Wound Closure

Casey Holmes, MD Geoff Vana, MD Favin Babu MD
General Surgery Residents
Burn and Shock Trauma Research Institute
Wound Closure Basics

- Basic Options
  - Sutures
  - Steri-strips
  - Staples
  - Dermabond (“glue”)

- Always EVERT
Suture Material

- Generally categorized by three characteristics:
  - Absorbable vs. Non-absorbable
  - Monofilament vs. Multifilament
  - Natural vs. Synthetic
Absorbable Suture

• Degraded and loses tensile strength within 60 days
• Eventually eliminated in one of two ways:
  • Via inflammatory reaction utilizing tissue enzymes (natural absorbables)
  • Via hydrolysis (synthetic absorbables) → less inflammation
• When to use it:
  • Primarily used under the skin (e.g. subcuticular closure)
  • Also used in children when suture removal may be difficult (likely more scarring)
## Absorbable Suture Degradation

<table>
<thead>
<tr>
<th>Suture Material</th>
<th>Method of degradation</th>
<th>Time to degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catgut</td>
<td>Proteolytic enzymes</td>
<td>Days</td>
</tr>
<tr>
<td>Vicryl, Monocryl</td>
<td>Hydrolysis</td>
<td>Weeks to months</td>
</tr>
<tr>
<td>PDS</td>
<td>Hydrolysis</td>
<td>Months</td>
</tr>
</tbody>
</table>
Non-absorbable Suture

- Not readily broken down by the body’s enzymes or by hydrolysis
  - Ultimately encapsulated or walled off by the body’s fibroblasts
- “Permanent” (maintains tensile strength >60 days)
- Examples:
  - Naturals – Stainless steel, Silk
  - Synthetics – Prolene (polypropylene), Nylon, Ethibond
- When to use it:
  - Closing the abdominal fascia
  - Repairing superficial lacerations
  - Vascular anastomoses
  - Bowel anastomoses
Monofilament Suture

- Grossly appears as single strand; all fibers run parallel
- Causes less friction, thus less tissue trauma
- Resist harboring micro-organisms
- Ties smoothly, but requires more knots than multifilament (5-6 knots vs. 3 with silk)
- Possesses memory → tendency not to lie flat, but rather to return to given shape set by the material’s extrusion process or the suture’s packaging
- Preferred for skin closure b/c less tissue reaction, less traumatic, fewer infections, and better cosmetic result
- Examples:
  - Monocryl, PDS, Prolene, Nylon
Multifilament Suture

- Fibers are twisted or braided together
- Causes greater resistance in tissue, question of more trauma
- Greater ease of handling and tying
  - Higher coefficient of friction
  - Knots remain as they are laid down → fewer knots required, less likely to slip
- Increased infection risk
- Examples:
  - Vicryl (braided), Chromic (twisted), Silk (braided)
### Natural vs. Synthetic Suture

**Natural Suture**
- Biologic origin
- Causes intense inflammatory reaction
- Examples:
  - Catgut (purified collagen fibers from intestine of healthy sheep or cows)
  - Chromic (catgut treated with chromium salts to delay breakdown)
  - Silk

**Synthetic Suture**
- Synthetic polymers
- Do not cause intense inflammatory reactions (or at least cause a much less intense reaction)
- Examples:
  - Vicryl
  - Monocryl
  - PDS
  - Prolene
  - Nylon
Knot Tying 101
Two-handed Square Knot

1\textsuperscript{st} Throw
Two-handed Square Knot
2\textsuperscript{nd} Throw
Two-Handed Knot

https://youtu.be/0M7v3BCnhFI
Surgeon’s (Friction) Knot
1st Throw
Surgeon’s (Friction) Knot
2nd Throw
Checklist

• Hands are located appropriate distance from knot
• Efficient range of motion is used
• Adequate tension is maintained throughout
• Equal tension is applied as throw is pulled down
• Knots are tied firmly (no slipping)
• Square knot is correctly placed
Instrument Tying
Instrument Tie: Right Handed

https://youtu.be/eh74OqUwMz4
Suture Technique
Forceps

- Used to create counter traction and control the position of the skin edge to facilitate passage of the needle.
- Hold forceps like a writing utensil
  - One arm is extension of thumb
  - Other is extension of index finger
- For skin, use fine-toothed forceps (e.g. Adson forceps)
- For other tissues, use without teeth (e.g. debakey forceps)
  - But avoid crushing the skin edges!!!!
Needle Drivers

- Most common method for holding: thumb and ring fingers slightly in the rings
- Some do not put their fingers into the rings and simply grasp the needle holder in their palm
- Tip of the needle holder should grasp the needle ~ 2/3 back from the point
- Needle holder and needle roughly perpendicular
- Try not to grab needles by their tips (they will become blunt)
- **NOTE**: Suture scissors similar
Coordinated Movements

- **TIPS:**
  - Use the natural curvature of the needle
  - Alternate pronating and supinating

- **HOW TO (right-handed):**
  - Elevate skin edge with forceps in left, while the right is pronated with needle
  - Needle should penetrate the skin **perpendicularly**
  - Rotate the needle through the skin by supinating
  - **KEY TO SUCCESS:** Maintain the position of the skin edge using the forceps
  - Fully pronate the right hand and regrasp the needle on the other side
  - Complete the “bite” by supinating the hand to finish the needle’s rotation
Simple Interrupted

**Advantages:**
- Easy to place
- Greater tensile strength
- Less likely to impair circulation than the continuous suture

**Disadvantages:**
- Takes longer to place than the continuous suture
- Increased risk of cross-hatch marks
Simple Interrupted

- Single stitches, individually knotted (all knots on one side of wound)
- Used for uncomplicated laceration repair and wound closure
- Always start AWAY from yourself and sew towards yourself
Simple interrupted suture with instrument tie

https://www.youtube.com/watch?v=yWrm2MAfPUo
Checklist

- Holds needle perpendicular to the long axis of needle holder
- Inserts the needle tip approx 0.5 - 1 cm from wound edge
- Inserts needle perpendicular to the tissue surface
- Supinates wrist to facilitate needle passage through tissue
- Traverses the epidermis, dermis and a small portion of the subcutaneous tissue
- Approximates wound edges without undue tension
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Places sutures 1 cm apart
- Cuts suture leaving 1 cm tail
- Avoids handling needle with fingers
- Avoids grasping needle tip
- Avoids torqueing
- Avoids multiple forceps grasps of skin
Horizontal Mattress

- **Advantages:**
  - Useful for wounds under high tension (provides strength and eversion)
  - Added strength in fascial closure
  - Also used in calloused skin (e.g. palms and soles)

- **Disadvantages:**
  - High risk of leaving suture marks
  - High risk of tissue strangulation and wound edge necrosis
Horizontal Mattress

- Two-step stitch:
  - Simple stitch, then
  - Needle reversed and 2nd simple stitch made adjacent to first
  - Same size “bite” as first stitch
Horizontal Mattress

Checklist

- Holds needle perpendicular to the long axis of needle holder
- Inserts needle perpendicular to the tissue surface
- Supinates wrist to facilitate needle passage through tissue
- Traverses the epidermis, dermis and a small portion of the subcutaneous tissue
- Advances 0.5-1.0 cm along the axis of the wound on the same side
- Reinserts the needle tip into the tissue approx 0.5-1.0 cm from the wound edge
- Approximates wound edges without undue tension
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Places sutures at least 1 cm apart
- Everts skin edges
- Cuts suture leaving 1 cm tail
  - Avoids handling needle with fingers
  - Avoids grasping needle tip
  - Avoids torqueing
  - Avoids multiple forceps grasps of skin
Vertical Mattress

- **Advantages:**
  - Precise approximation of skin edges
  - Maximal eversion
  - Reduces dead space
  - Minimizes tension across the wound

- **Disadvantages:**
  - Cross-hatching
  - More time to place
Vertical Mattress

Two-step stitch:

1. Simple stitch made “far, far” relative to wound edge (large “bite”)
2. Needle reversed and 2nd simple stitch made “near, near” inside 1st (small “bite”)
Vertical Mattress

https://youtu.be/vzYpfrrjp-g?t=2
Checklist

- Holds needle perpendicular to the long axis of needle holder
- Inserts needle perpendicular to the tissue surface
- Supinates wrist to facilitate needle passage through tissue
- Traverses the epidermis, dermis and a small portion of the subcutaneous tissue
- Reinserts the needle tip on the same side approx 0.1-0.2 cm from the wound edge at the intradermal level
- Passes needle out of skin on opposite side approx 0.1-0.2 cm from wound edge
- Approximates wound edges without undue tension
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Places sutures at least 1 cm apart
- Everts skin edges
- Cuts suture leaving 1 cm tail
  - Avoids handling needle with fingers
  - Avoids grasping needle tip
  - Avoids torqueing
  - Avoids multiple forceps grasps of skin
Subcuticular (intradermal)

- Useful when there is minimal tension and the dead space has been eliminated

- **Advantages:**
  - Better cosmetic outcome
  - Precisely approximates wound edges

- **Disadvantages:**
  - Does not provide significant wound strength
Subcuticular (intradermal)

- Usually a running stitch
- Intradermal horizontal bites
- Allows suture to remain for a longer period of time without development of crosshatch scarring
- No suture removal required
Deep Dermal Suture

https://youtu.be/1od-y0OEwpM?t=3
Running (continuous) Subcuticular Suture

https://youtu.be/Gebipizw6ZU?t=77
Checklist

- Holds needle perpendicular to the long axis of needle holder
- Starts at the wound edge farthest away
- Inserts needle into dermal-subcutaneous junction perpendicular to the wound edge
- Supinates wrist 90° clockwise to facilitate needle passage
- Assures needle tip comes out at the dermal-epidermal junction without including epidermis
- Reinserts needle tip into dermis on opposite side of wound directly across from exit site
- Approximates wound edges without undue tension
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Places sutures 1 cm apart
- Cuts suture on the knot
- Avoids handling needle with fingers
- Avoids grasping needle tip
- Avoids skin puckering
- Avoids multiple penetrations of the dermis
- Avoids multiple forceps grasps of skin
Checklist

- Holds needle perpendicular to the long axis of needle holder
- Passes needle tip through subcuticular tissue at apex of wound farthest away
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Inserts needle into the dermis parallel to the epidermis at apex of wound
- Assures needle tip comes out at the dermal-epidermal junction without including epidermis
- Reinserts needle tip into dermis on opposite side of wound directly across from exit site
- Angles the needle approximately 45°
- Secures ties with 2-handed technique (after removing needle) or instrument tie
- Buries knot with a simple interrupted suture beyond edge of wound
- Approximates wound edges without undue tension
- Avoids handling needle with fingers
- Avoids grasping needle tip
- Avoids skin puckering
- Avoids multiple penetrations of the dermis
- Avoids multiple forceps grasps of skin
Simple Interrupted
Running/Continuous
Horizontal Mattress

Two-step stitch:

1. Simple stitch, then
2. Needle reversed, 2\textsuperscript{nd} simple stitch made adjacent to first
3. Same size “bite” as first stitch
Vertical Mattress

Two-step stitch:

1. Simple stitch made “far, far” relative to wound edge (large “bite”)
2. Needle reversed and 2\textsuperscript{nd} simple stitch made “near, near” inside 1\textsuperscript{st} (small “bite”)

Subcuticular (intradermal)