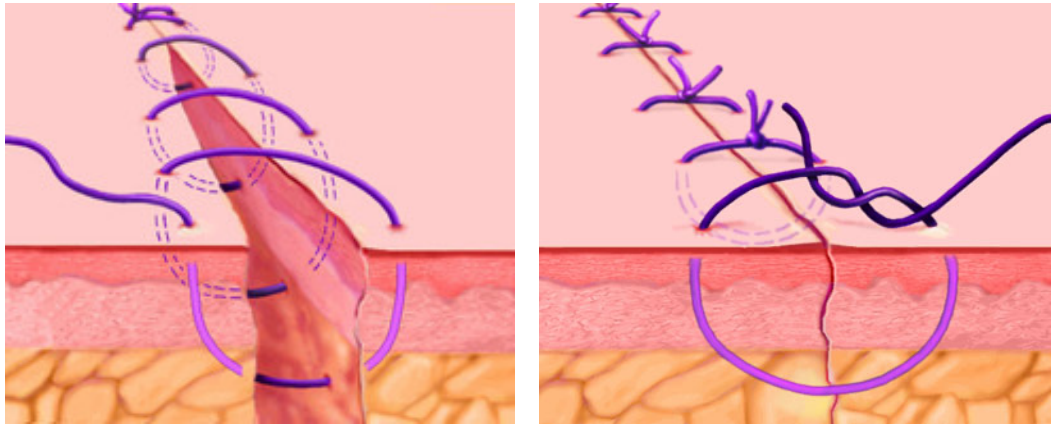
Continuous vs Interrupted

- Important things to be considered:

1. Closure speed
2. Suture tension management
3. Excessive suture mass
4. Transfer of infection
5. Security

Closure Speed

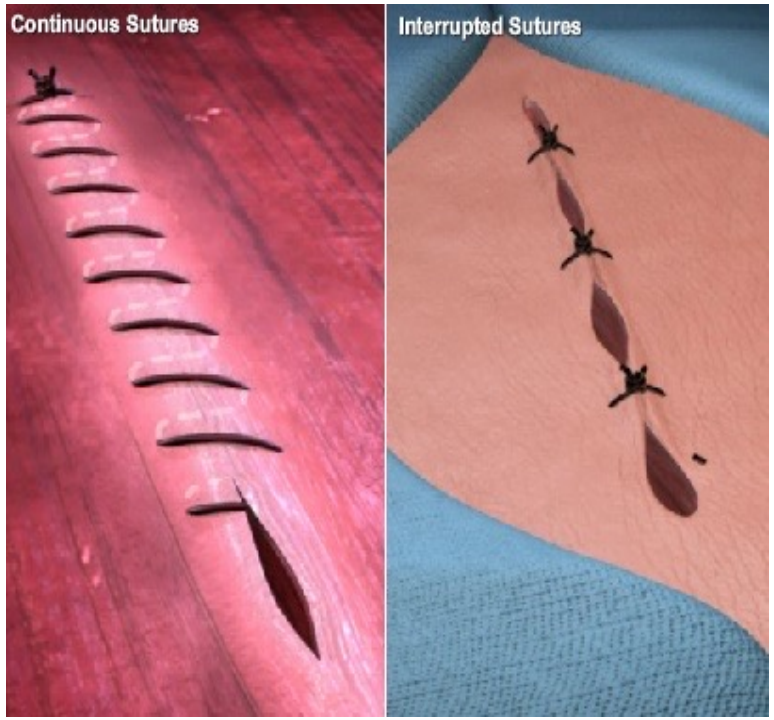
- Wound edges approximation is established rapidly using continuous suture as there are typically two knots tied at the ends of wound edges
- Wound edges approximation using interrupted suture consumes a longer time as each knot needs to be tied individually



Suture Tension Management

- Optimal closure is achieved when the edges of the wound were approximated and aligned properly at all points along the wound edges

- Place a sufficient number of stitches that addressed to approximate:
  - Too tight : strangulation leading to tissue necrosis
  - Too loose : gaping and herniation or poor healing



Continuous Sutures

- A continuous suture line allows the suture tension to be redistributed evenly along the wound edges

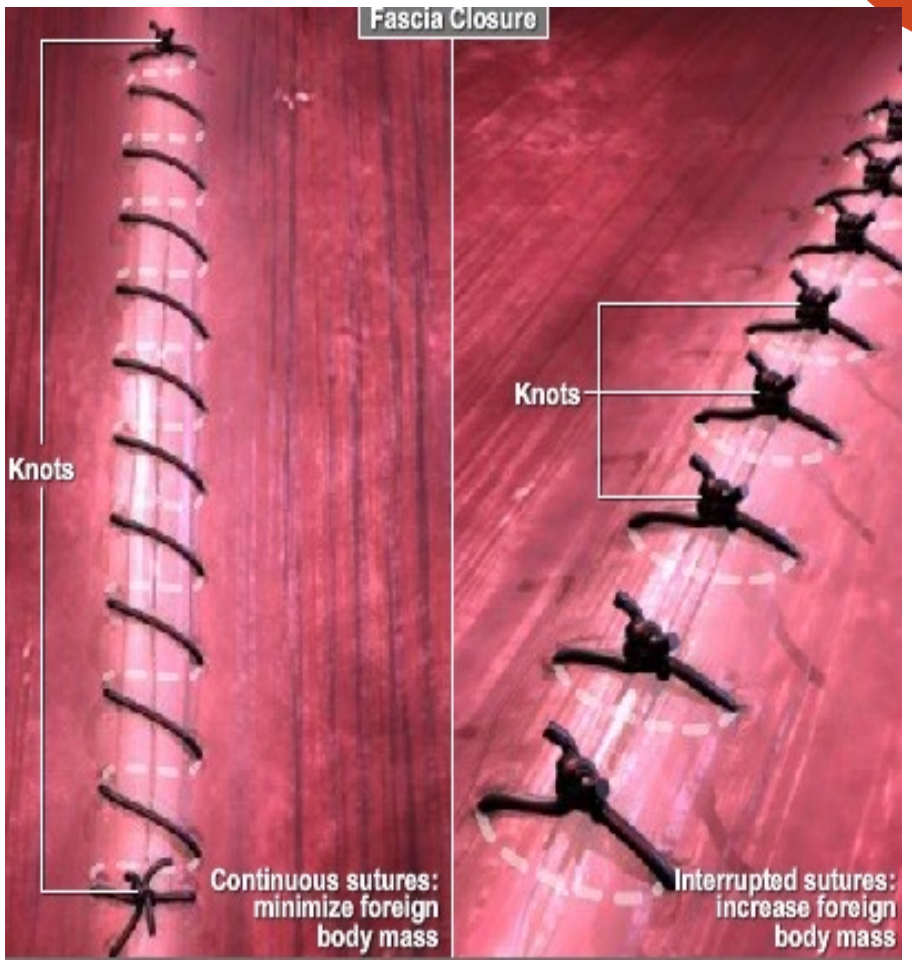
- Potential downside: In a wound does have significantly varying degree of tension at different points along the suture line, the suture tension may redistribute unevenly and allowing the wound gap at a point while strangulating tissues at another

Interrupted Sutures

- Each stitch approximate the wound edges at a certain point
- Effective where degree of tension at different points along the wound were found in vary and should be managed independently
  - Potential downside: Tension can not be redistributed from a stitch to the others
    - Too tight : strangulation leading to tissue necrosis
    - Too loose : gaping, poor healing, and herniation

Foreign Body Mass

- Foreign body mass invites tissue reaction
  - A continuous suture line is anchored by knots at the two ends, thus minimizing the number of suture mass in the wound
  - An interrupted suture line contains many knots independently

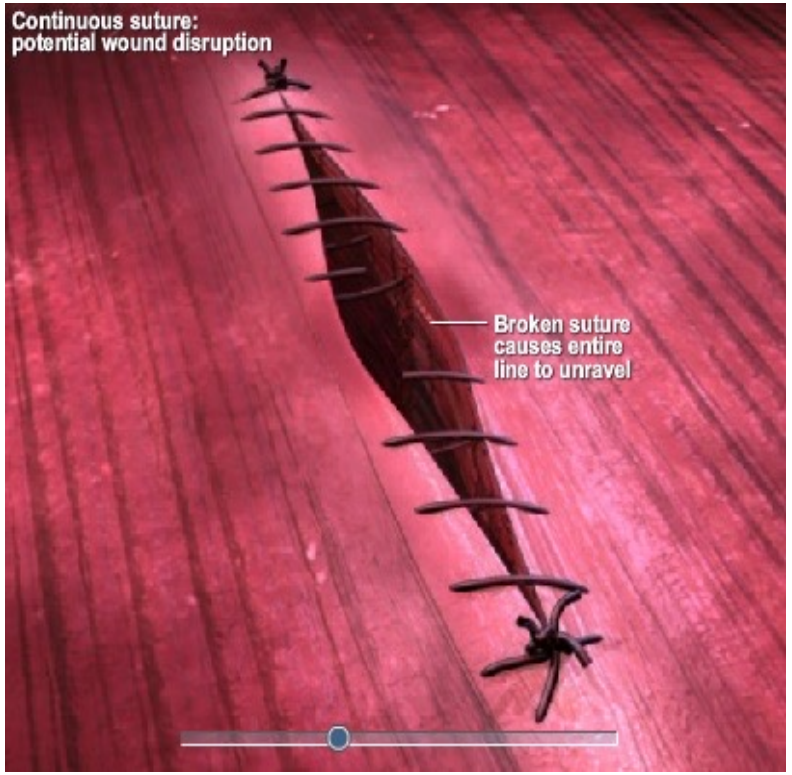


Transfer of Infection

- Capillarity (wicking) is the potential for fluid and contaminants traveling along the suture line.
- Interrupted stitches were of a low potential

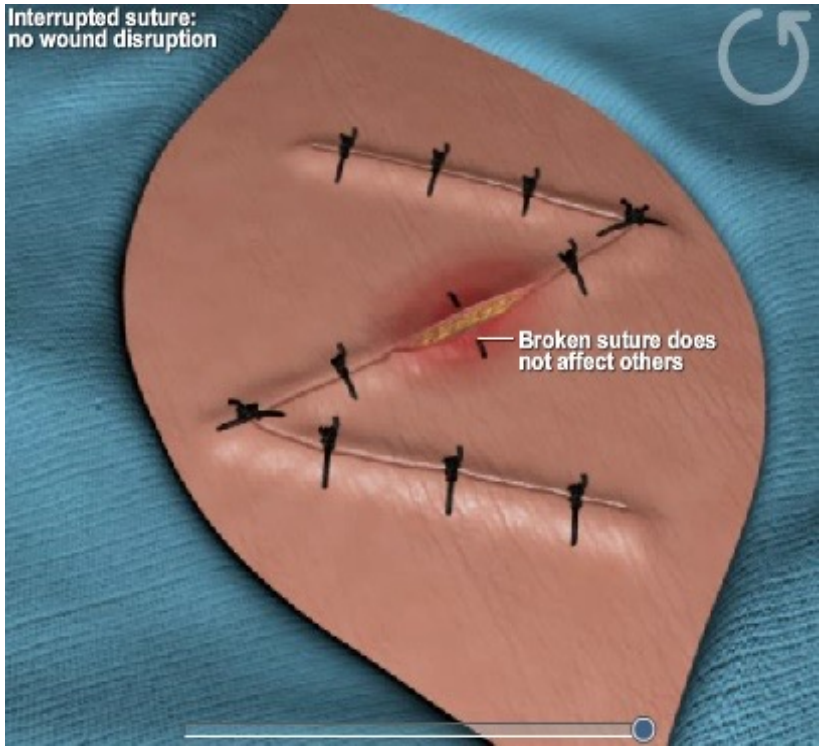
Security

- A continuous suture line consists of a single suture strand.
  - As the tension suture is distributed along the stitch, a loose or broken suture somewhere will be followed by wound disruption as a logic consequence



Security

- Individually tied stitches of an interrupted suture line
  - Potency of suture line breakdown is not an issue; when a loose/broken single suture found, the others typically remain secure



Continuous Sutures

- Inappropriate for wounds with tension at different points along suture lines, or wounds across the joints (elbow, knees)
- Mostly used for rapid closure, when the advantage of timing outweighs any potential disadvantages a continuous line might present
- Uses only two knots, continuous closure technique minimizing the number of suture material in the wound.
- Well suited for closure in sensitive skin/tissue or superficial

Interrupted Sutures

- Effective as there a tension
- Thick discrepancy of the tissue at the edge: interrupted suture hold the thinner layer in a better apposition to the thicker one
- To be considered in contaminated wound or wherever the risk of infection quite high

Module 2 : Suture Classification

Module 2: Suture Classification

Learning Objectives

→ Familiar with

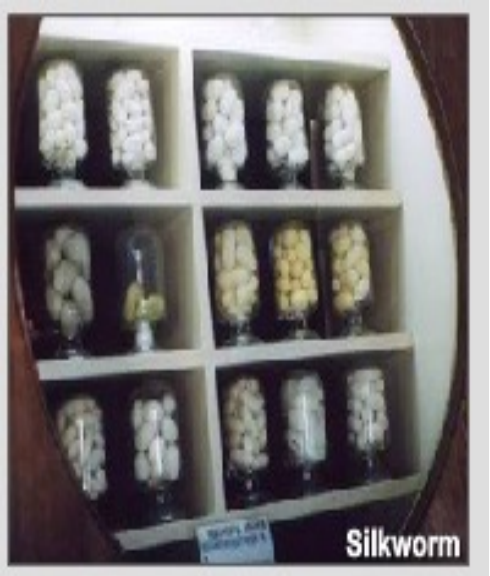
- Difference between natural and synthetic sutures
- Advantages and disadvantages of synthetic and natural suture materials
- Differences between monofilament and multifilament sutures
- Differences between absorbable and non–absorbable sutures
- Indication of absorbable and non–absorbable sutures
- Potential advantages with the use of antibacterial sutures

Synthetic Sutures

- Made from polymers, designed and manufactured to optimize qualities (strength, strength retention, low reactivity and pliability)
- Two particular desirable qualities of synthetic sutures:
  - Reactivity : inflammatory response minimal
  - Predictability: polymers are not affected by bodily response (temperature, protein status, etc.)
- Synthetic absorbable sutures provide tensile strength retention and absorption profile, they can be relied on to perform to expectations.

Natural Sutures

- Made from natural (organic) materials (NOT modified to produce the sutures)
- Can not be engineered for optimal performance as synthetic sutures
- Example :
  - Silk sutures (silk filaments of silkworm's cocoon)
  - Gut sutures (sheep/cows intestinal submucosa/serosa)
  - Stainless steel



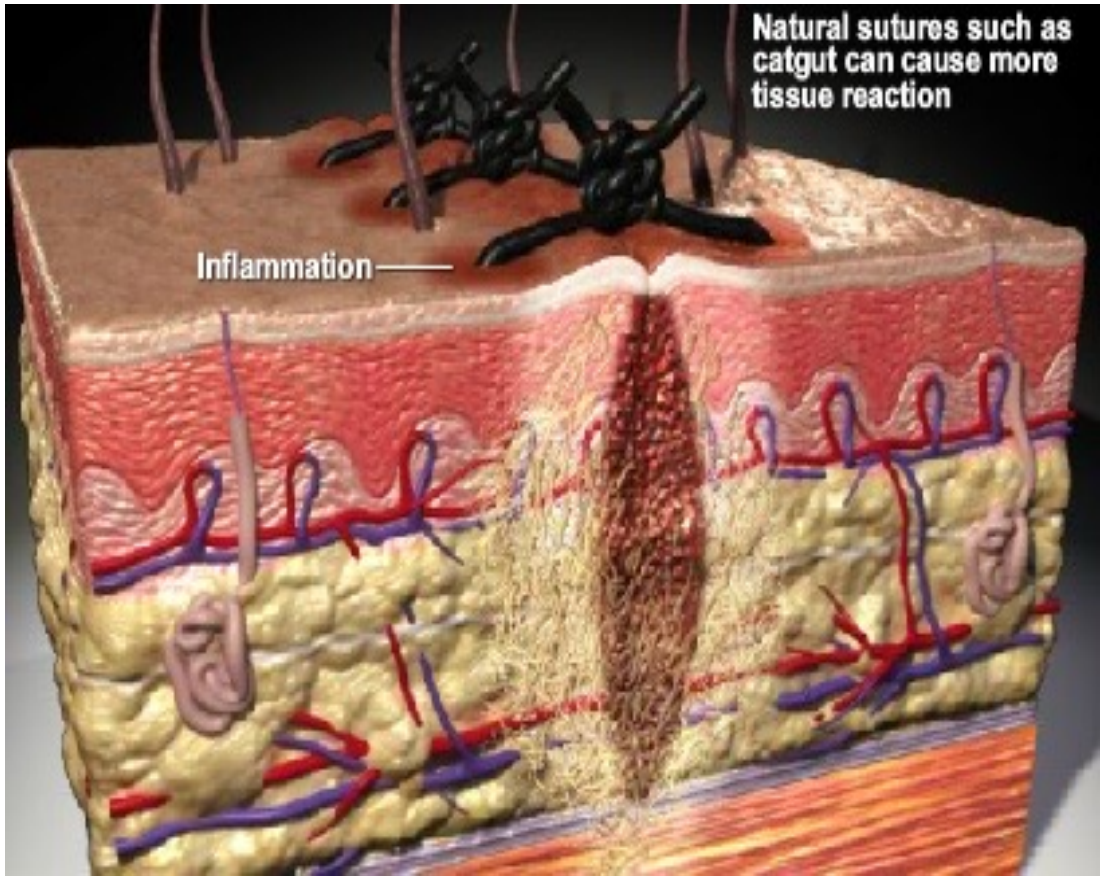
Advantages of Natural Sutures

Preferred in some surgeries:

- Silk and Guts were exceptionally tied well or ‘easily handling’ (surgeon’s preference)
- Stainless steel provides strong, approximate and stabilize bones (exp. sternal edges) though provides a poor handling material

Disadvantages of Natural Sutures

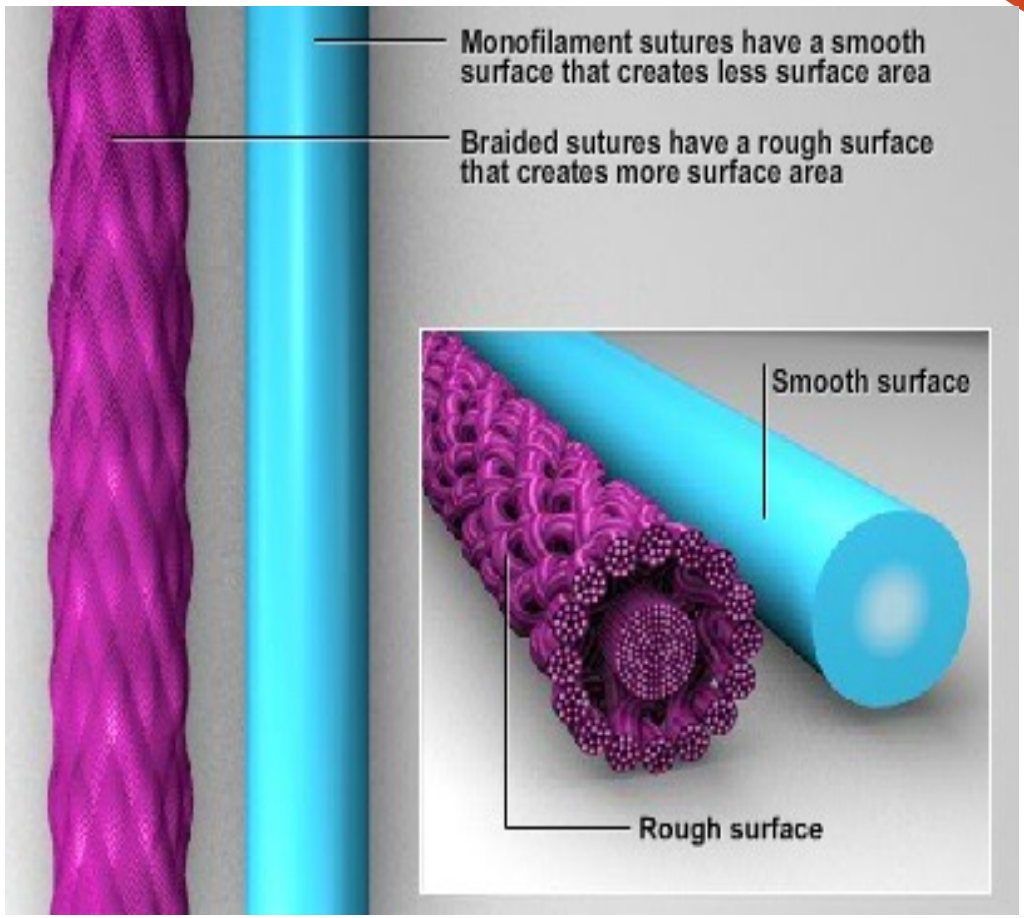
- Maximal tissue reaction and more reactive than synthetic sutures (inflammation, enzymatic reaction led to fibrosis)
- Less predictable retention as the absorbability



Monofilament and Multifilament

There are two types of suture construction :

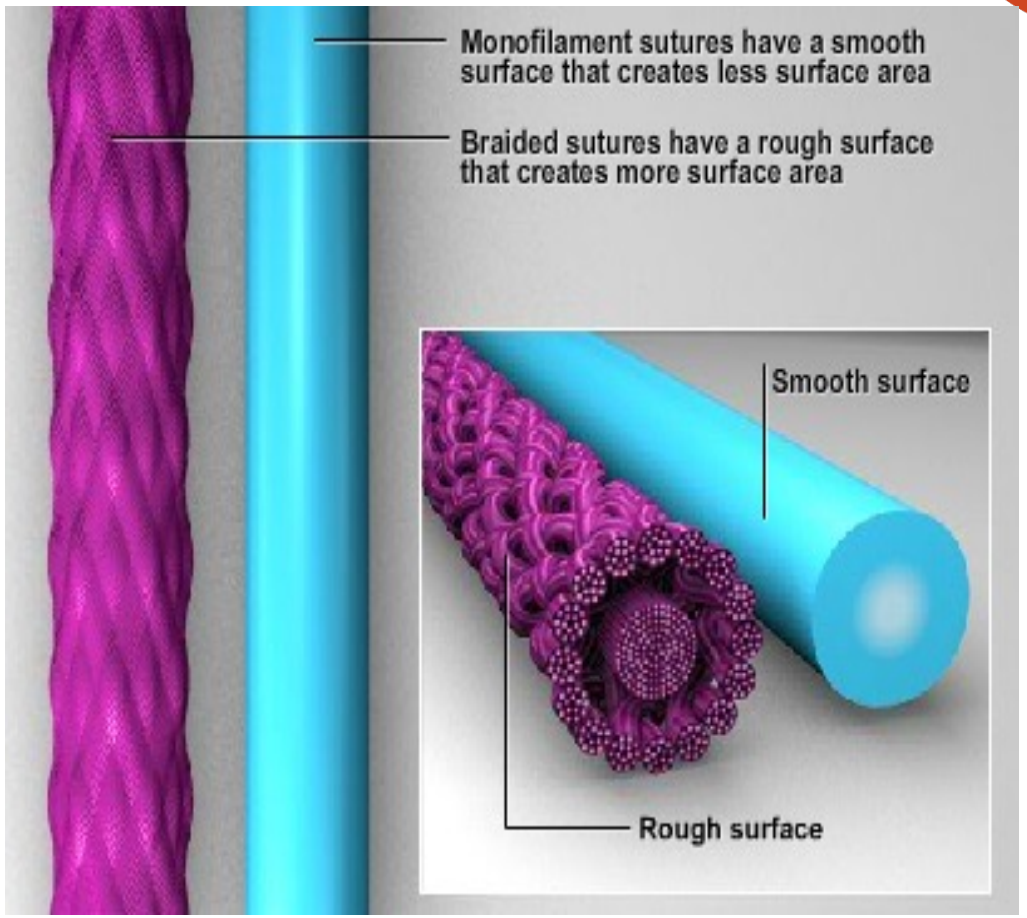
- Monofilament composed of a single filament
- Multifilament (braided): twisted/braided a number of filament (of a smaller sized material) into a single suture



Monofilament and Multifilament

The advantages:

- Monofilament:
  - Less tissue trauma
  - Less capillarity
  - Less tissue reaction
- Braided:
  - More pliable
  - Superior knot tying properties (holds tight)
  - Strength/resistance to crushing



Tissue Passage

- Smooth surface of a monofilament suture allows it to be drawn through tissue with minimal resistance,
  - Minimal tissue disruption (‘atraumatic’)
  - Suitable for continuous closure technique, vascular anastomosis, tendon repair and esthetic result

Tissue Passage

- The rough surface of braided sutures led to unnecessary resistance (drag) as the suture drawn through tissues,
- Precise approximation more difficult
- May even saw through delicate tissues

→ Lubricant coated to minimize the drawbacks

Capillarity – Monofilament

- A single solid filament with smooth surface does not have interstices to wick fluids or bacteria harbor, but the knots have
- Handling is not as easy as the multifilament

Capillarity – Braided

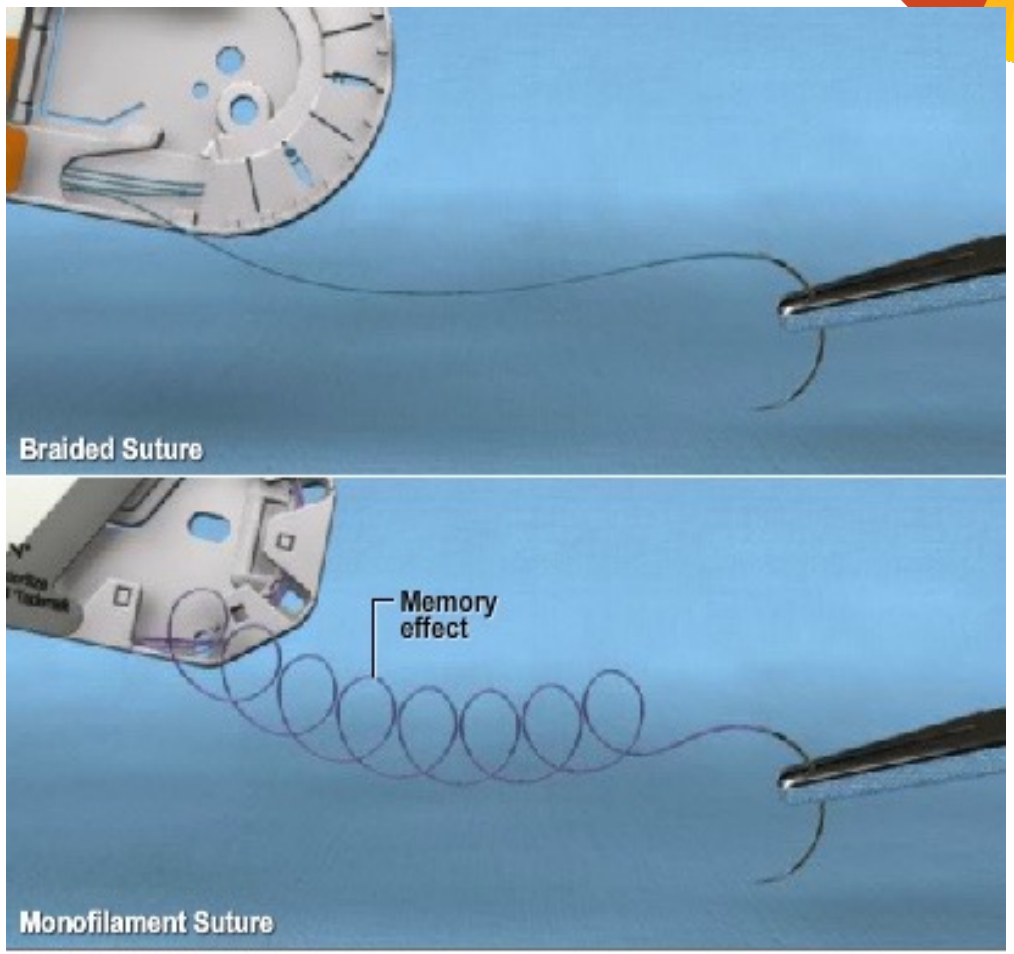
- The multifilament construction of a braided suture does have capillary action that may increase the risk of contaminant transmission along the suture line
- Interstices provides a media for bacteria to thrive in
- Antimicrobial coated sutures inhibits bacterial growth on the suture

Tissue Reaction

- Monofilament sutures have less surface area, creating a lower tissue–foreign body interface with less potential for reaction than braided sutures of a same diameter
- In highly sensitive tissues like thin skin in esthetic area, a monofilament suture may interfere less with healing and yield better esthetic outcomes

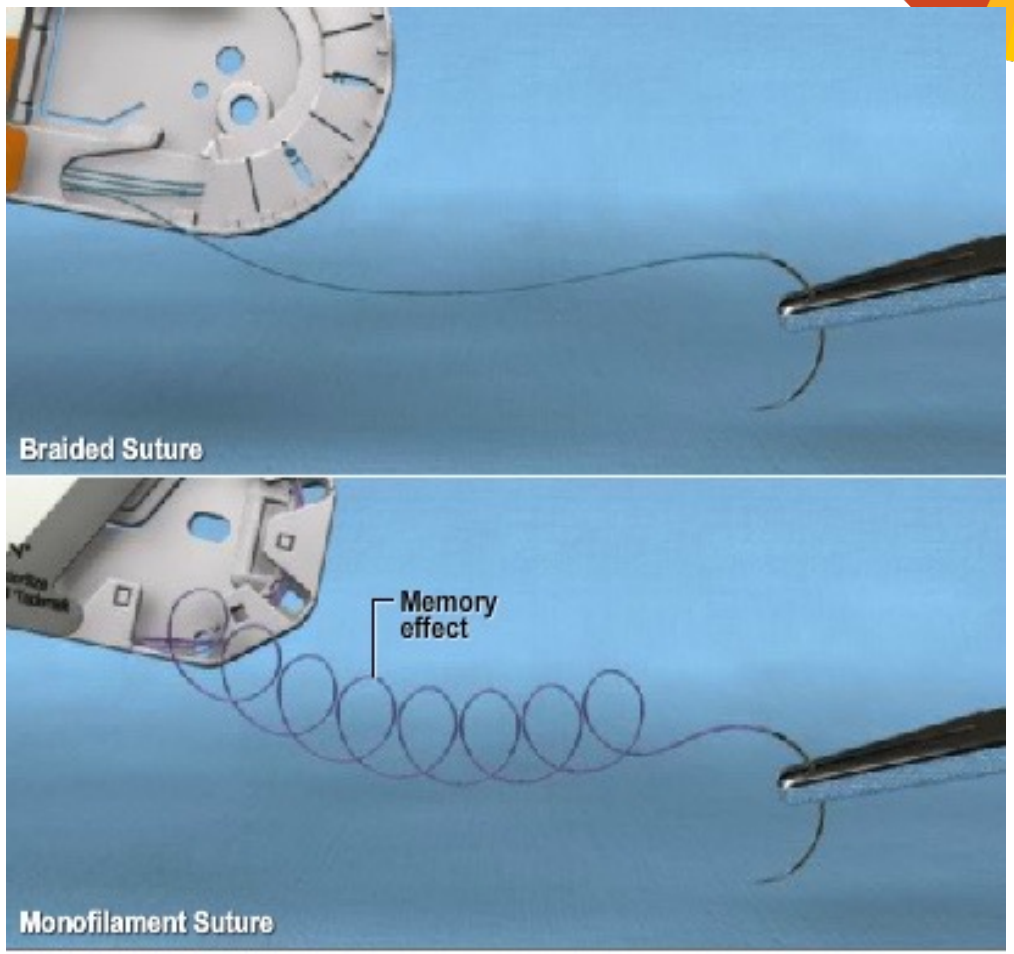
Memory and Pliability

- Memory refers to the tendency of a suture to return to its in–package shape which is tightly curled or coiled and resist to being straightened
  - Braided sutures are more pliable, and have no such a memory. Thus showed a better handling than monofilament of a same diameter.



Memory and Pliability

- Memory refers to the tendency of a suture to return to its in–package shape which is tightly curled or coiled and resist to being straightened
  - Monofilament suture is not pliable and have such a memory. Thus, it may be very stiff, springy, provide a more difficult handling than braided sutures of a same diameter



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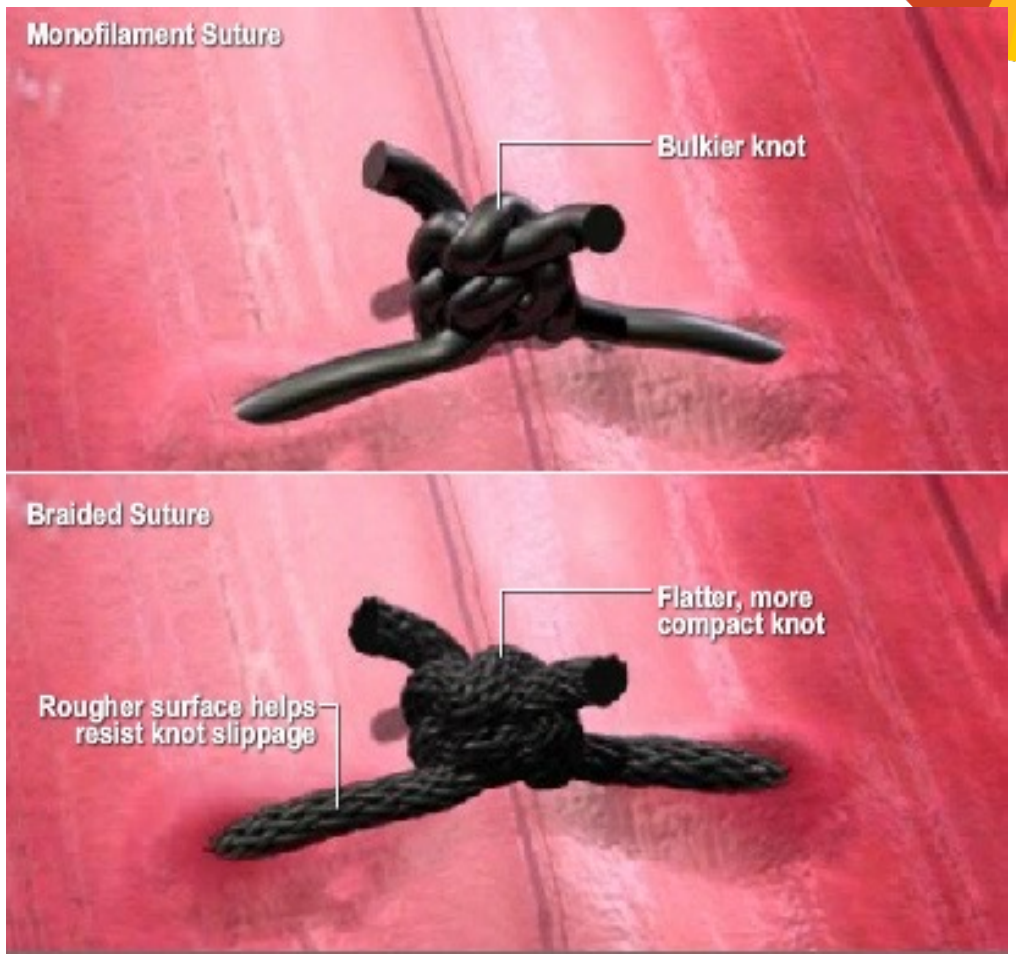
Knot Tying Properties

Braided suture ties better than monofilament suture:

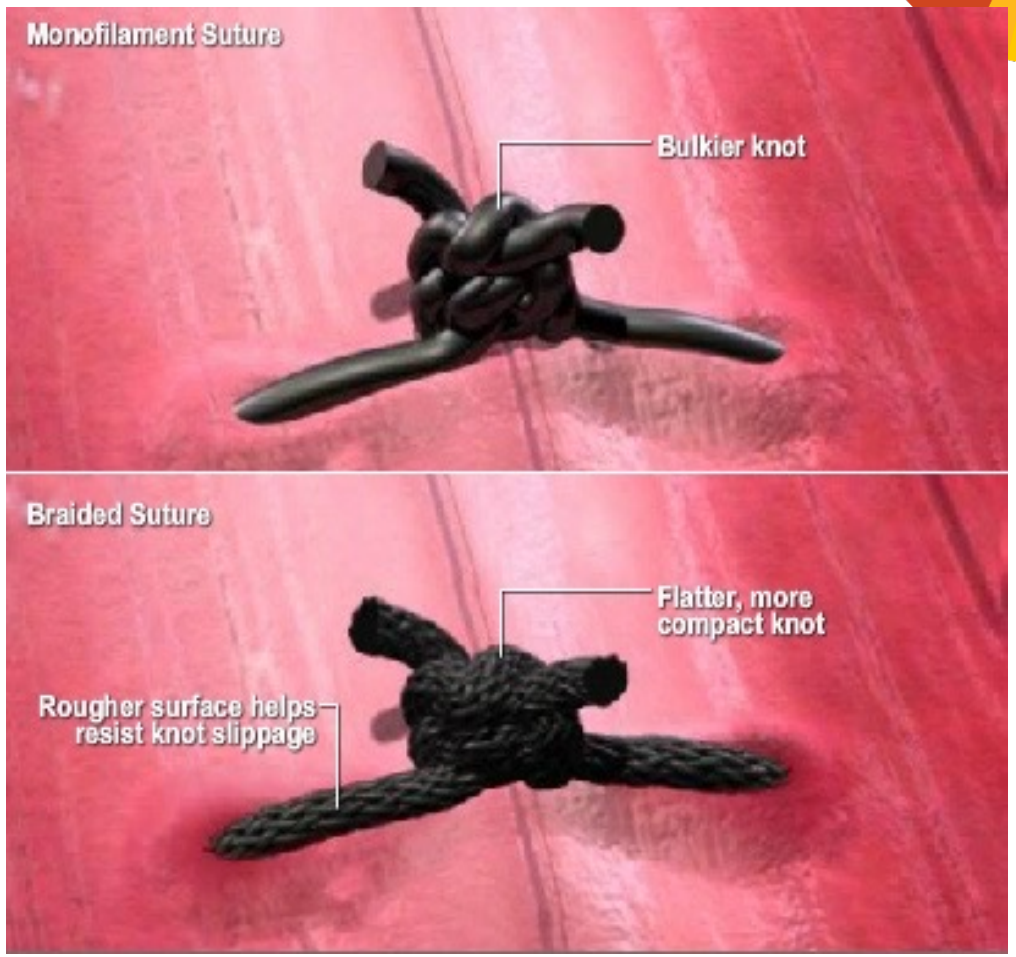
- The multifilament core compresses or flattens into a knot more easily than monofilament sutures with their solid cores
- The strands do not have the memory of monofilament, and not easy to untied



Knot Tying Properties

Braided suture ties better than monofilament suture:

- The multifilament (braided) hold the knots and resist to slipping
- Lubricant coated allow for smooth knot run–down the tying properties make knotting more easy

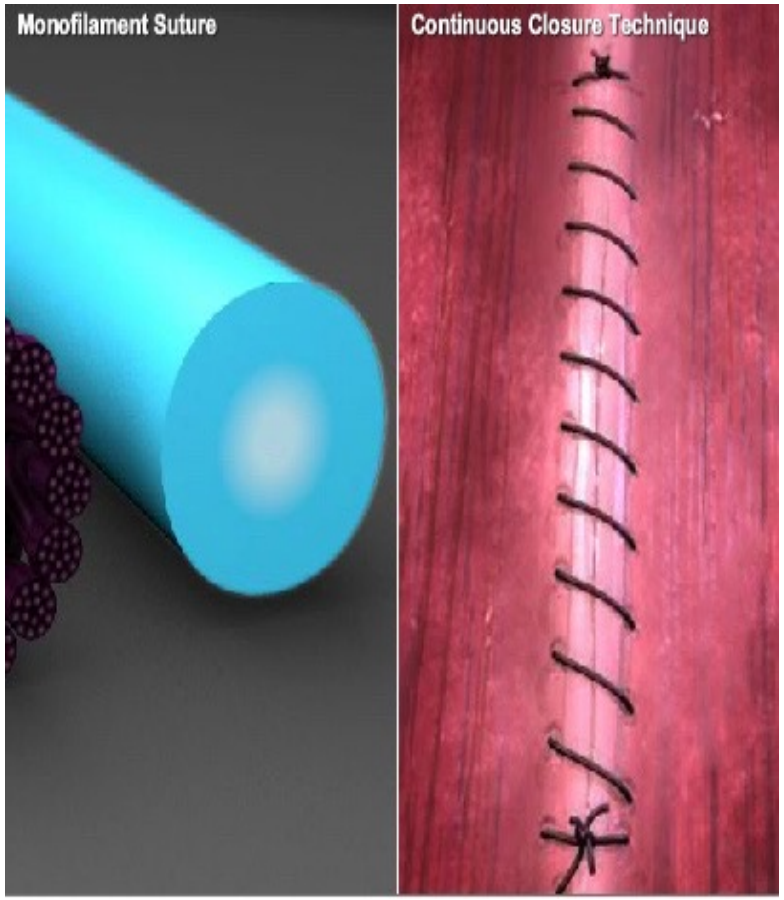


Strength

- Braided sutures are less susceptible to suture failure due to crushing by an instrument
- Monofilament sutures are more easily damaged when mishandled by an instrument than braided sutures

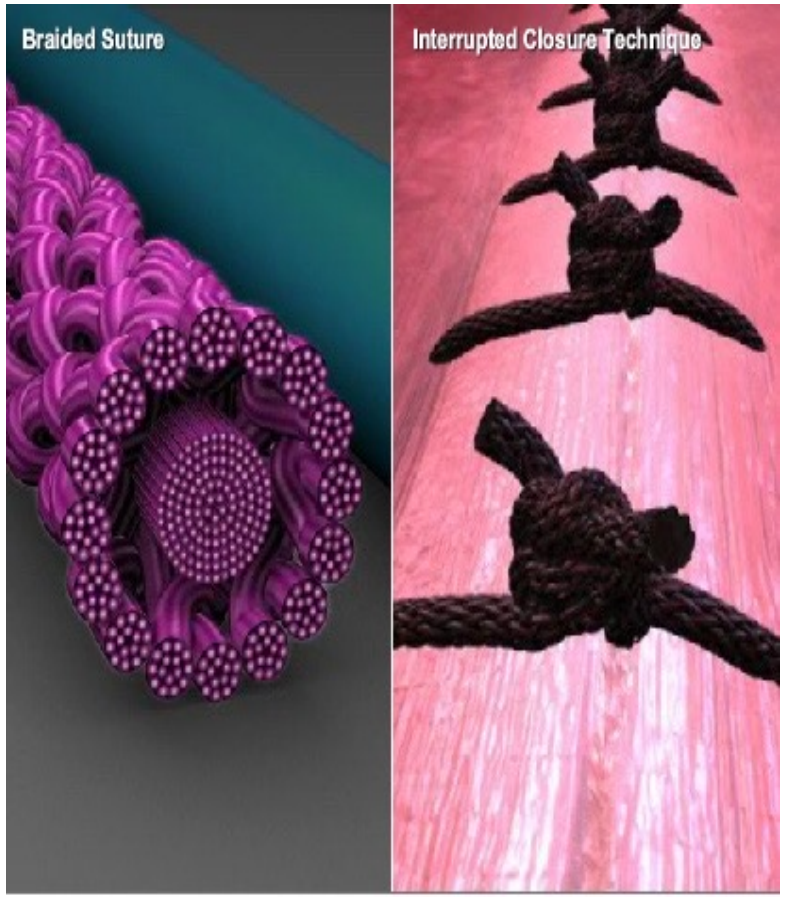
Monofilament Sutures

- Smooth surface, non capillarity and low reactivity make monofilament sutures a frequent choice for continuous suture line
- Conversely, the knotting abilities make them less optimal for closure requiring a great deal of tying such as interrupted suture lines.
- Also optimal for suturing delicate tissues (thin–walled vessels or friable organ)



Braided Sutures

- The superior tying abilities of braided sutures make them the optimal choice for interrupted closures of all tissue layers, except the skin.
- Even though braided sutures have interstices, using an interrupted closure technique minimize the risk of transference of infection due to wicking
- Lubricant coatings on some braided sutures do help minimize drag and antimicrobial impregnation minimizes the risk of transference of infection, but monofilament still offer advantages for continuous suture line technique.

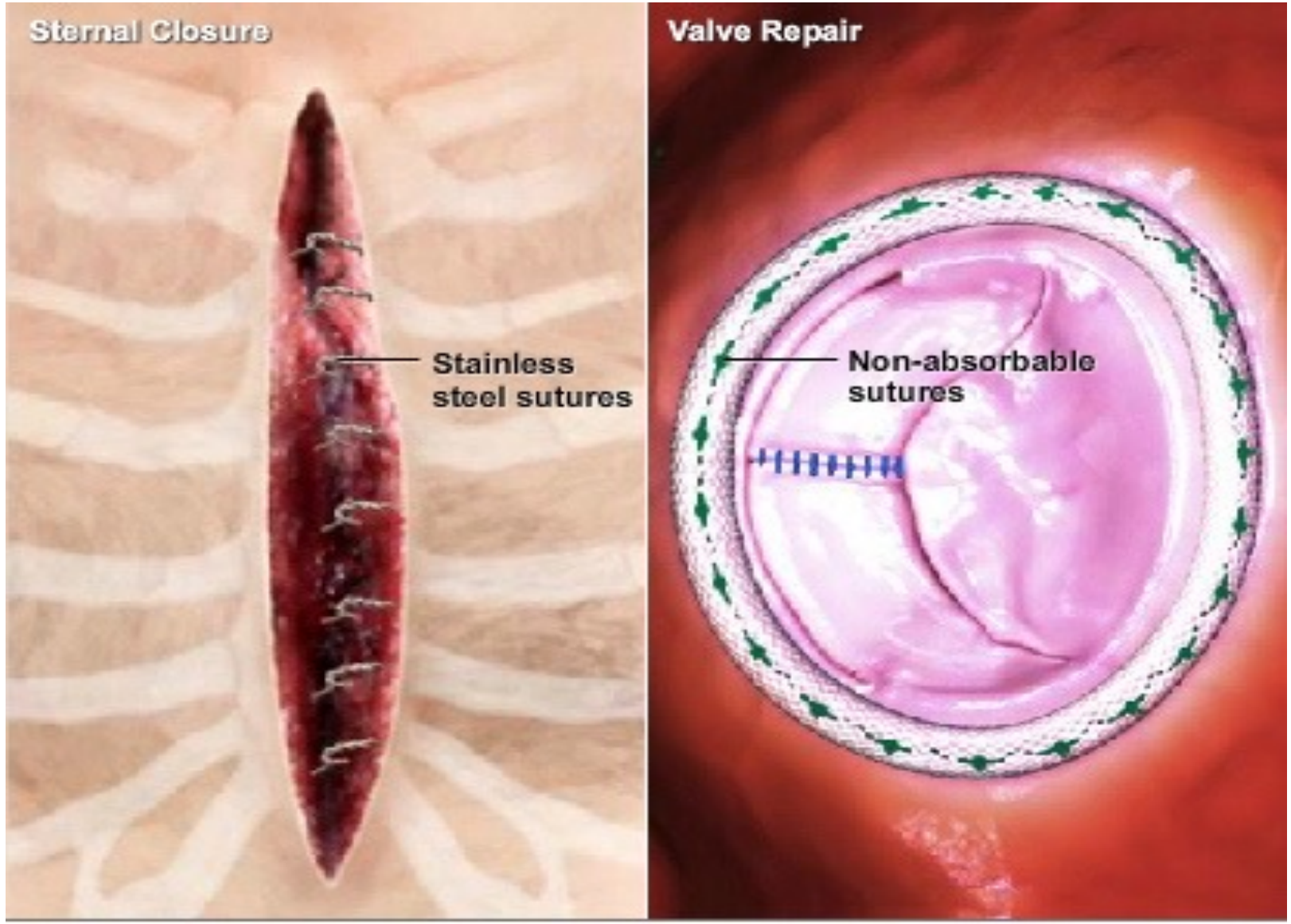


Non Absorbable Sutures

- Once implanted, non absorbable sutures resist bodily responses and lose mass slowly over time, if at all
- Can be left in the wound indefinitely or removed once they have served their purpose
- Silk and Nylon do exhibit gradual loss of strength and mass over time
- Stainless steel, polyester, polypropelene and expanded PTFE, lose neither mass nor strength

Applications

- Non absorbable sutures are used when a wound requires support that exceeds the abilities of any absorbable sutures or when the suture itself must remain unchanged during its implantation
- Some common uses include:
  - Sternotomy closure
  - Cardiac valve repair/replacement
  - Prosthetic (vascular graft) implantation
  - Vascular anastomosis
- Should also be used when the sutures are temporary and intended for subsequent removal
- Should not be used if long term support is not needed and if their long term presence has the potential to cause other problems like stone formation in the bladder, extrusion, chronic reaction in sensitive tissue.


Sternal Closure
Stainless steel sutures
Valve Repair
Non-absorbable sutures

Absorbable Sutures

- Absorbable sutures are broken down and absorbed by the body
- Sutures loses tensile strength and subsequently mass
- Difference with non–absorbable:
  - Absorbable are designed to be absorbed by the body in weeks or months post implantation
  - Non–absorbable eventually lose tensile strength and mass but do so over a period of months to years

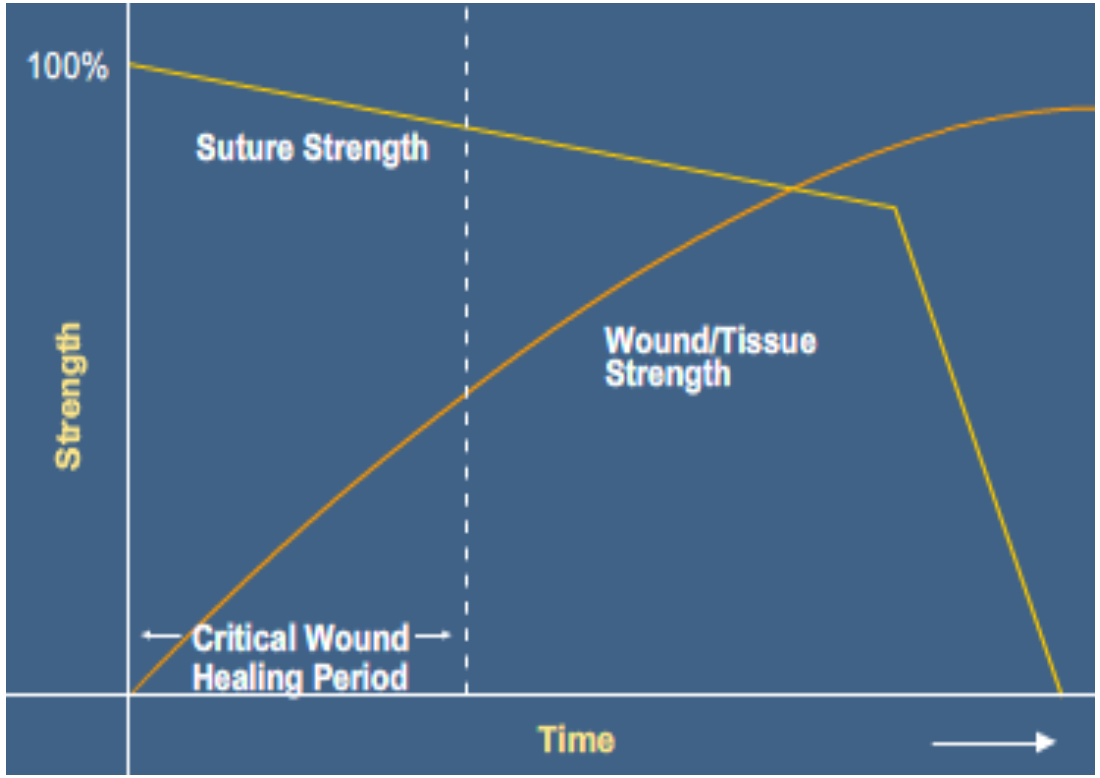
Absorbable Sutures

The material:

- Natural: digested by enzymes that breaks the strand down
  Potential drawback: systemic influences (protein deficiency, leukocytosis, temperature, infection)
- Synthetic: hydrolyzed let the strength retention and absorption predictable, and less affected by systemic factor
- Consideration in absorbable sutures:
  - Tensile strength retention (TSR)
  - Absorption

Tensile Strength Retention (TSR) Profile

- TSR is the ability of suture material retaining tensile strength over time *in vivo*
  - Example: VCP 75% TSR in 14d, 25% TSR in 28d
- The suture selected for a given repair should have a TSR profile that matches the tissue's strength gain profile
- Currently there are no absorbable sutures available in the market that retain significant strength beyond six weeks



Absorption Profile

- Absorption refers to a suture's loss of mass as the body breaks it down
- As an absorbable sutures loses mass, it loses strength
- The visibility of presence of an absorbable suture does not indicate its tensile strength or any ability to continue to support the wound

Applications

Absorbable sutures:

- Tissues that heal and provide self supportive relatively rapid
- Subcutaneous that need no removal
- Should not be used if delayed healing is predicted
- Synthetic absorbable sutures of medium and long term support will not be absorbed when it used as simple interrupted skin sutures since skin humidity insufficient to hydrolyze the sutures. Thus, should be removed

Module 3 : Suture Selection

Module 3: Suture Selection

Learning Objectives

Be familiar to:

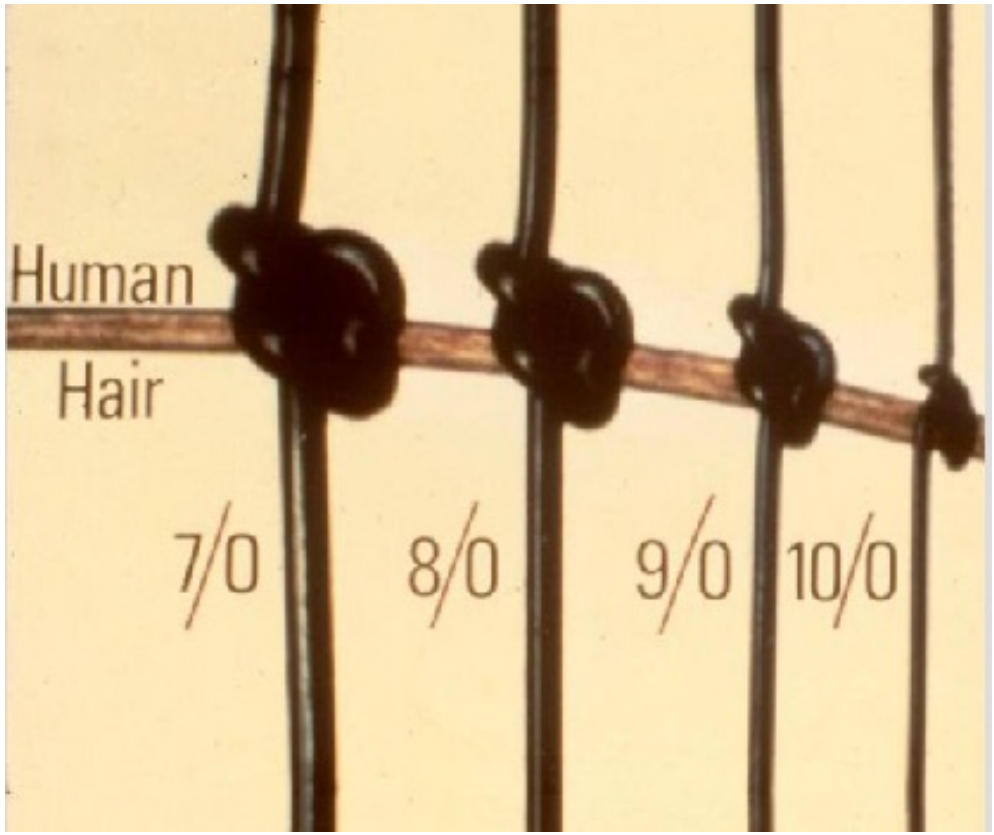
- Suture sizing nomenclature
- Proper sizes for specific organs and tissue types
- General principle in suture selection
- Clinical characteristic in sutures evaluation

Suture Size

- The united States Pharmacopeia (USP) naming convention as listed:

(the smallest diameter available in the market)

11-0
10-0
9-0
8-0
7-0
6-0
5-0
4-0
3-0
2-0
0
1
2
5
6
7

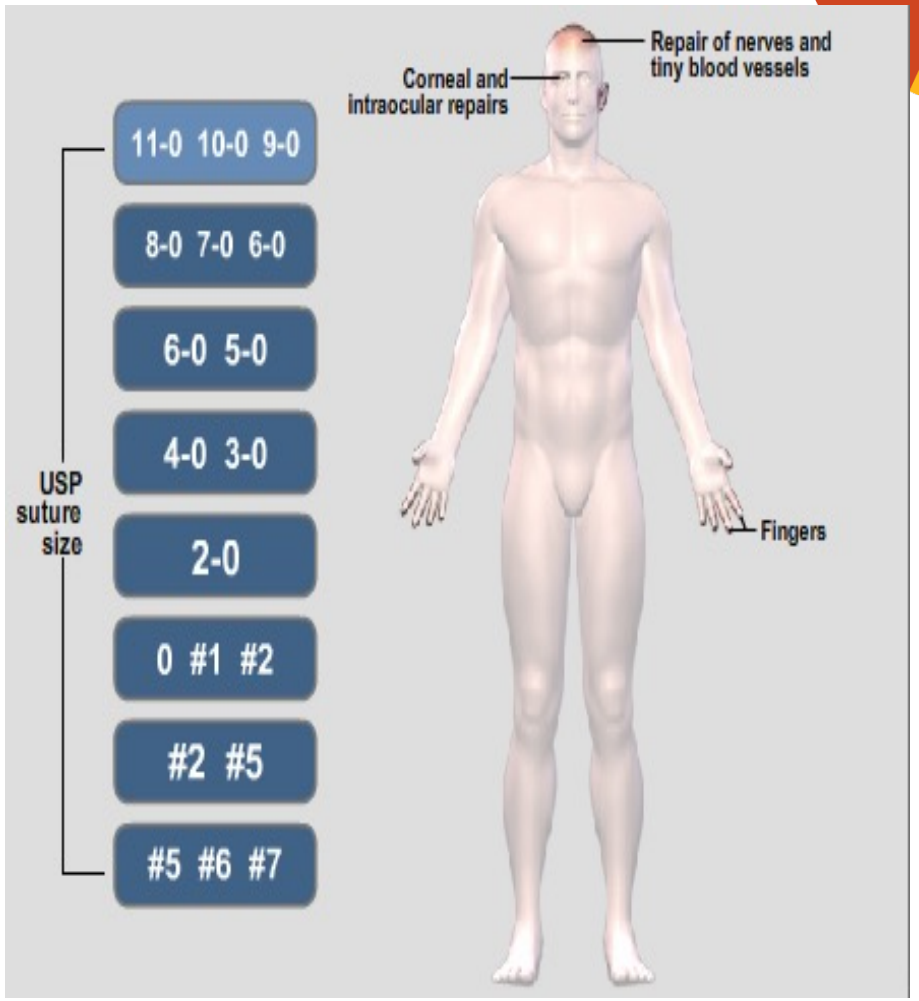


(the largest diameter)

Suture Size Selection

11-0,10-0,9-0 are typically used for:

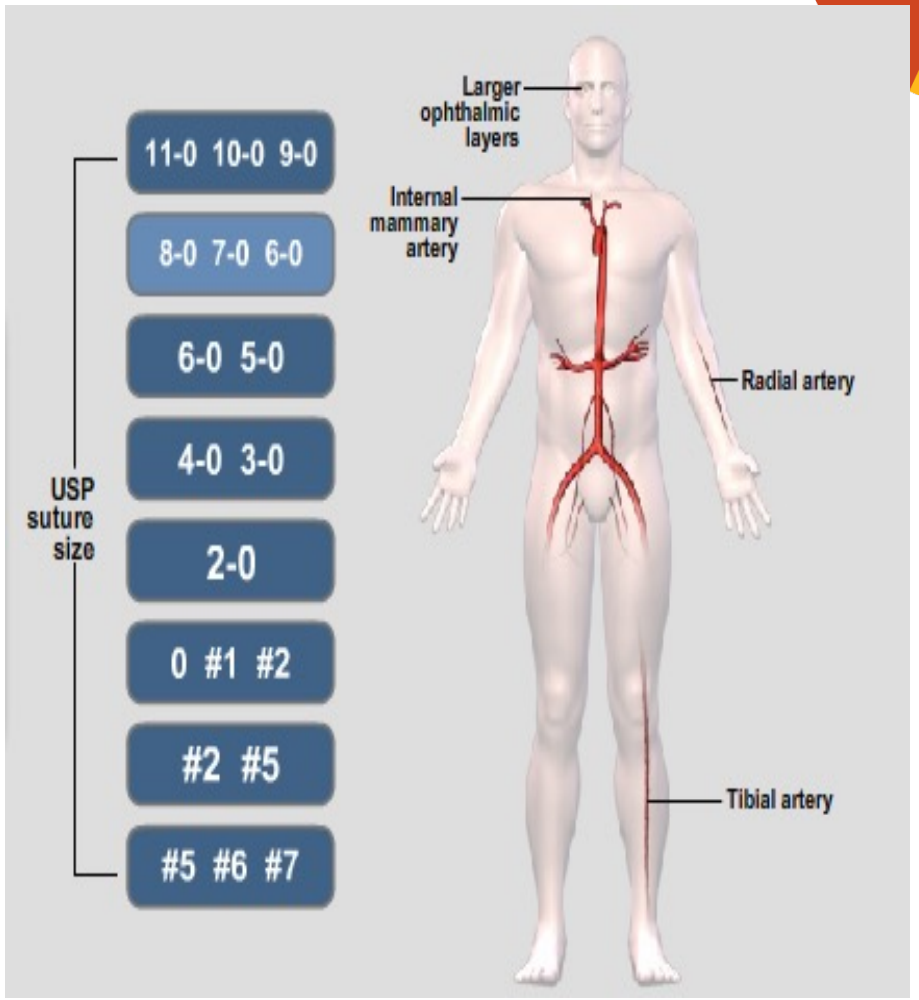
- Extremely small structures
- Microsurgical anastomosis
- Repair of nerves and small blood vessels
- Cornea, sclera and intraocular repairs
- Fingers



Suture Size Selection

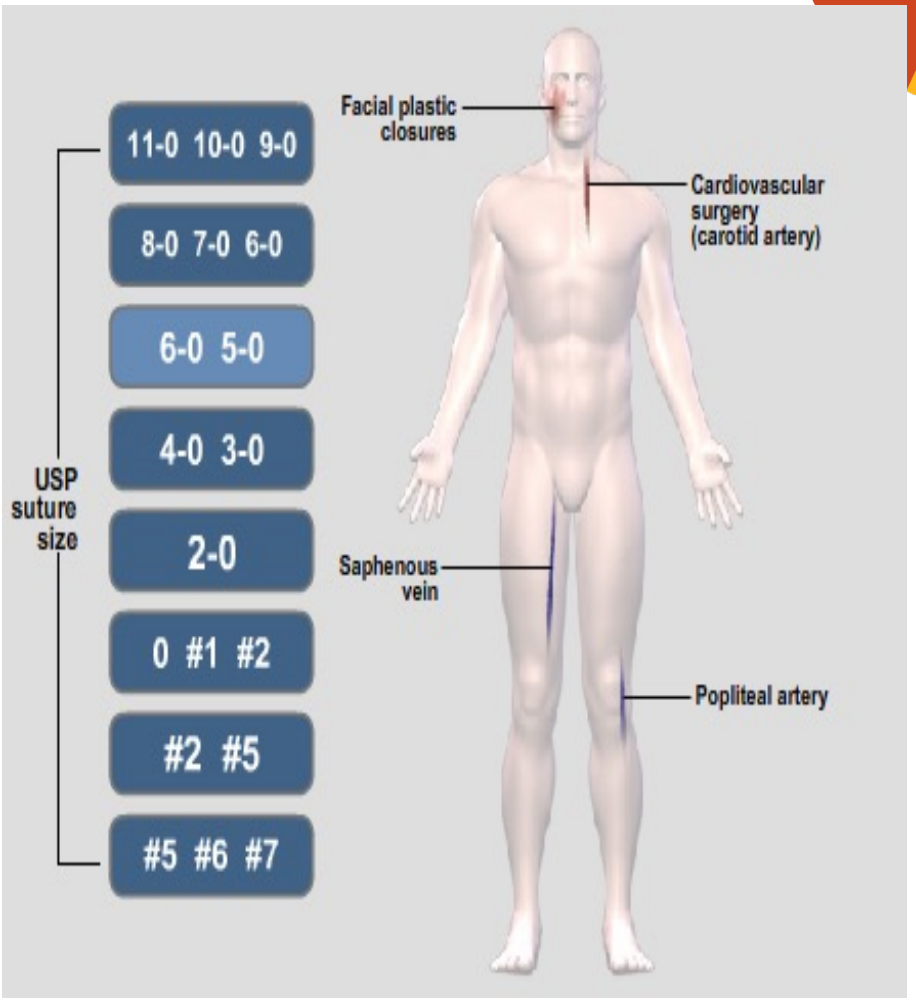
8-0,7-0,6-0 are typically used for:

- Repair and anastomosis of small blood vessel:
  - Internal mammary artery (IMA)
  - Radial artery
  - Tibial artery
  - Distal anastomosis of CABG
  - Some larger ophthalmic layers (conjunctiva, sclera)



Suture Size Selection

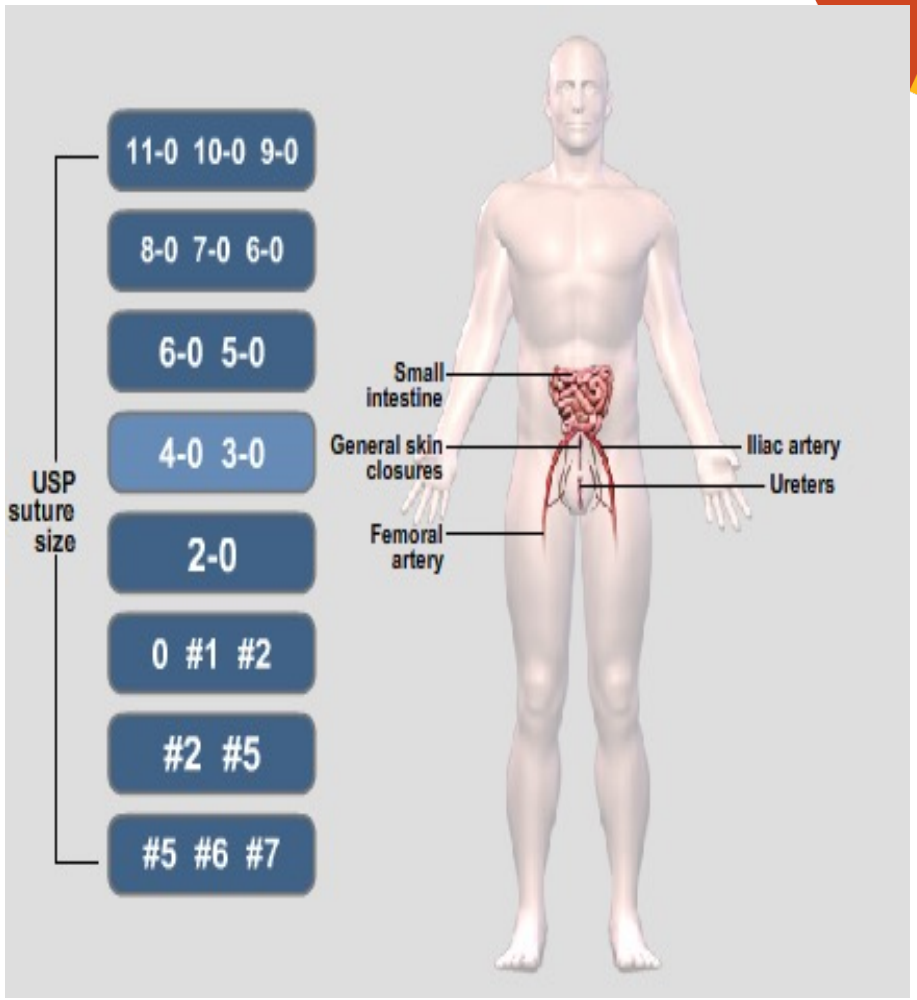
- 6-0,5-0 are typically used for:
- Facial plastic closures, such as face, eyelids
- Cardiovascular surgery for repair and anastomosis of blood vessel such as :
  - Distal saphenous vein
  - Proximal saphenous vein
  - Popliteal artery
  - Carotid artery



Suture Size Selection

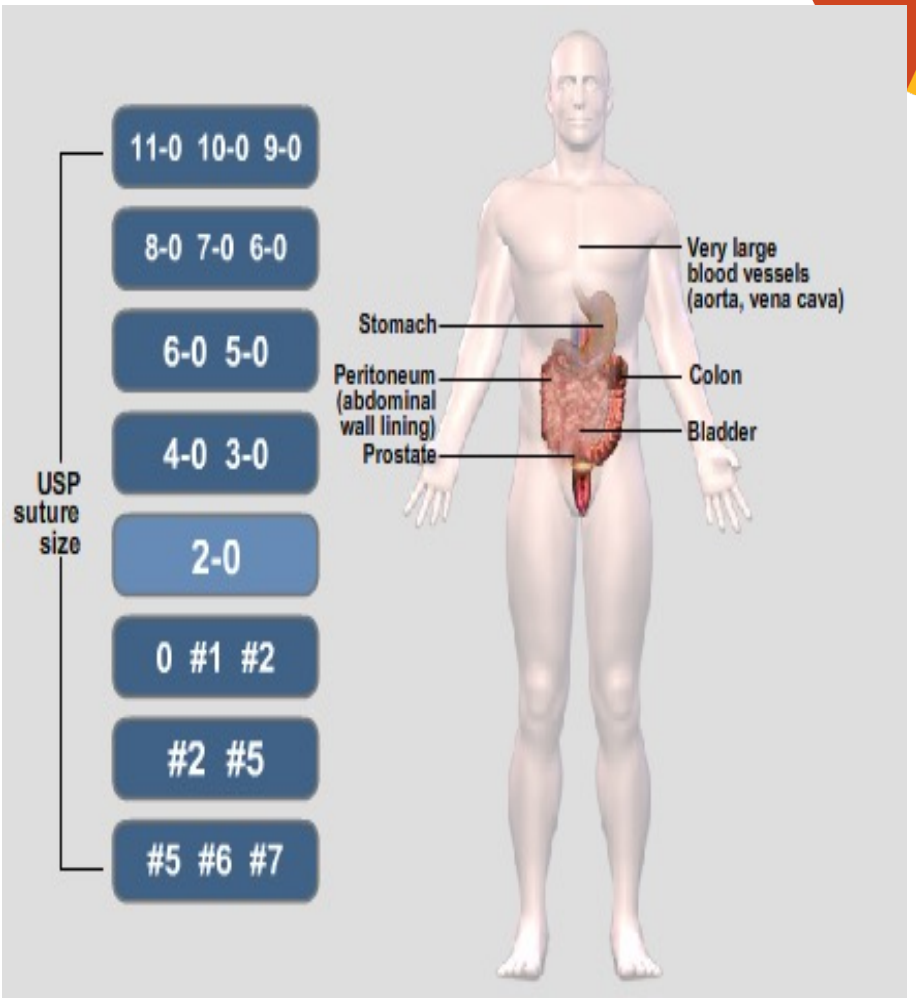
4-0,3-0 are typically used for:

- Small intestine
- Ureters
- Larger blood vessels such as femoral artery, iliac artery
- Duramater
- General skin closure



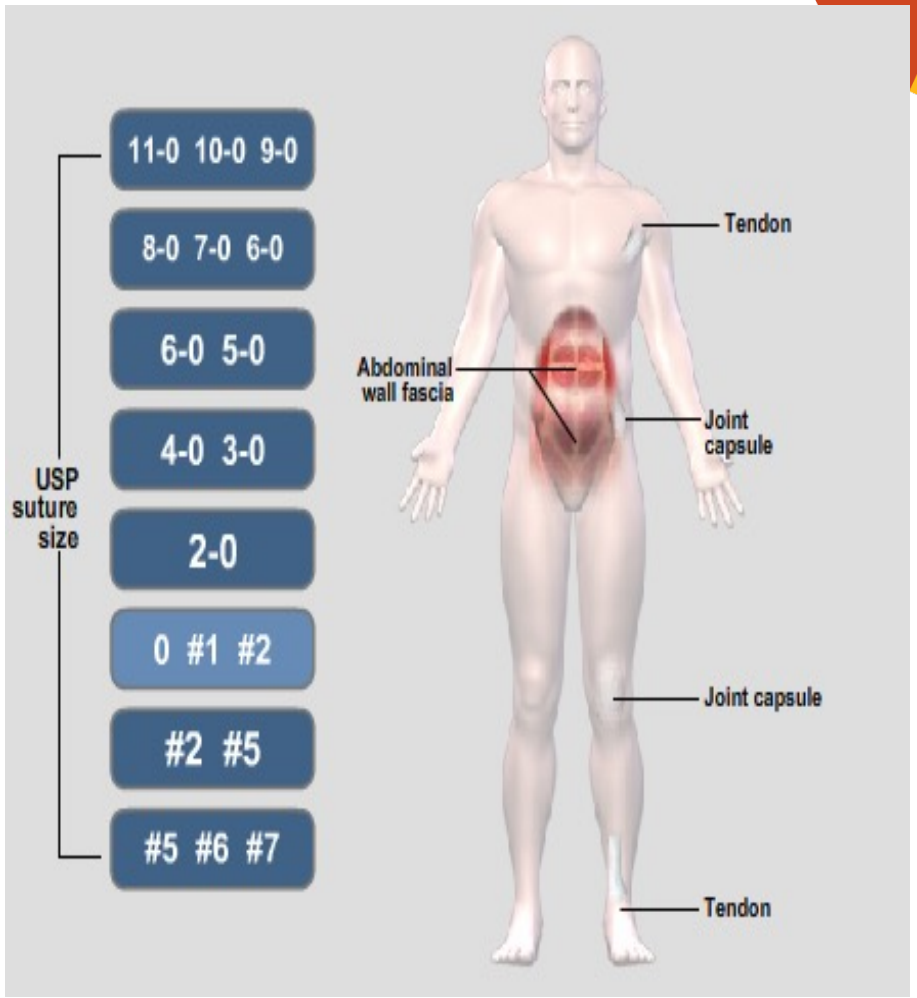
Suture Size Selection

- 2-0 are typically used for:
  - Very large blood vessel such as: Aorta, Vena Cava
  - Bladder
  - Prostate
  - Stomach
  - Colon
  - Subcutaneous fat
  - Utility Stitches such as: Cannulation, Retraction Sutures in cardiovascular surgery



Suture Size Selection

- >2-0 are typically used for musculoskeletal applications involving fascia, tendon, and/or bone
- 0,#1,#2: Fascia, Joint Capsule, Tendon
- #2,#5: Very high stress orthopedic repair
- #5,#6,#7: Sternal closures



Sutures on Excessive Tension

- Principle of suture selection is to choose the smallest size diameter that will adequately hold the healing tissue in apposition during critical wound healing period

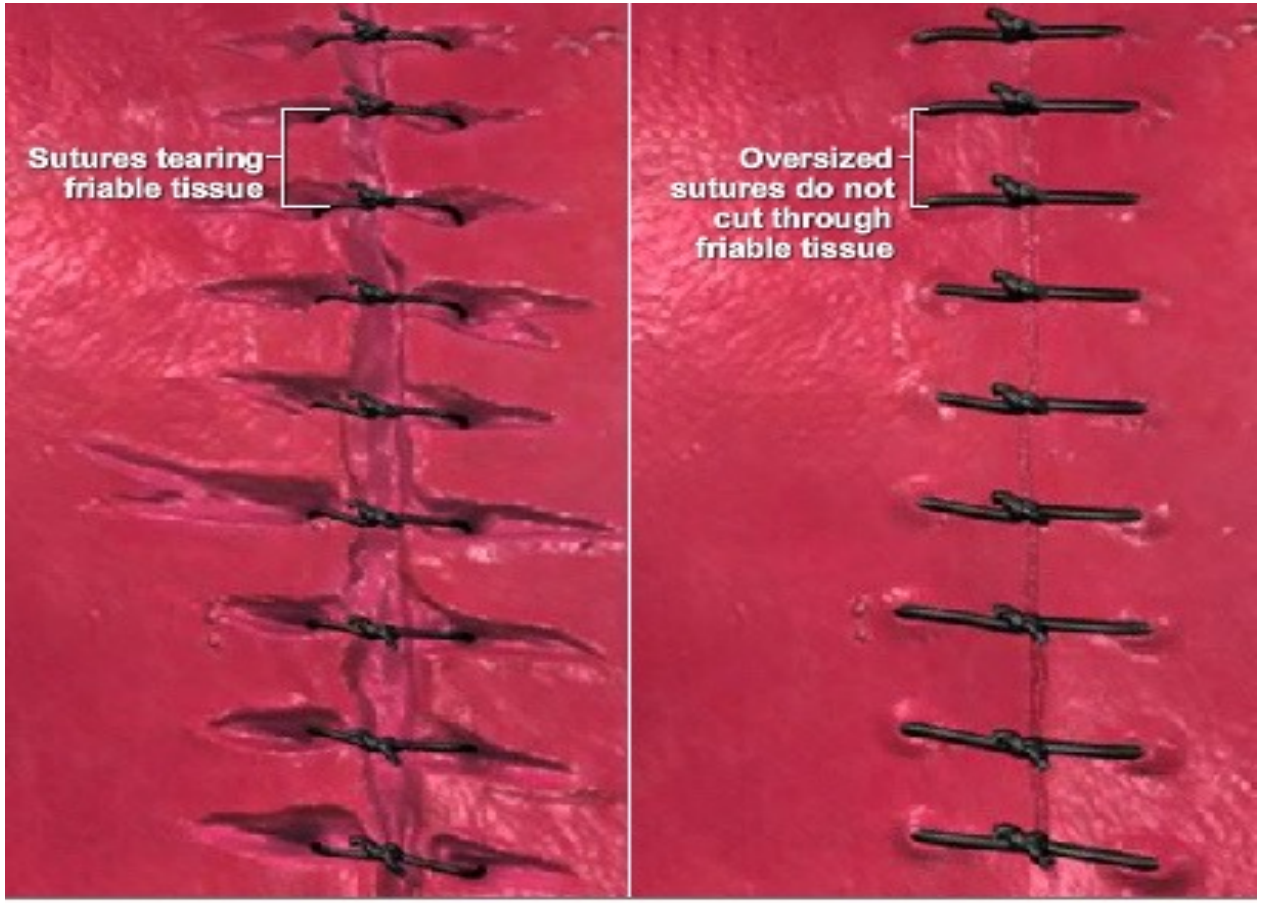
Sutures on Excessive Tension

- In some cases, principle may need to be considered:
  - Wounds under excessive tension: require larger suture
  - Friable tissue (exp.: liver) : require oversized suture

Sutures on Excessive Tension

- Using very fine diameter suture on tissues under tension can cause the suture to act like a cheese wire and cut its way out of the tissue instead of supporting the wound.

Sutures on Friable Tissue

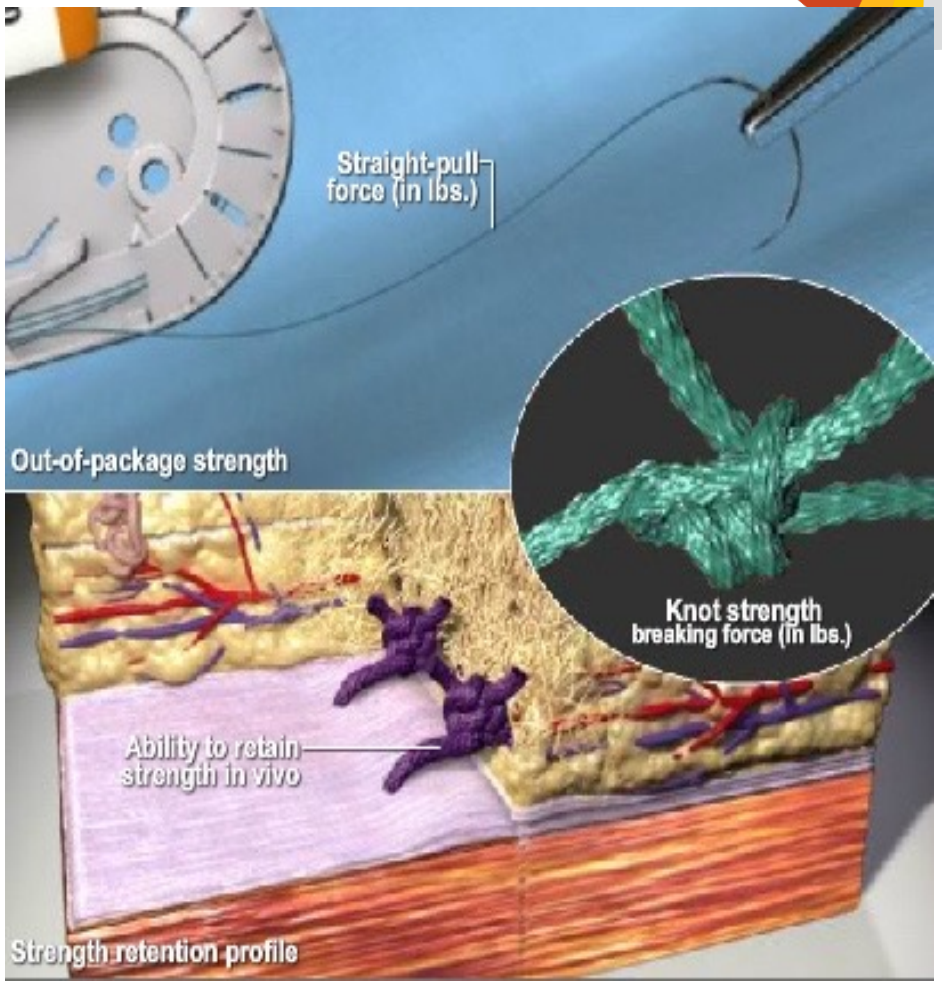


Friable tissue (exp.: liver): require oversized suture

Suture Strength

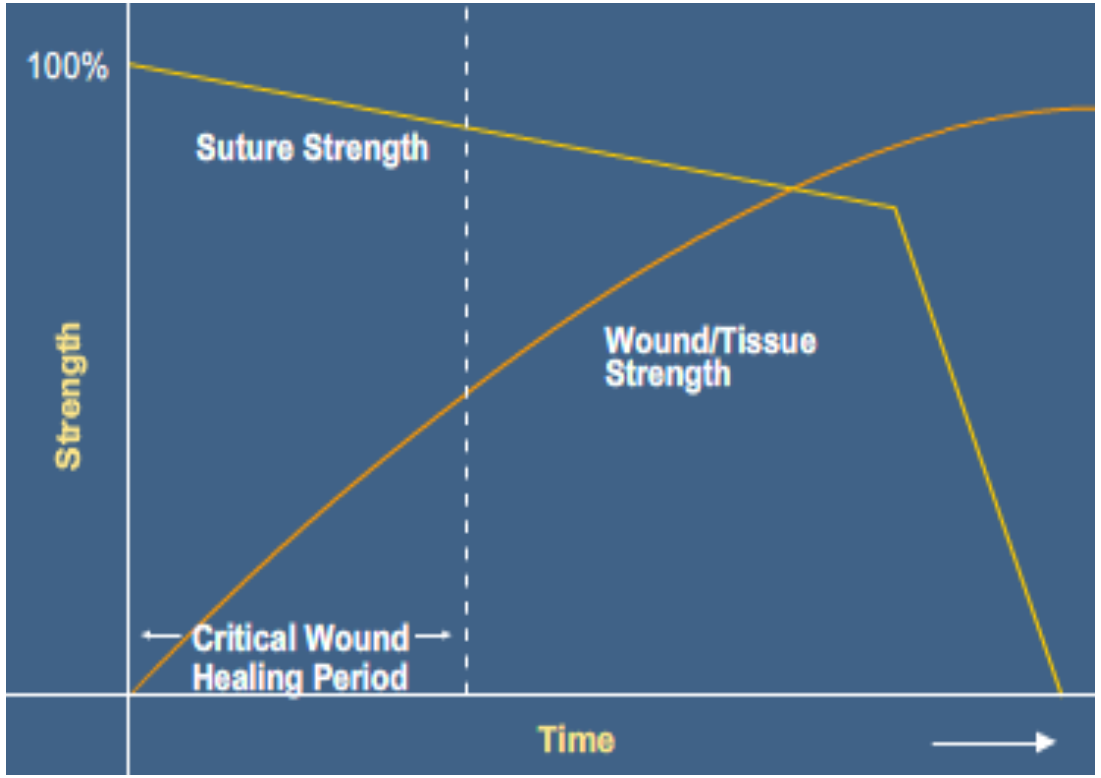
The three characteristics:

- Out of package strength (the straight pull force)
- Knot strength: suture lose a significant amount of their straight pull strength when knotted
- Tensile strength retention profile: the measurement of a suture's ability to retain its strength over time in vivo



Tensile Strength

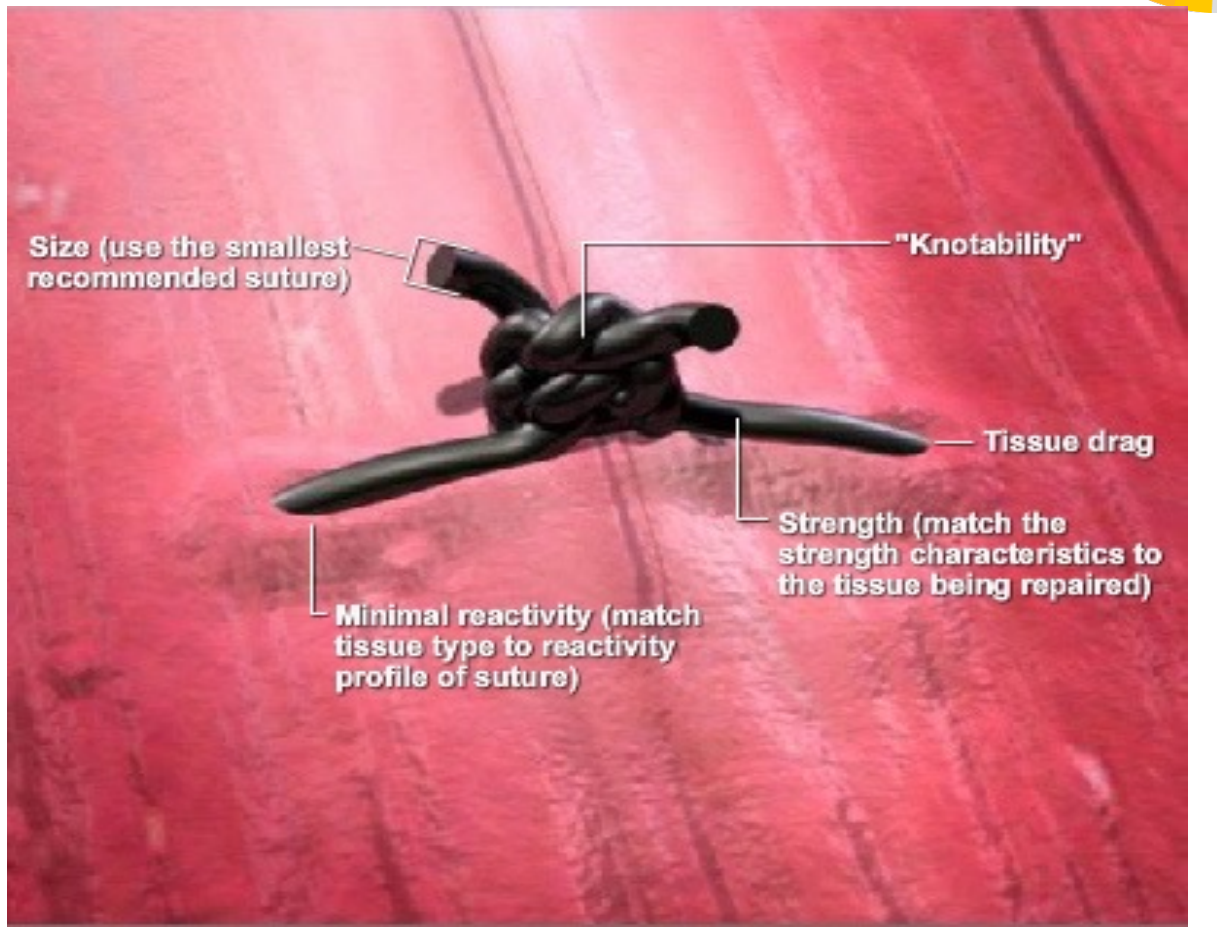
- The tensile strength of the tissue to be approximated determines the size and tensile strength of suture material selected
- Rule: the tensile strength of the knotted suture does not need to exceed the tensile strength of the tissue
- The suture should not lose its tensile strength faster than the tissue regain its strength



The Ideal Suture

Consider the clinical characteristic:

- Size
- Tensile strength
- Tensile strength retention
- Pliability and Handling
- Lack of memory
- Knot ability (ease of tying and achieve secure knots)
- Drag (resistance to passage through tissue)
- Minimal reactivity
- Predictability of performance
- Absorption profile



End of modules: Thank You