

# Abdominal Wall Closure.

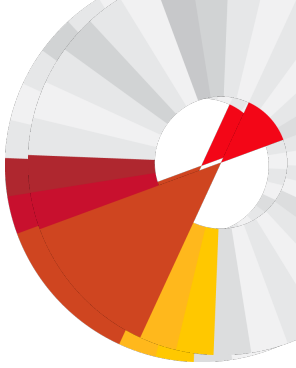
The Science of Tissue Management



SoTM Applied

Evidence-based  
Conversation

External Confidence

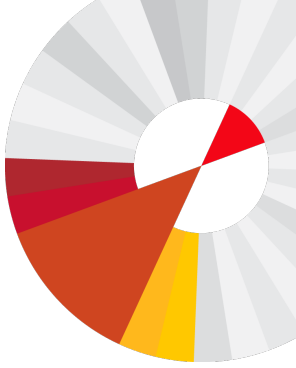


# Today's Presentation

- Critical factors of fascia healing
- Epidemiology and impact of wound complications
- Clinical evidence supporting innovative surgical solutions to achieve superior patient outcomes
- Evidence-based best practices in fascia closure
- The evolution of wound closure: Anchored tissue control devices



# What is The Science of Tissue Management?



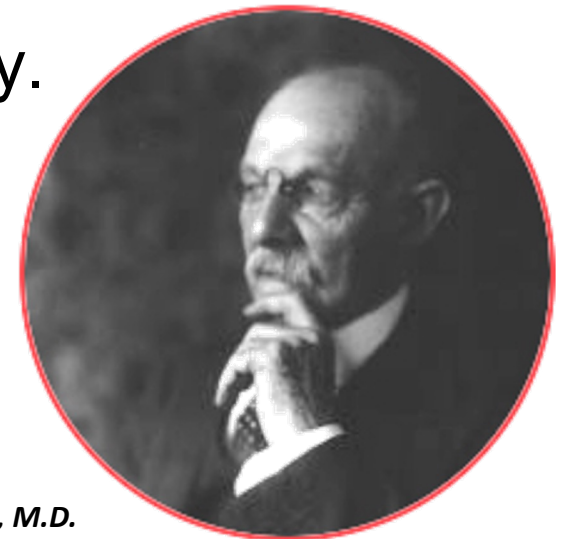
- The Science of Tissue Management is a principle we follow to achieve a scientific understanding of living tissue/device interaction
- ... to improve patient care and
- ... to enhance clinical outcomes



# Tissue Management is based on The Tenets of Halsted



- **Obliteration of dead space** and adequate removal of material.
- **Careful hemostasis** to improve conditions for the procedure and limit infection and dead space.
- **Strict aseptic technique** during preparation and surgery.
- **Sharp anatomic dissection** of tissues.
- **Avoidance of tension.**
- **Gentle handling of tissue.**



*William S. Halsted, M.D.*



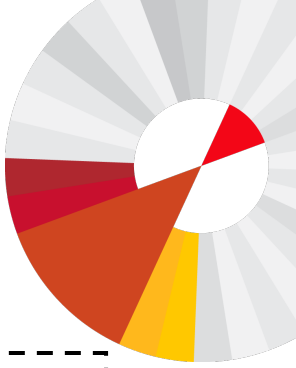
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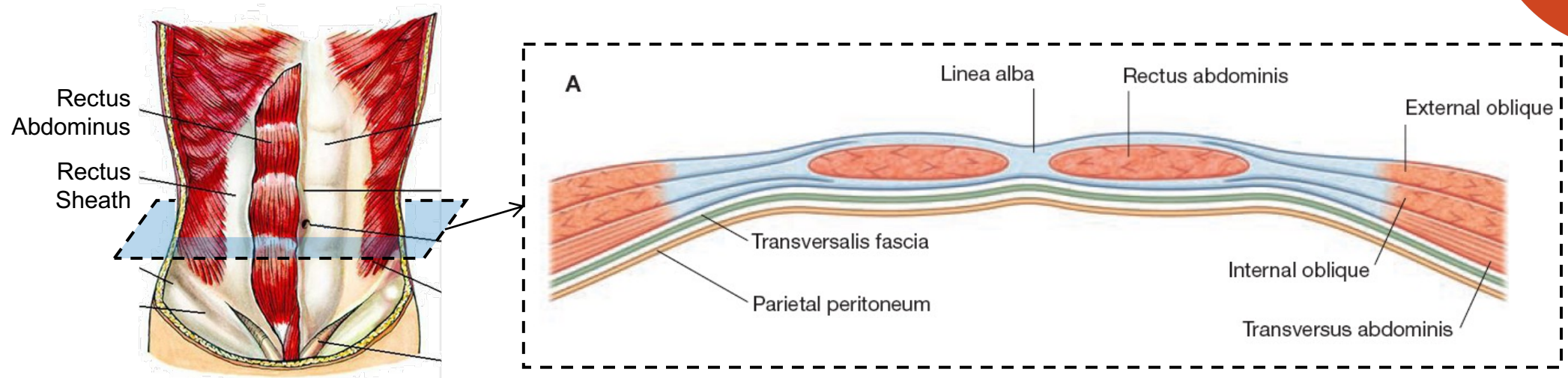
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# Critical Factors in Fascia Healing

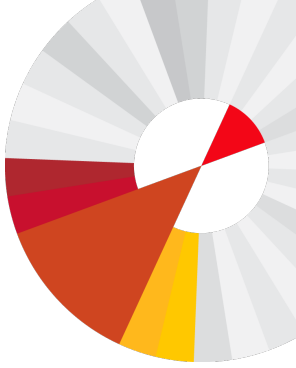


# Anatomy of the Anterior Abdominal Wall



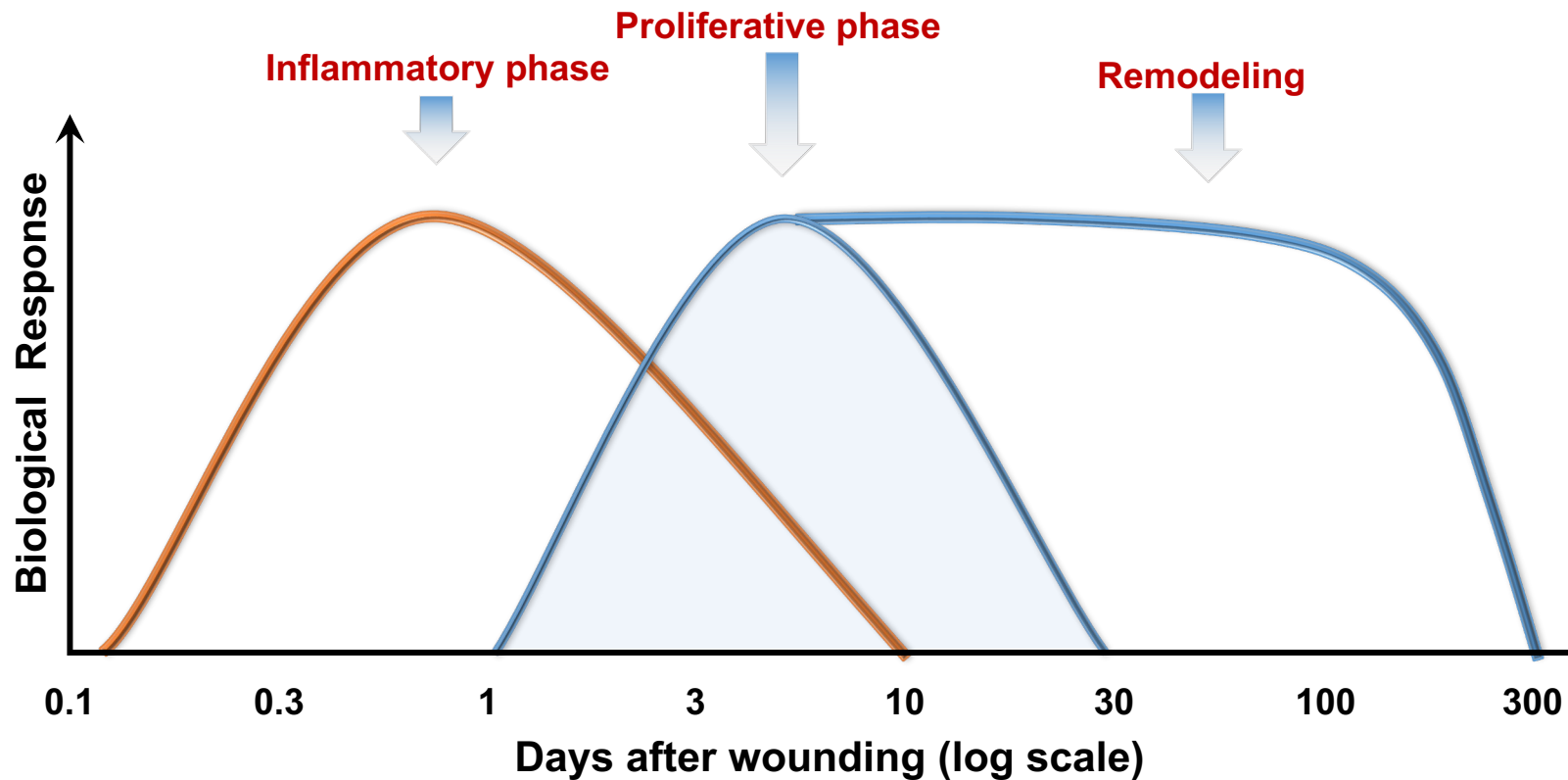
## Fascia

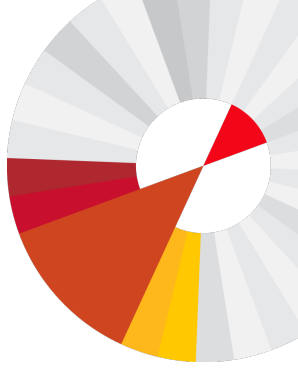
- Firm, strong connective tissue that sheaths muscles and is a main supportive structure of the body
- Laparotomy incisions transect fascia for access into the abdominal cavity
  - A vertical midline incision passes through the skin, subcutaneous fat, Scarpa's fascia, white line, transversalis fascia, extra peritoneal fat and parietal peritoneal layer with no muscle involvement



# The Phases of Fascia Healing

- Fascia healing consists of 3 consecutive, overlapping phases





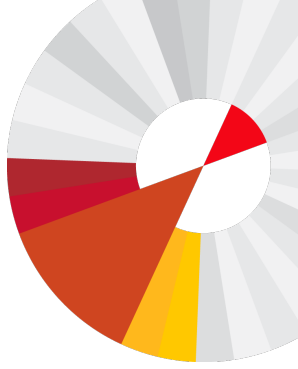
# Interruptions in the Healing Process Can Lead to Wound Complications

- Surgical site infection (SSI)
  - Post-operative infection involving the layers (e.g., skin, fascia) incised during surgery but can also extend to organ/anatomic spaces<sup>1</sup>
    - Examples of evidence of infection: purulent drainage, isolated organisms



1. Pessaux Arch Surg 2003; 138: 314-24;
2. Clark JJ. Crit Care Nurs Q 2002; 25:1-12
3. Franz, et al. Wound Rep Reg 2008; 16: 723-48



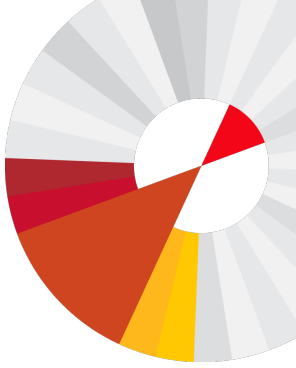


# Interruptions in the Healing Process Can Lead to Wound Complications

- Tissue separation/wound dehiscence
  - Disruption of the sutured edges of the wound. Partial separation of the fascia may result in an incisional hernia, whereas complete disruption of fascia and overlying tissues may result in a burst abdomen<sup>2</sup>



1. Pessaux Arch Surg 2003; 138: 314-24;
2. Clark JJ. Crit Care Nurs Q 2002; 25:1-12
3. Franz, et al. Wound Rep Reg 2008; 16: 723-48

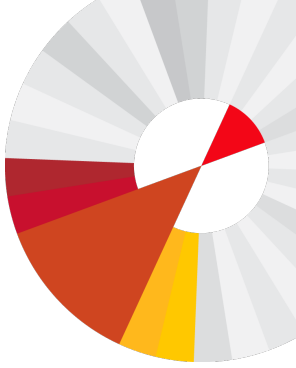


# Interruptions in the Healing Process Can Lead to Wound Complications

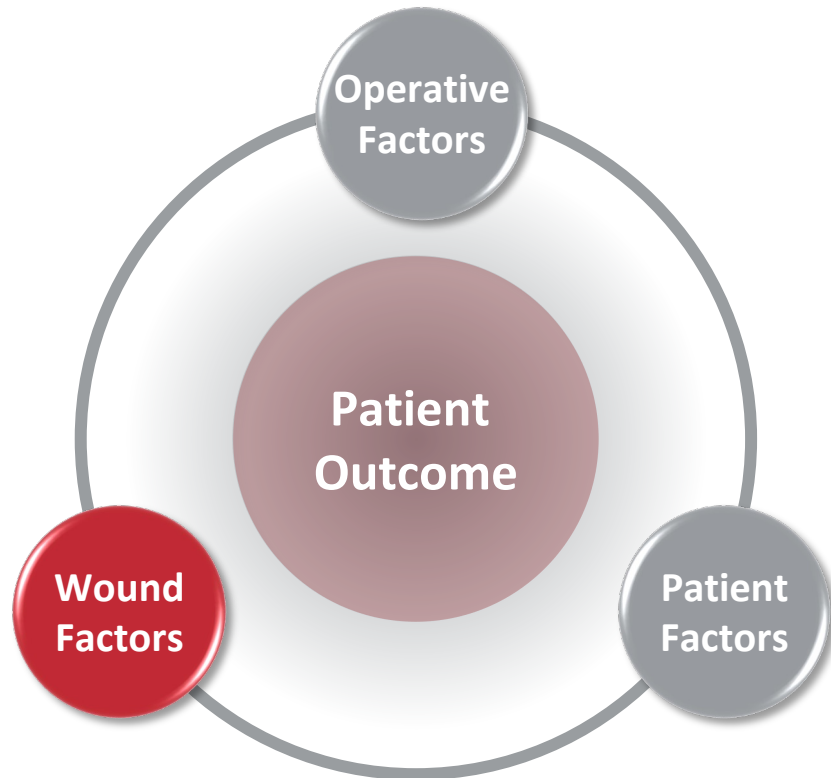
- Incisional hernia
  - Any abdominal wall gap with or without a bulge in the area of a postoperative scar perceptible or palpable by clinical examination or imaging<sup>3</sup>



1. Pessaux Arch Surg 2003; 138: 314-24;
2. Clark JJ. Crit Care Nurs Q 2002; 25:1-12
3. Franz, et al. Wound Rep Reg 2008; 16: 723-48

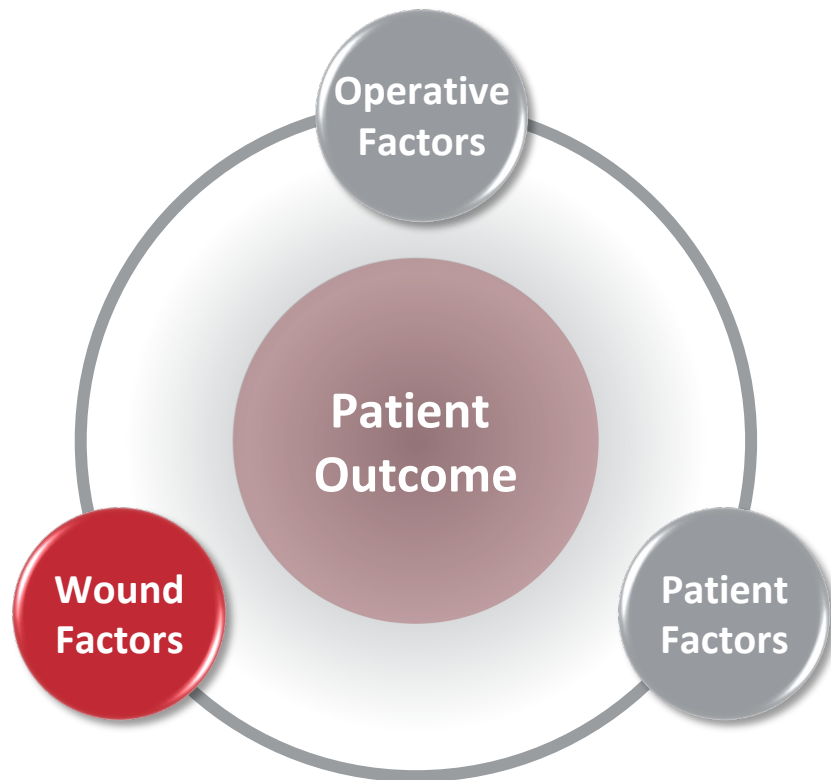
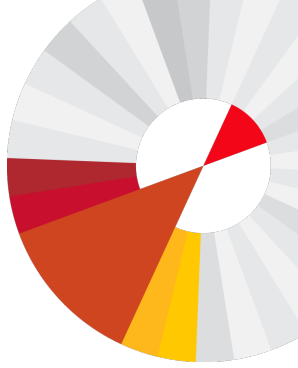


# What are the Patient Factors that Influence Wound Healing?



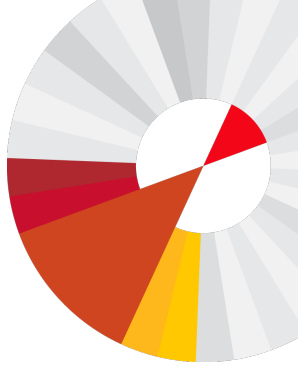
- Age
- Gender
- Nutrition
- Comorbidities & underlying disease
  - Infection
  - Diabetes
  - Heart disease
  - Pulmonary disease
  - Hypertension
- Lifestyle Factors
  - Smoking
  - Obesity

# What are the Wound Factors that Affect Fascia Healing?



- Tissue perfusion/blood supply
- Necrosis
- Presence of foreign body
- Localized infection/contamination [Wound classification]
  - I. Clean
  - II. Clean-contaminated
  - III. Contaminated
  - IV. Dirty

# How Do Patient & Wound Factors Affect the Phases of Healing

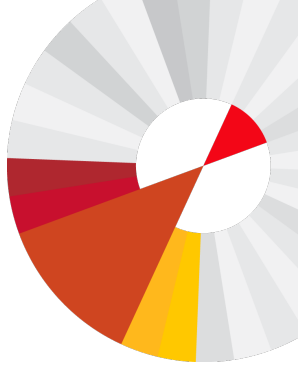


- Age & Gender
  - Compared to younger patients, older patients often have
    - Reduced collagen synthesis and elevated collagen degradation during wound healing compared to younger adults, particularly in men<sup>1</sup>
    - Increased type III collagen synthesis (weaker) vs. type I collagen<sup>2,3</sup>
      - Increased type III collagen associated with risk of incisional hernia<sup>4</sup>
    - Reduced blood circulation<sup>5</sup> and angiogenesis<sup>6</sup>

1. Sorensen LT. Hernia 2006; 10:456–461
2. Hoer, et al. Hernia 2002; 6:93-8;
3. Henriksen, et al. Br J Surgery 2011; 98: 210-19.
4. Dinunno, et al. Circulation 1999; 100:164-70.
5. Rivard, et al. Circulation 1999; 99: 111-20
6. Stechmiller JK. Nutr Clin Pract 2010; 25: 61-8
7. Jonsson, et al. Ann Surg 1991; 214: 605-13
8. Hopf, et al. Arch Surg 1997; 132: 997-1005
9. Levy, et al. Circulation 2008; 2008: 968-76



# How Do Patient & Wound Factors Affect the Phases of Healing

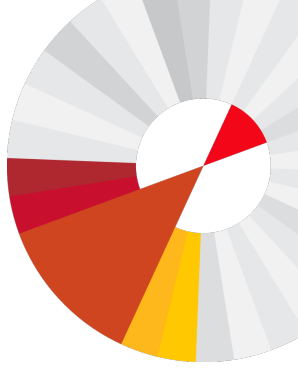


- Nutrition & Tissue Perfusion
  - Impaired access to protein and oxygen result in impaired healing
    - Low dietary protein related to low skin and fascial wound strength<sup>7</sup>
    - Inadequate tissue oxygen perfusion associated to reduced collagen deposition and wound strength<sup>8</sup>, along with increased risk of infection<sup>9</sup>
  - Impaired tissue perfusion evident in hypertension, diabetes, obesity<sup>10</sup>

1. Sorensen LT. Hernia 2006; 10:456–461
2. Hoer, et al. Hernia 2002; 6:93-8;
3. Henriksen, et al. Br J Surgery 2011; 98: 210-19.
4. Dinunno, et al. Circulation 1999; 100:164-70.
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# How Do Patient & Wound Factors Affect the Phases of Healing

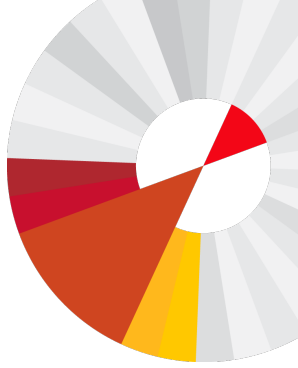


- Infection
  - Wounds considered “contaminated” or “dirty” are more likely to have a surgical site infection<sup>1</sup>
  - Infection prolongs inflammatory phase of wound healing<sup>2</sup>
    - Wound cannot heal if it does not progress through all 3 stages
  - Increase the risk of incisional hernia and wound dehiscence<sup>3-5</sup>

1. Pessaux *Arch Surg* 2003; 138: 314-24.
2. Dubay, et al. *Surg Clin N Am* 83: 463-48.
3. Israelsson, et al. *Eur J Surg* 1996 162:125-9.
4. van Ramhorst et al. *World J Surg* 34:20-7.
5. van't Riet, et al. *Am Surg* 2004 70:281-6.
6. Brem et al. *J Clin Invest* 2007; 117: 1219-22



# How Do Patient & Wound Factors Affect the Phases of Healing

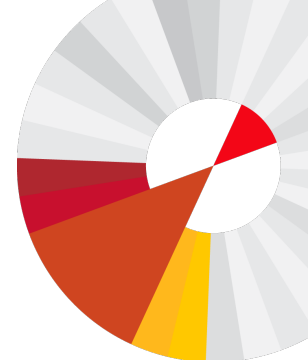


- Diabetes<sup>6</sup>
  - Decreased tissue perfusion/circulation
  - Impaired macrophage and fibroblast response
    - Slower wound healing, greater susceptibility to infection
  - Known risk factor for incisional hernia<sup>5</sup>

1. Pessaux Arch Surg 2003;138: 314-24.
2. Dubay, et al. Surg Clin N Am 83:463-48.
3. Israelsson, et al. Eur J Surg 1996;162:125-9.
4. van Ramhorst et al. World J Surg. 2010;34:20-7.
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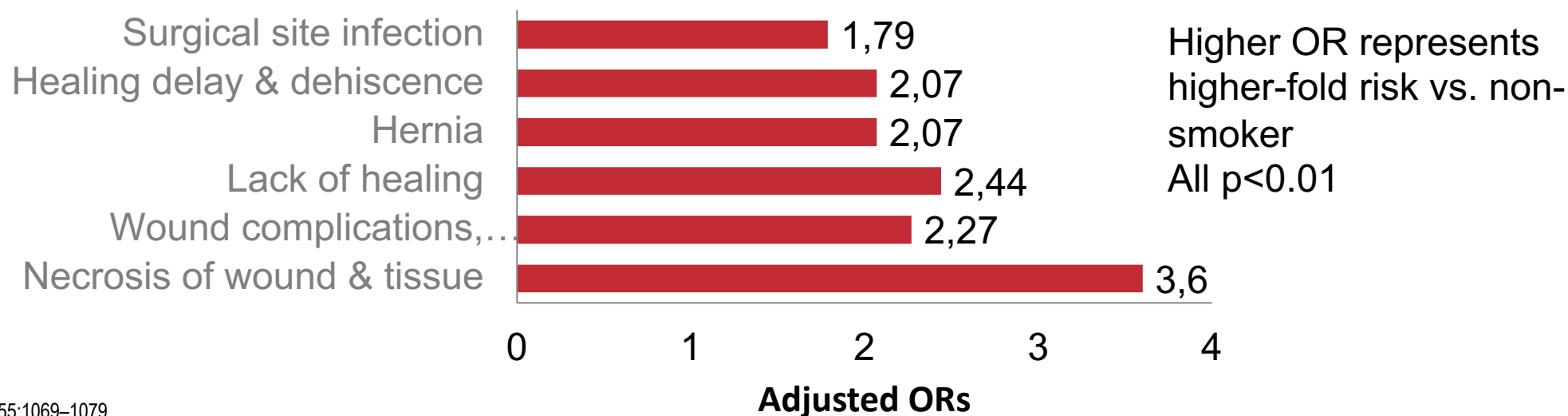






# Smoking Greatly Increases the Risk for All Wound Complications

- Smoking lead to increased type III collagen synthesis (weaker collagen), increased collagen degradation<sup>1</sup>
- Smoking can reduce tissue perfusion and circulation<sup>1</sup>
- In a meta-analysis of 479150 patients across 140 cohort studies in countries all of the world, smoking was found to **significantly increase the risk of all wound complications**<sup>2</sup>

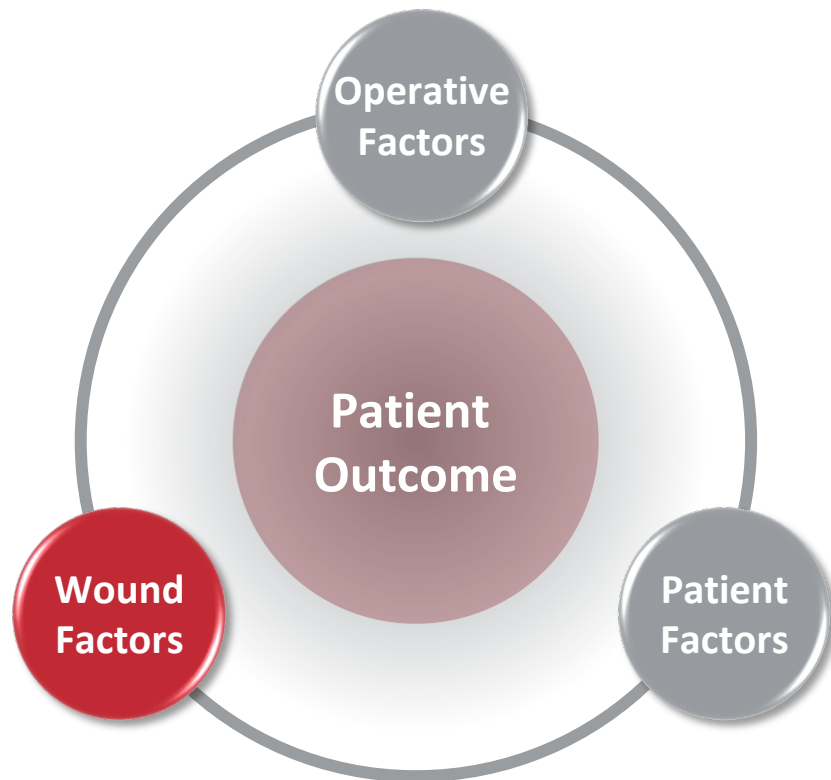
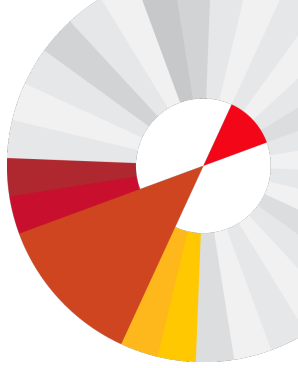


1. Sorensen, et al. Ann Surg 2012;255:1069–1079

2. Sorensen, et al. Arch Surg 2012; 147: 373-383



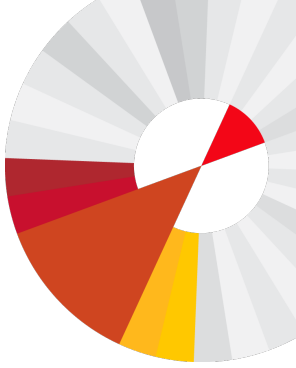
# What are the Operative Factors that Affect Fascia Healing?



- Pre-operative preparation
  - Antibiotic prophylaxis
- Surgical Approach
  - Incision location
  - Suturing technique
  - Suture choice
  - Intra-operative patient care (e.g., blood transfusions, normothermia)
- Post-operative care
  - Antibiotics

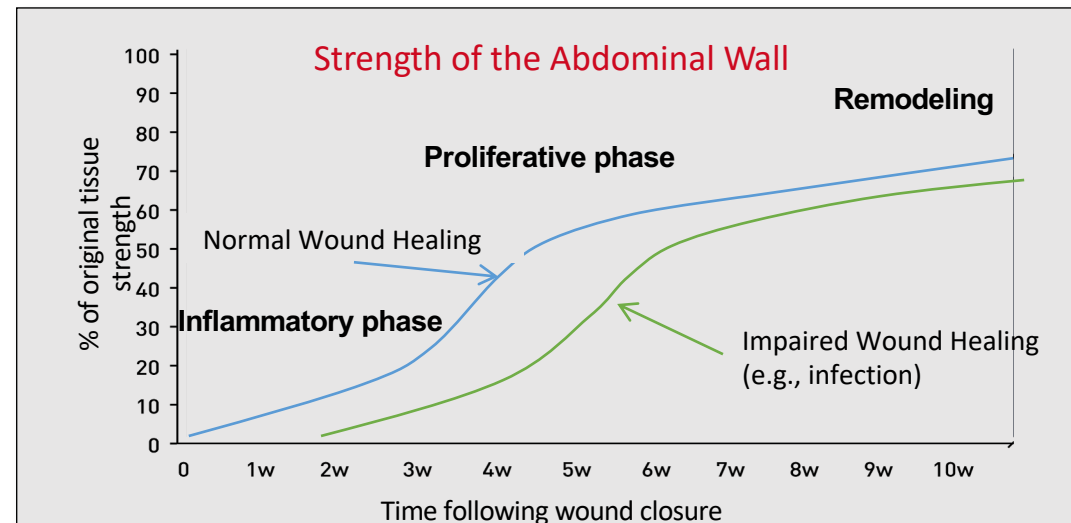
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2. Clark JJ. Crit Care Nurs Q .2002;25:1-12
3. Franz, et al. Wound Rep Reg. 2008;16:723-48





# Fascia Healing Depends on Successful Wound Closure

- The closure device must bear the fascial load of recovering patients until the wound regains sufficient strength<sup>1</sup>
- For fascia, this takes<sup>1,2</sup>
- Disruptions in these phases can lead to complications or reduce the strength of the healing fascia



1. Dubai, et al. Surg Clin N Am 83: 463–481  
2. Douglas DM. Br J Surg 1952;40:79-84.





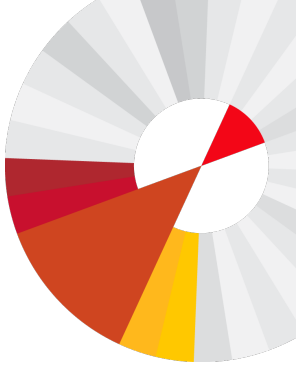
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# Epidemiology and Impact of Wound Complications



# Wound Complications Remain a Challenge

- The reported incidence of wound complications in the literature remains high

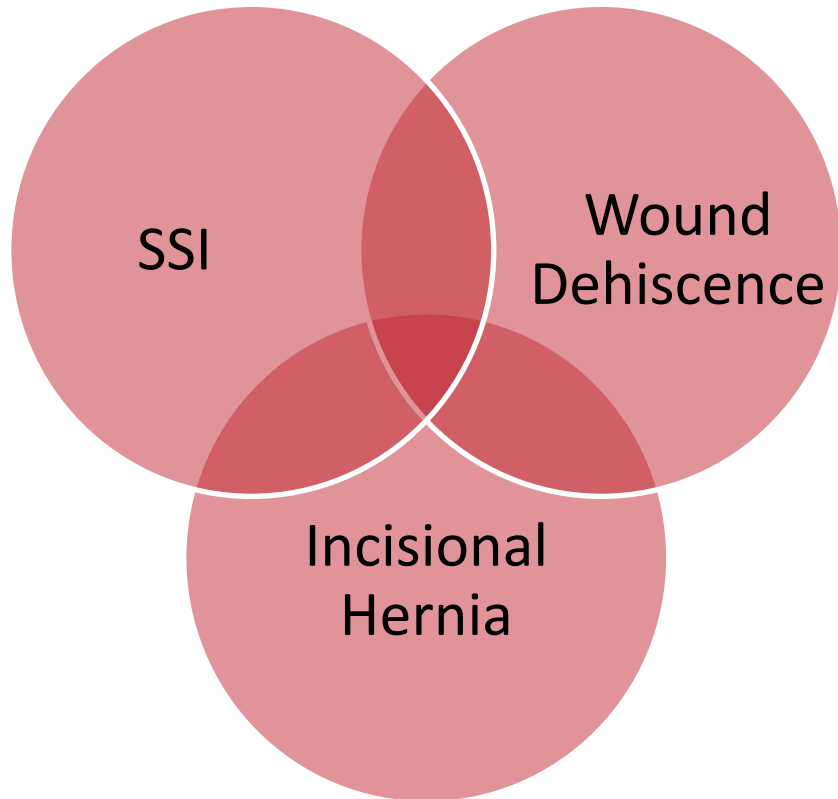
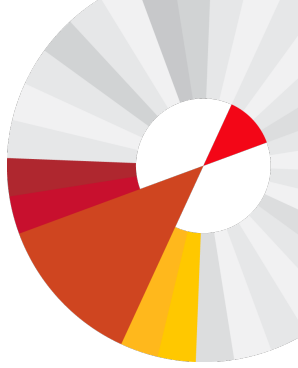
Complication	Reported Incidence <sup>1,2</sup>	Potentially Achievable Incidence <sup>3</sup>
Surgical Site Infection (SSI)	up to 19%	~5 %
Wound dehiscence	up to 5%	<0.5 %
Incisional hernia	up to 23%	~6%

Recent publications imply that refinements in technique and care can impact the occurrence of complications

1. Seiler , et al, *Ann Surg* 2009;249:576-82.
2. Bloemen, et al, *Br J Surg.* 2011;98:633-9.
3. Millbourn, et al, *Arch Surg* 2009;144:1056-9.



# Wound Complications Occur As A Cascade



- A wound complication is an associated risk for another complication
  - SSI can result in a
    - 2X risk of incisional hernia<sup>1</sup>
    - 6X risk of wound separation when considering emergency surgery and patients in poor condition<sup>2</sup>
  - Wound dehiscence is a significant risk factor for incisional hernia, associated in up to ~47% of incisional hernias<sup>3</sup>
  - Incisional hernias occur post-dehiscence and are often associated with SSIs<sup>2,3</sup>
- **Preventing one complication can potentially prevent others from occurring**

1. Israelsson, et al. Eur J Surg 1996 162:125-129;  
2. van Ramhorst et al. World J Surg. 2010 34:20-27;  
3. van't Riet, et al. Am Surg 2004 70:281-6



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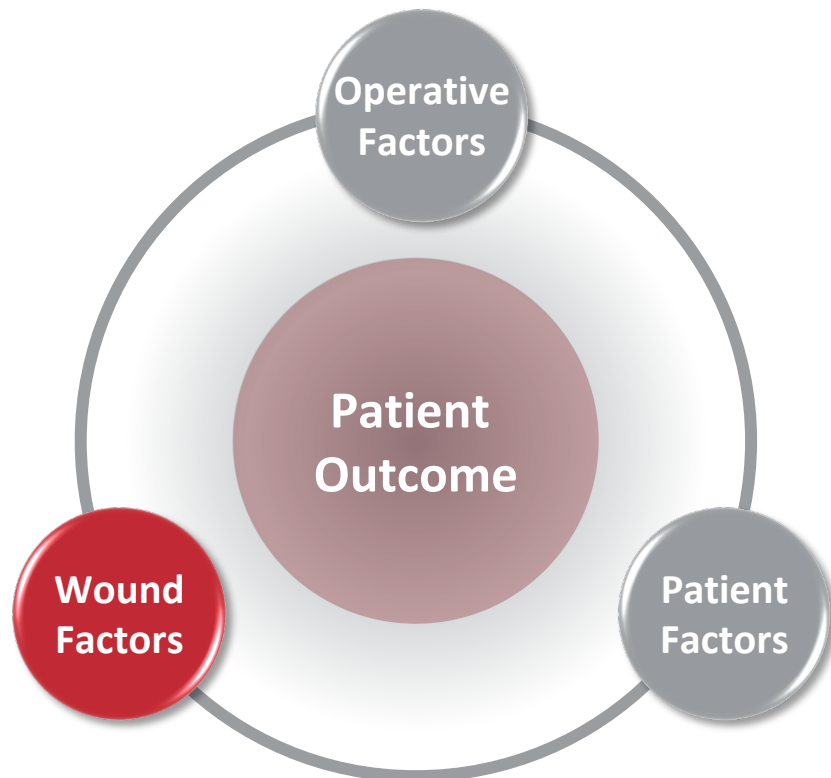
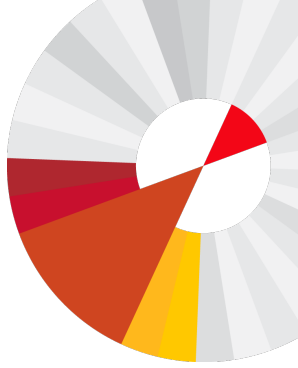
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# Clinical Evidence Supporting Innovative Surgical Solutions to Achieve Superior Patient Outcomes



# What are the Operative Factors that Affect Fascia Healing?



- Pre-operative preparation
  - Antibiotic prophylaxis
- Surgical Approach
  - Incision location
  - Suturing technique
  - Suture choice
  - Intra-operative patient care (e.g., blood transfusions, normothermia)
- Post-operative care
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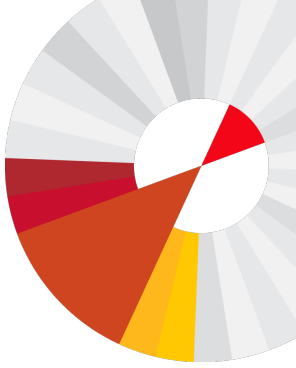
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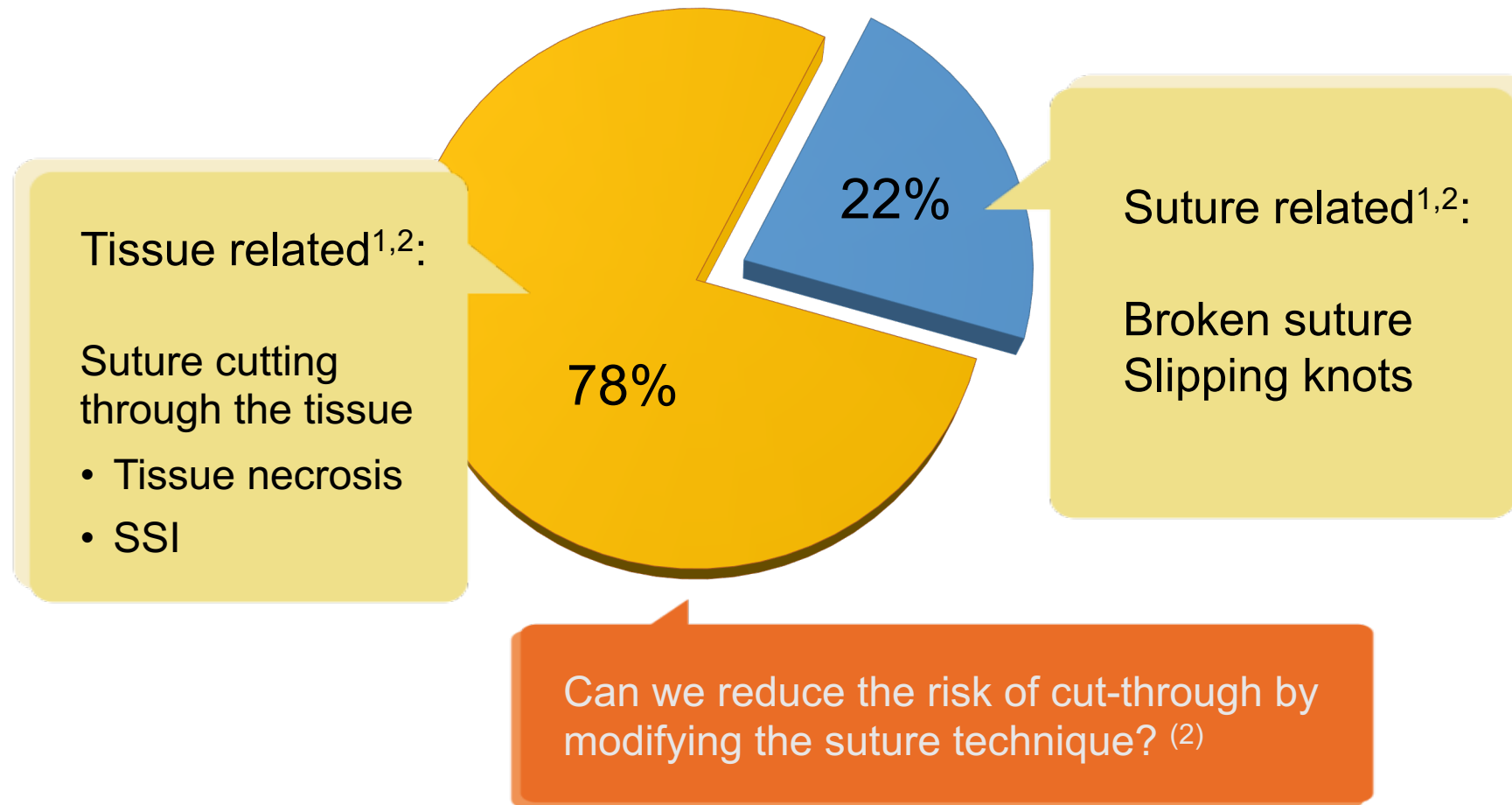


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# Suturing Technique



# Known causes of wound dehiscence

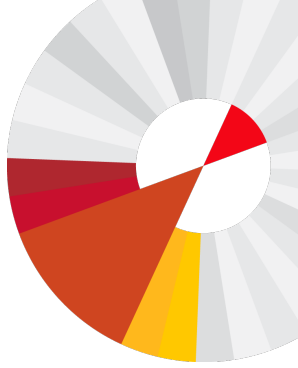


1. Poole GV Jr, 1985;97(6):631-40.

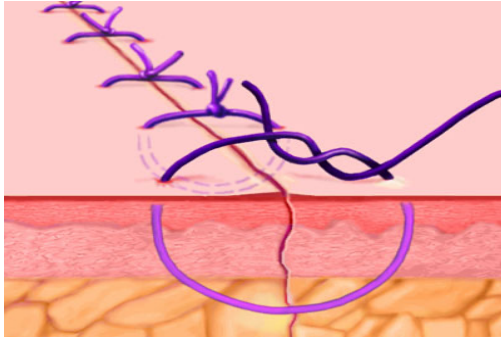
2. Van Ramshorst GH, World J Surg. 2010;;34(1):20-7.



# Review of Continuous and Interrupted Suturing Patterns



## Interrupted suturing pattern



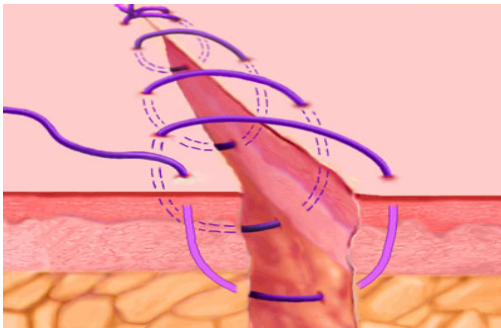
### Advantages<sup>1,4</sup>

- May be required in wounds with irregular areas
- Use has been described in infected wounds to minimize spread of infection and allow for removal of only the infected stitches
- Lower risk of complete wound closure failure if there is a break in one suture

### Disadvantages<sup>1-3</sup>

- Knots increases foreign body material and risks of complications
- Time Consuming

## Continuous suturing pattern



### Advantages<sup>1,4</sup>

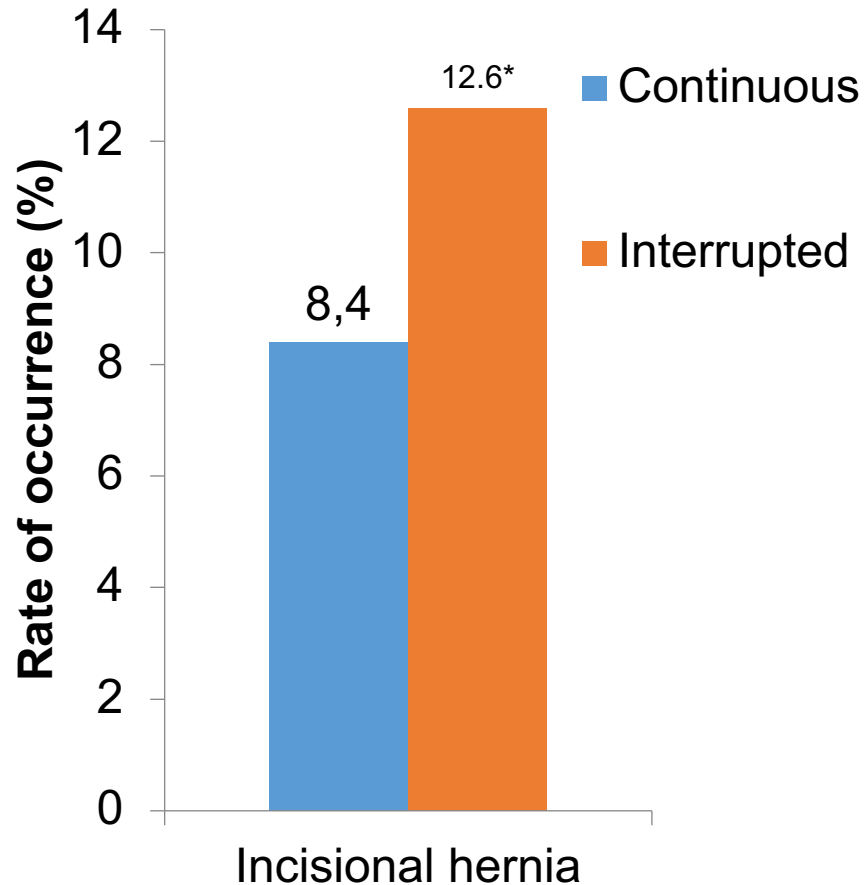
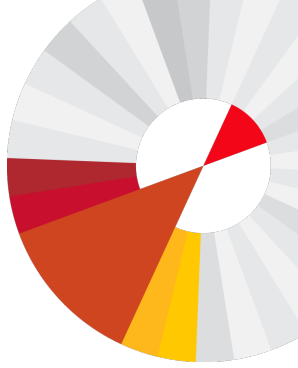
- Better distributes tension and minimize tissue strangulation
- Faster than interrupted sutures, shortening procedure time
- Less expensive than interrupted sutures<sup>5,6,7</sup>
- Use less material, reducing foreign body introduction into the wound

### Disadvantages<sup>2,3,4</sup>

- Strength and security can be compromised with a break in the suture<sup>2,3,4</sup>

1. Sissener T. *Comp Anim.* 2006;11:14-9.
2. Boutros S, et al. *J Trauma Injury Infect Crit Care.* 2000;48:495-7.
3. Seiler CM, et al. *Ann Surg.* 2009;249:576-582.
4. Wong NL. *J Dermatol Surg Oncol.* 1993;19:923-31.
5. Kettle, et al. *Cochrane Database Syst Rev* 2012;11:CD000947.
6. Boutros, et al. *J Trauma* 2000;48:495-47.
7. Colombo, et al. *Obstet Gynecol* 1997;89:684-9.

# Effect of Continuous vs. Interrupted Suture Pattern on Incisional Hernia

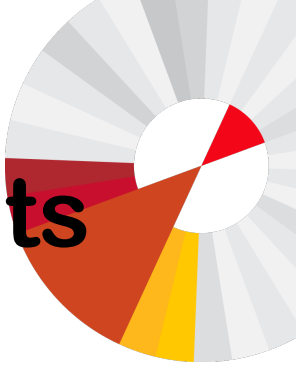


- A meta-analysis of 14 randomized controlled trials<sup>1</sup> (7711 patient enrolled in multiple countries) examining abdominal fascial closure after midline laparotomy found that
- Closure with continuous sutures had a significantly lower rate of incisional hernia compared with interrupted sutures<sup>a</sup>
- No significant difference found in rates of other complications (wound dehiscence, suture sinus, infection, wound pain)

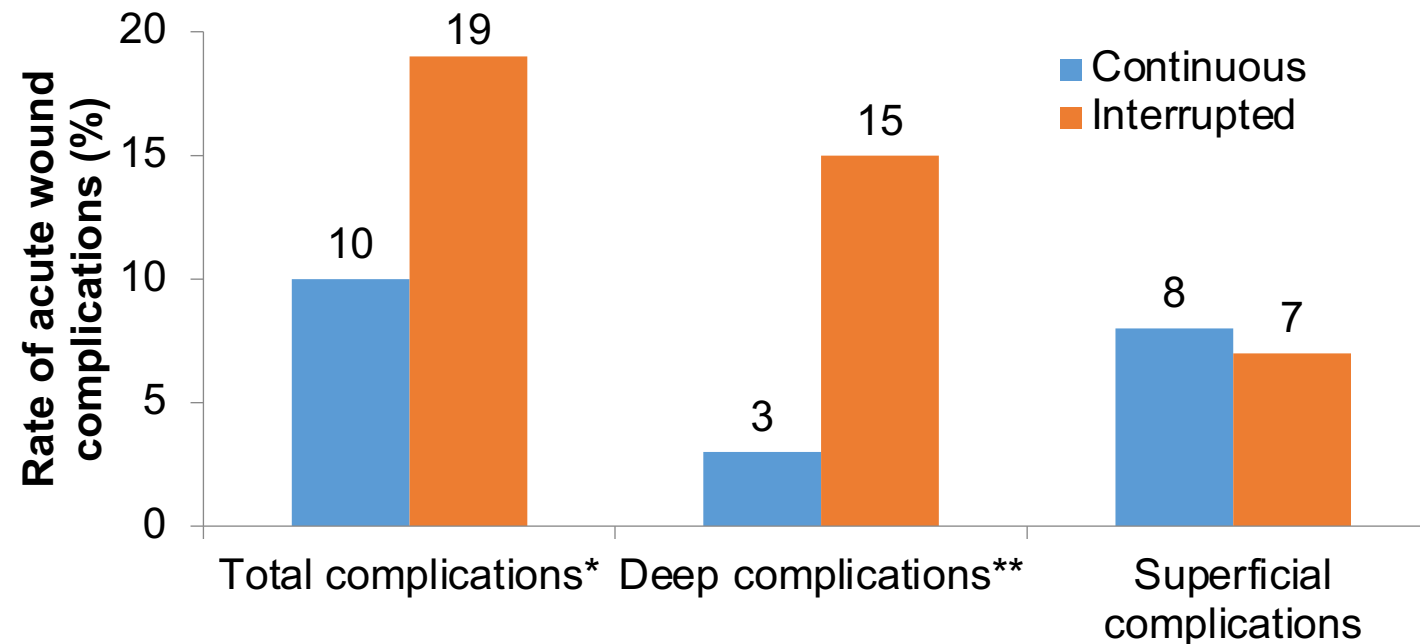
1. Diener et al. Ann Surg. 2010;251:843-56.

<sup>a</sup> Sutures were classified as non-absorbable, slowly absorbable, or rapidly absorbable. Specific products used included Maxon, Vicryl, PDS I, PDS II, Monoplus, Prolene, Nylon, Ethibond, and Dexon.

# Focus on High Risk Population: Obese Patients



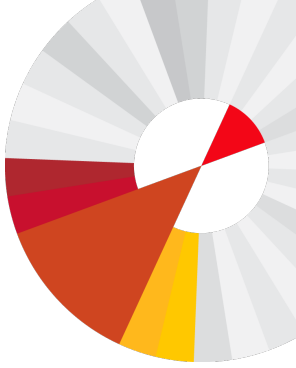
- Morbid obesity is a patient factor that increases the risk for acute wound complications
- In a randomized study of continuous vs. interrupted closure techniques in 331 gastric bypass surgeries.<sup>1</sup>



1. Derzie AJ et al. J Am Coll Surg. 2000;191:238-43.



# Suture Choice

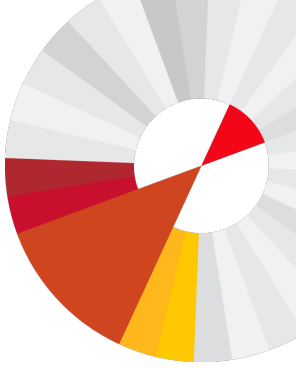


# Different Suture Materials Are Available For Fascia Closure

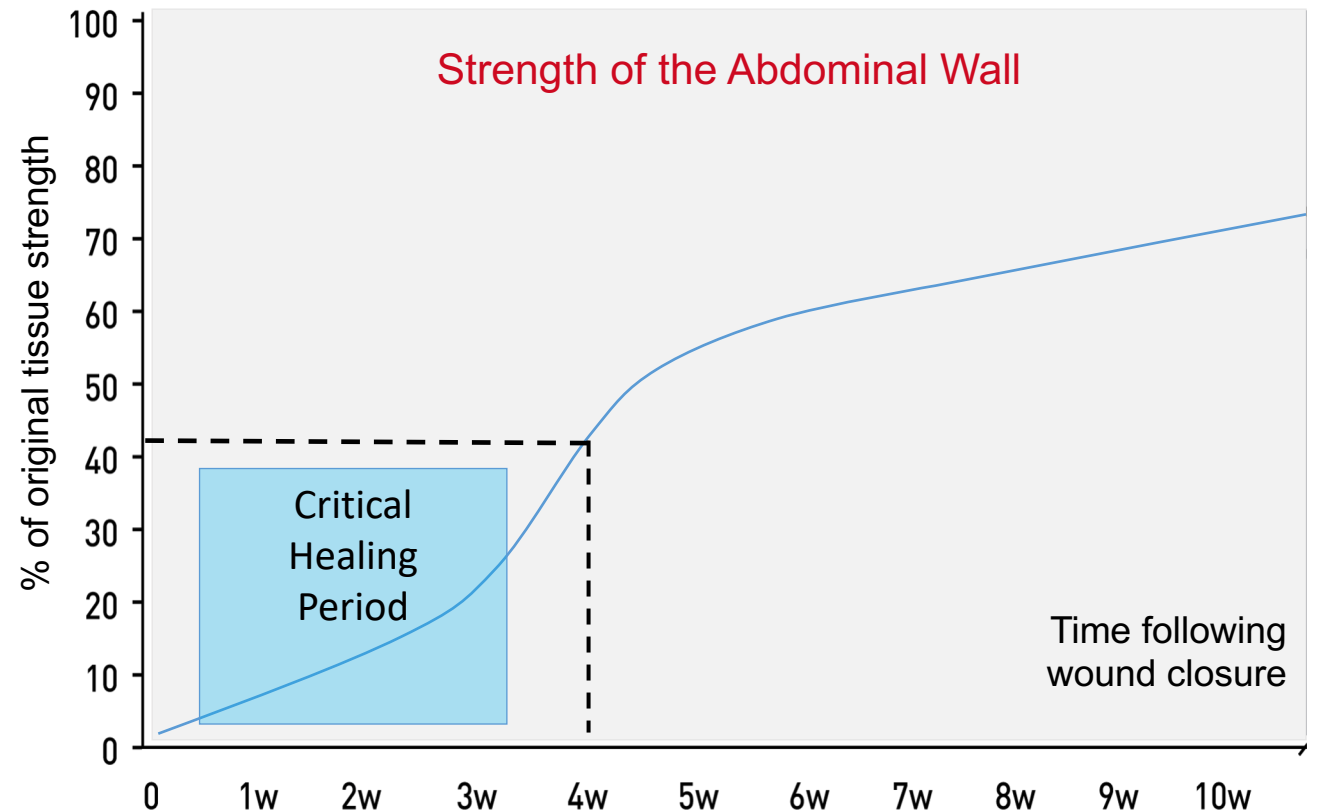
	Nonabsorbable	Rapidly Absorbable	Slowly Absorbable
Example suture materials	Nylon, polypropylene	Polyglycolic acid, polyglactin 910	Polyglyconate, polydioxanone
Clinically important characteristics	<ul style="list-style-type: none"><li>• Long-term wound support</li><li>• High foreign body response (i.e., encapsulation)</li></ul>	<ul style="list-style-type: none"><li>• Medium-term wound support</li><li>• Minimal tissue reaction</li></ul>	<ul style="list-style-type: none"><li>• Long-term wound support</li><li>• Minimal tissue reaction</li></ul>



# Suture Choice Is Crucial During Critical Healing Period

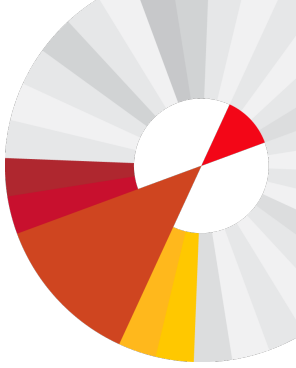


- Critical Healing Period
  - From 14–28 days, the healing fascia begins to have the strength to be self-supporting, but is still vulnerable to wound separation
  - Wound support from the suture continues to provide mechanical strength during this time frame

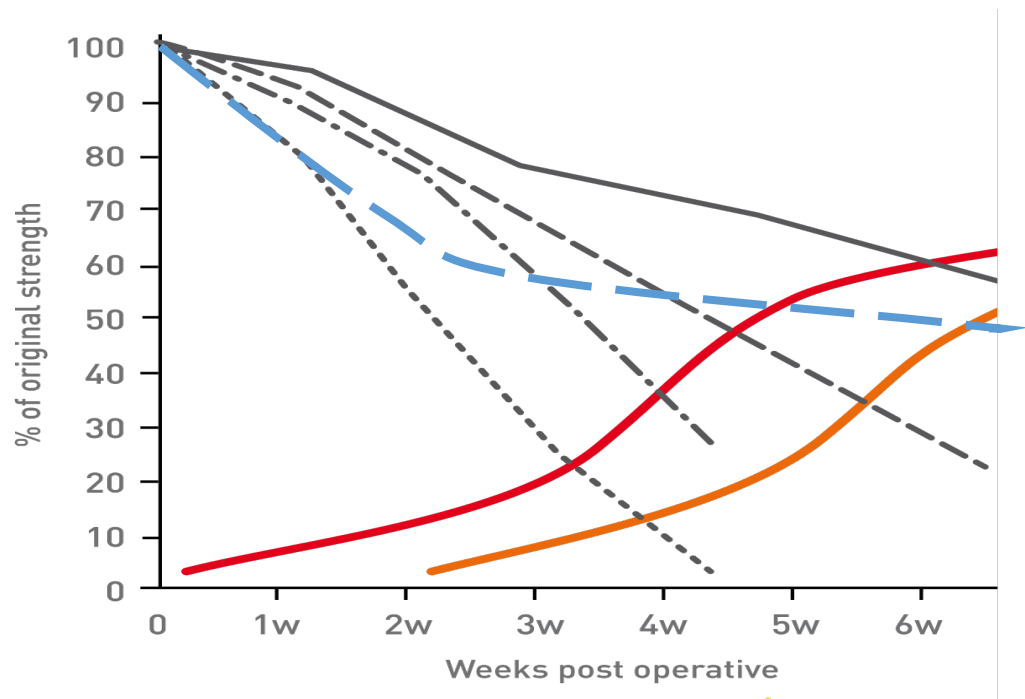




# Breaking Strength Retention Profile Of Suture Materials Vs. Wound Strength Of Healing Fascia



- At 4 weeks, fascia has regained only 40% of its original strength
- Rapidly absorbable sutures have lost the majority of their strength through hydrolysis
- Silk sutures, though long-lasting overall, have been observed to rapidly lose strength in vivo due to protein degradation during initial 2 weeks



Normal fascia healing (illustrative)

Delayed fascia healing (illustrative)

Polyglycolic acid

Polyglactin 910

Polyglyconate

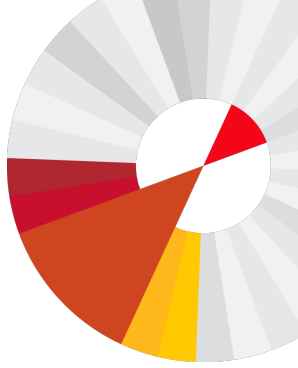
Polydioxanone

NOTE FOR REVIEWERS:  
 Blue dotted line = silk in vivo BSR based on papers:  
 Herrmann et al. Arch Surg 1973; 106: 707-10.  
 Karaca, et al. J Biomed Mater Res Part B 2008; 87B: 580-9.



# Suture material: Absorbable vs. Non-absorbable

## Clinical evidence



- In a meta-analysis that included 15 studies ( $n = 6,566$ )<sup>a</sup> and evaluated outcomes associated with different closure techniques for abdominal midline incisions,

Suture type	N	Incisional hernia (n)	Dehiscence (n)	Infection (n)	Suture sinus (n)	Wound pain (n)
Continuous Rapidly absorbable vs Nonabsorbable	379 372	60* 31	6 8	34 27	4* 23	25* 50
Continuous Slowly absorbable vs Nonabsorbable	1,330 1,339	119 117	17 17	106 107	12* 28	46* 85
Continuous Rapidly absorbable vs Slowly absorbable	379 370	60* 37	6 13	34 43	4 11	25 23
Interrupted Rapidly absorbable vs Nonabsorbable	59 102	0 6	0 1	6 7	0* 9	—

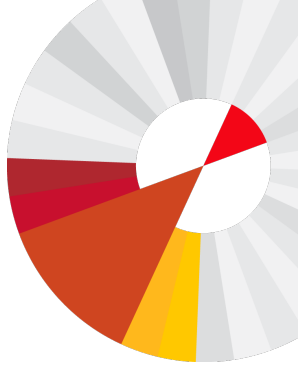
van't Riet M et al. Br J Surg. 2002;89:1350-6.

<sup>a</sup> Sutures were classified as nonabsorbable, slowly absorbable, or rapidly absorbable. Specific products used included Nylon, Maxon, Prolene, Vicryl, PDS, Dexon, Ethibond, and stainless steel.

\* $P < 0.05$ .

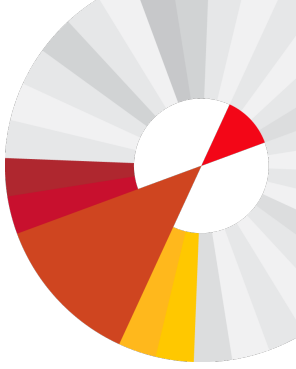


# Ideal suture for fascia closure: Clinical evidence



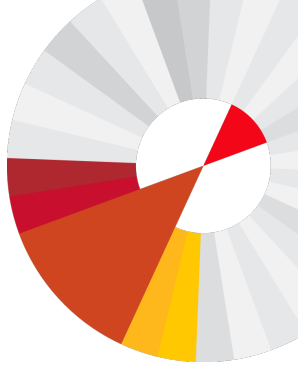
- A 2000 meta-analysis of 32 abdominal fascial studies published from 1966–1998 comparing absorbable and non-absorbable sutures found that
  - There was no difference in rates of incisional hernia between polydioxanone and polypropylene sutures
  - Polyglactin (rapidly absorbable) sutures showed higher incidence of incisional hernia
  - Non-absorbable polypropylene suture had increased occurrence of suture sinus and wound pain

# Ideal suture for fascia closure: Clinical evidence in obese patients

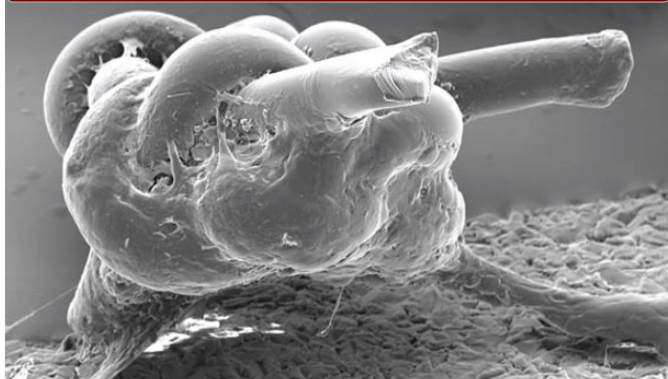


- A 1996 randomized clinical trial of 229 morbidly obese patients undergoing gastric surgery compared the incidence of complications between polydioxanone and polypropylene suture
  - Use of slowly absorbable polydioxanone suture resulted in significantly fewer incisional hernias vs. nonabsorbable polypropylene suture (10% vs. 18%,  $p \leq 0.04$ )

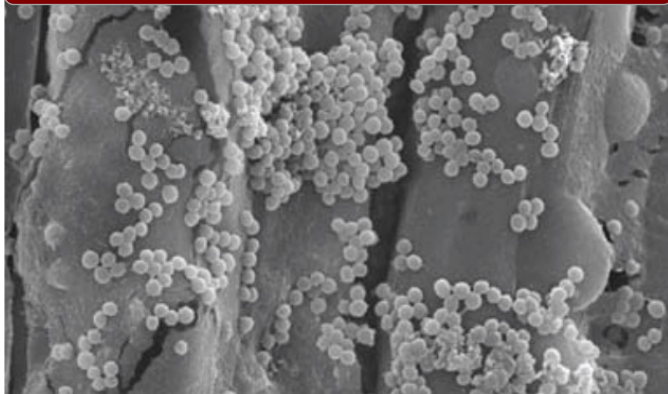
# Antibacterial Sutures: Rationale for Use



Colonization of a suture knot



Colonization of a braided suture



- Like all implants, sutures can be colonized by bacteria which lead to formation of biofilm<sup>1,2</sup>
- The biofilm on the suture is responsible for progress of chronic SSI requires long-term treatment<sup>3</sup> with substantial hi-costs

1. Mangram et al. Infect Control Hosp Epidemiol. 1999;20:250.
2. Henry-Stanley MJ, et al, Surg Infect (Larchmt). 2010;11(5):433-9.
3. Kathju S, Nistico L, Hall-Stoodley L, et al. Chronic surgical site infection due to suture-associated polymicrobial biofilm. Surg Infect (Larchmt). 2009;10(5):457-61.

# Preclinical studies: Antibacterial sutures combat bacterial colonization

- Antibacterial sutures coated with antiseptic compounds (e.g., triclosan/IRGACARE<sup>®</sup> MP) have been shown to:
  - Inhibit bacterial colonization of the suture *in vitro* for at least 7 days<sup>1\*</sup>
  - Be effective across a range of microbes *in vitro*<sup>2\*</sup>
    - *Staphylococcus aureus*, *Staphylococcus epidermidis* (MRSA, MRSE)
    - *Escherichia coli*, *Klebsiella pneumoniae*



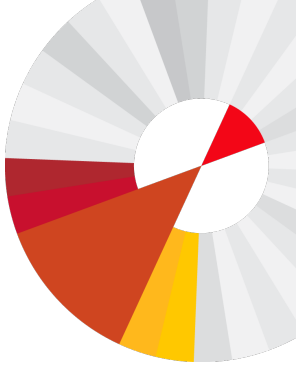
Antibacterial sutures create a zone of inhibition around the suture, demonstrated *in vitro*

1. Rothenburger et al. Surg Infect (Larchmt). 2002;3(suppl1):s79-87

2. Ming et al. Surg Infect (Larchmt). 2008;9:451-7;

\* Demonstrated in ETHICON MONOCRYL Plus and VICRYL Plus Sutures

# Clinical evidence for Plus Antibacterial Sutures is Growing

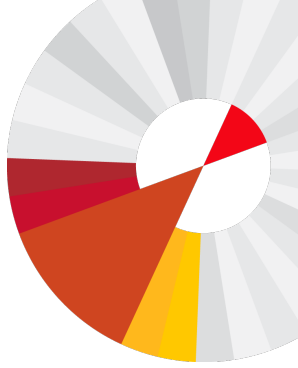


- Antibacterial sutures have been studied in 24 human clinical trials that included over 10,000 patients<sup>1</sup>
  - 22 studies performed independently of Ethicon
  - 10 randomized controlled trials (RCTs)

1. Data on file. Ethicon, Inc.  
2. APIC . Guide to the Elimination of Orthopedic Surgical Site Infections.  
[www.apic.org/downloads/ortho\\_guide.pdf](http://www.apic.org/downloads/ortho_guide.pdf). Accessed July 18, 2011



# Clinical evidence for Plus Antibacterial Sutures is Growing



Lead Author	Procedure	Ethicon Sponsored	RCT	Study Size (n)	Year
Williams	Breast		✓	150	2011
Galal	General Surgery		✓	450	2011
Zhang	Mastectomy	✓	✓	101	2011
Deliaert	Breast Reduction		✓	26	2009
Mingmalairak	Appendectomy		✓	100	2009
Zhuang	Laparotomy		✓	450	2009
Rozzelle	CSF Shunts		✓	84	2008
Justinger	Abdominal Wall		✓	2,088	2008
Defazio	Umbilical Incision		✓	93	2005
Ford	Pediatric Surgery	✓	✓	151	2005

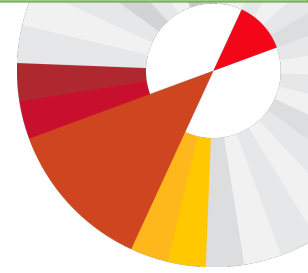
**Recent APIC Guidelines<sup>2</sup> note that “evidence-based clinical studies have demonstrated both the clinical and economic benefit of antimicrobial sutures”**

1. Data on file. Ethicon, Inc.
2. APIC . Guide to the Elimination of Orthopedic Surgical Site Infections. [www.apic.org/downloads/ortho\\_guide.pdf](http://www.apic.org/downloads/ortho_guide.pdf). Accessed July 18, 2011

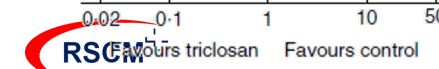
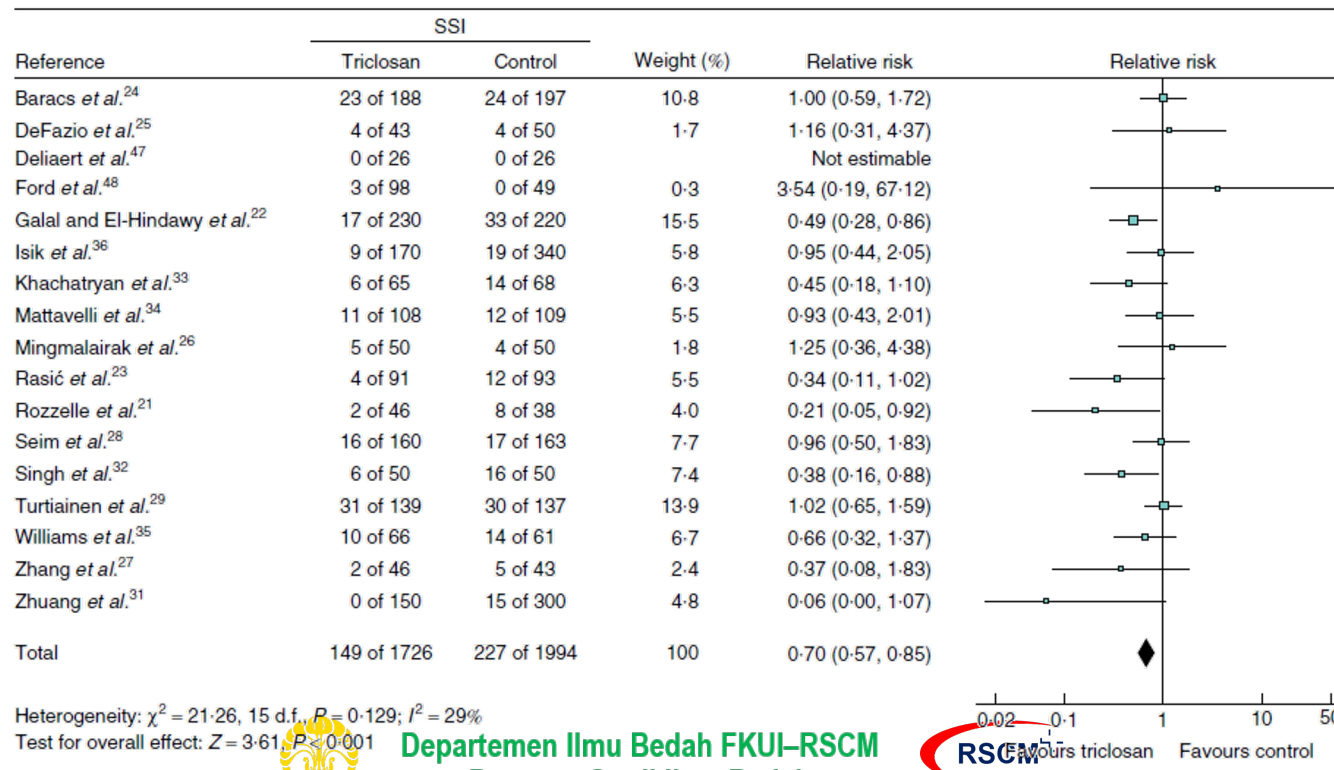




# Effectiveness of Antibacterial Sutures: Clinical Evidence



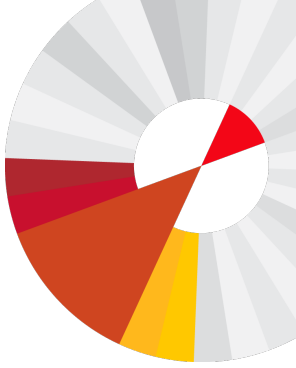
- In a recent 2013 meta-analysis of 17 trials (12 of the previous slide) across various surgical specialties found that
  - Triclosan antibacterial sutures had a lower relative risk (RR) of SSI vs. traditional (non-antibacterial) sutures (RR 0.70, 95% CI: 0.57 – 0.85,  $p < 0.001$ )



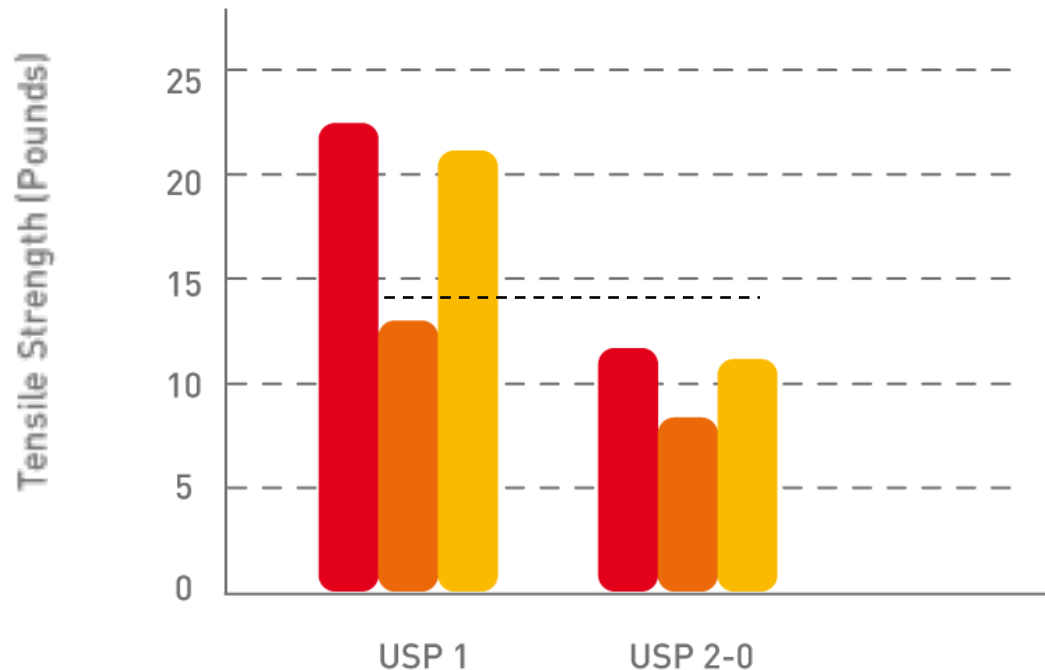


# Knotting technique

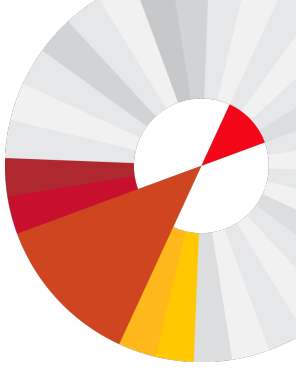
# Suture Knots



- The ideal suture knot has
  - High knot security
  - High knot efficiency (knot tensile strength: Straight tensile strength)
  - Minimal volume (to reduce foreign body response)
- Different knots have different knot efficiency

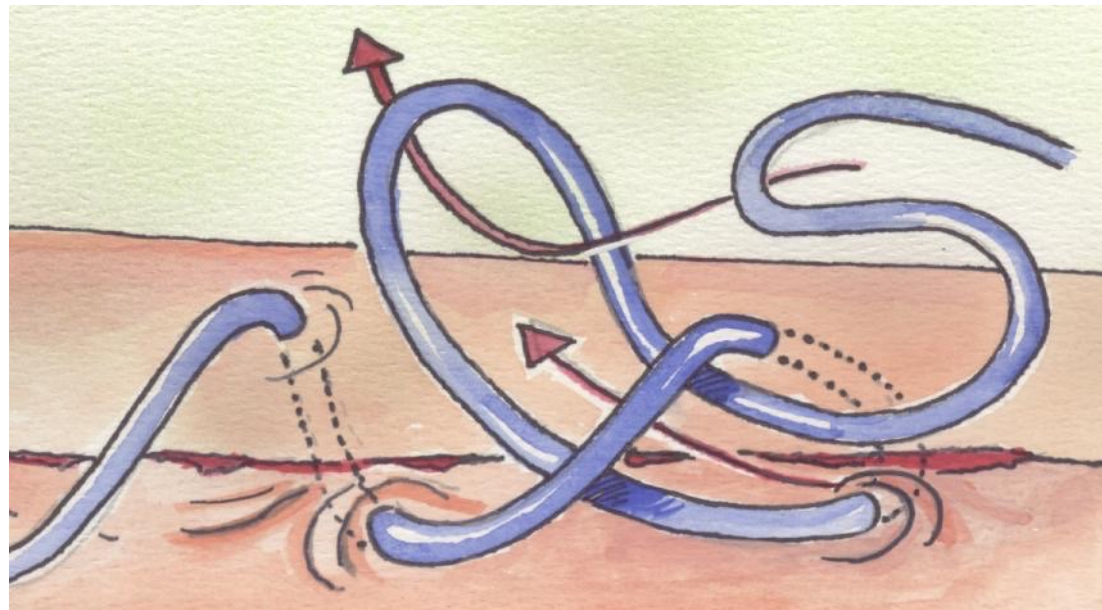
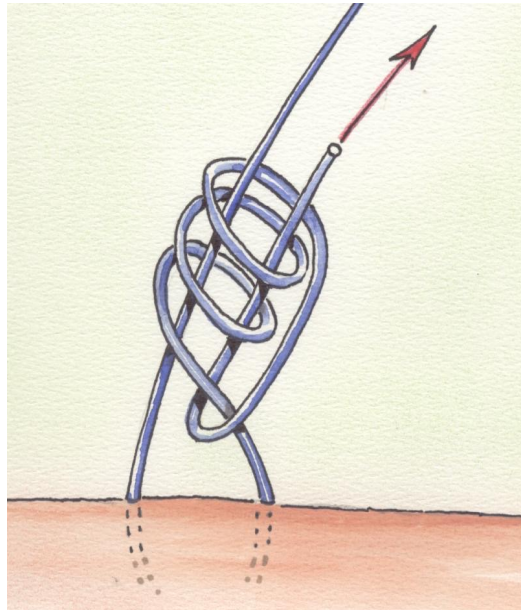


Tensile strength (USP 1)	%
Straight suture <sup>(2)</sup>	100%
Conventional knot <sup>(1)</sup>	58%
Self-locking knot <sup>(1)</sup>	94%



# Self-locking knot (1)

1. Does not slip
2. Minimal effect on suture strength
3. Small in volume





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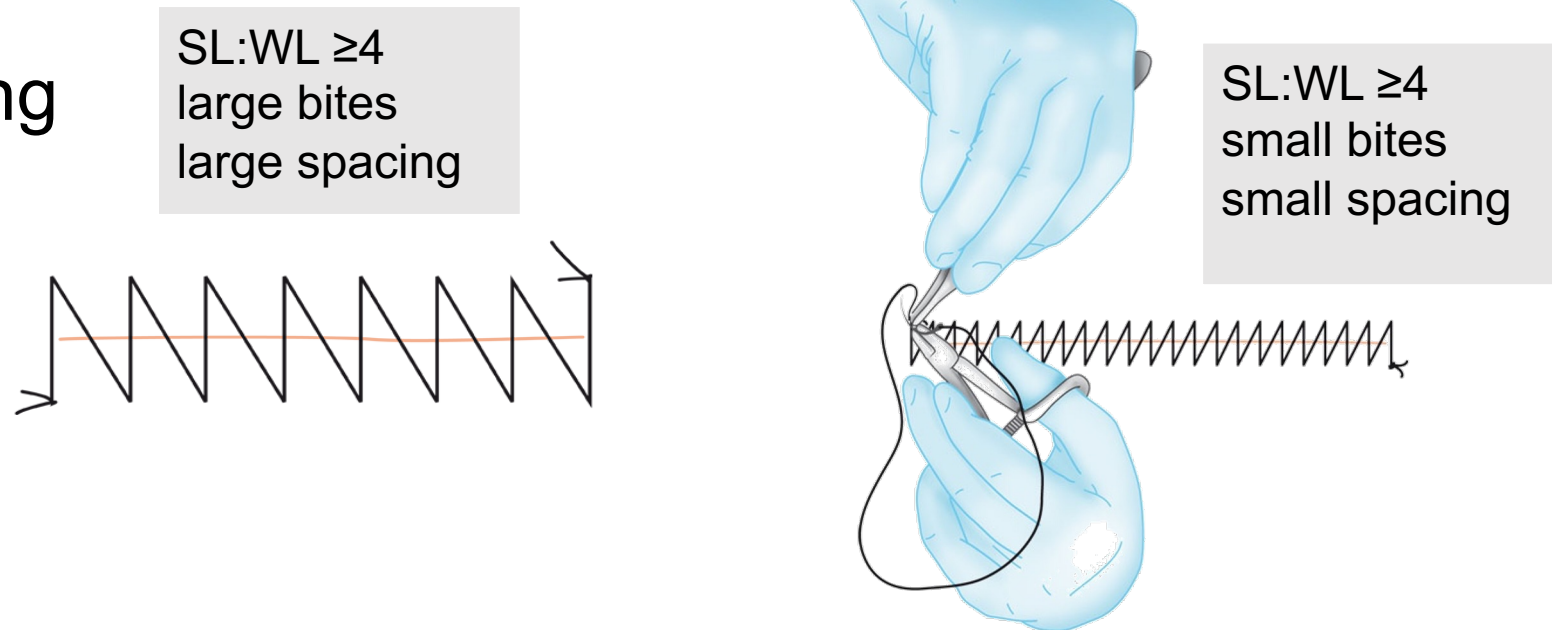


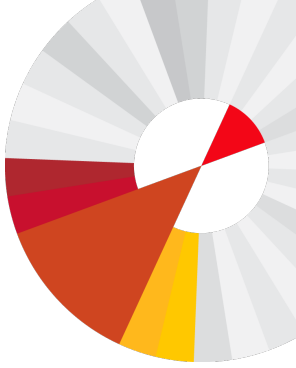
# Current Research in Further Improving Fascial Closure



# Technical Refinements of Continuous Suturing

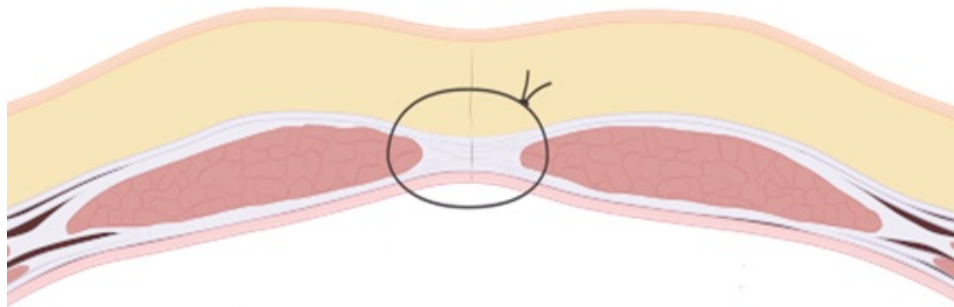
- The following technical factors for a continuous suture pattern can potentially have an influence on closure strength
  - Suture length to wound length ratio (SL:WL)
  - Bite size
  - Bite spacing



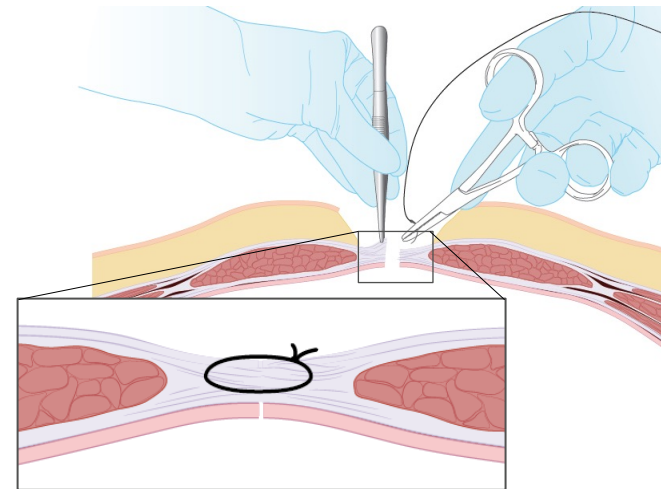


# Mass Closure vs. Aponeurosis Only Closure

- Clinical judgment is needed in between these approaches
  - The ideal closure method should provide adequate tensile strength and elasticity to accommodate increases in abdominal pressure during the postoperative period<sup>1,2</sup>

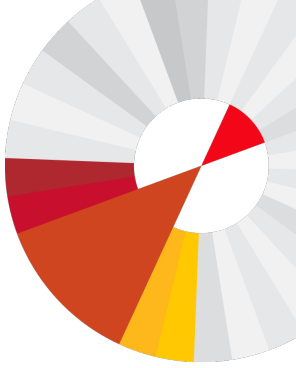


**Mass Closure**  
Closure of all layers of the abdominal wall together (except skin)



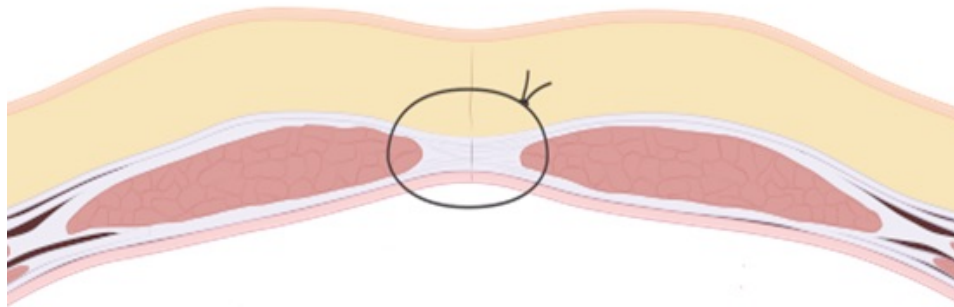
**Aponeurosis Only**  
Closure of aponeurosis alone

1. van't Riet M et al. Br J Surg. 2002;89:1350-6. 2. Cengiz Y et al. Eur J Surg. 2001;167:60-3.  
3. Weiland DE et al. Am J Surg. 1998;176:666-70. 4. Berretta R et al. Austral N Zealand J Obstet Gynecol. 2010;50:391-6.

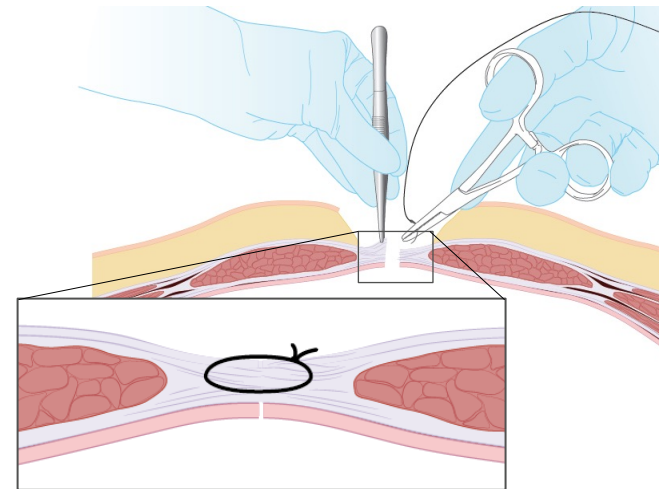


# Mass Closure vs. Aponeurosis Only Closure

- Clinical judgment is needed in between these approaches
  - Preclinical animal studies show aponeurosis only closure may have higher risk of wound separation under conditions of high intraabdominal pressure<sup>2</sup>



**Mass Closure**  
Closure of all layers of the abdominal wall together (except skin)



**Aponeurosis Only**  
Closure of aponeurosis alone

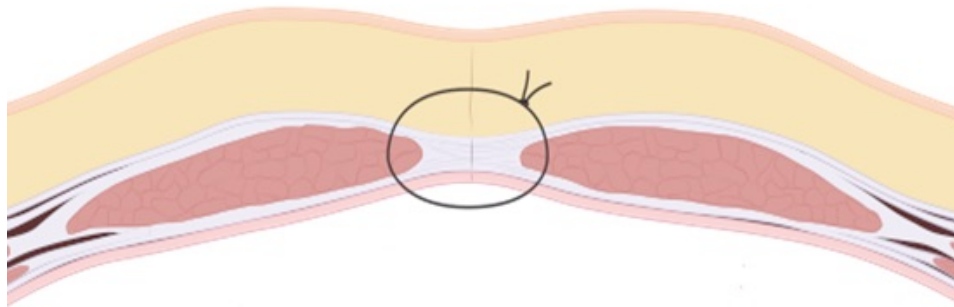
1. van't Riet M et al. Br J Surg. 2002;89:1350-6. 2. Cengiz Y et al. Eur J Surg. 2001;167:60-3.  
3. Weiland DE et al. Am J Surg. 1998;176:666-70. 4. Berretta R et al. Austral N Zealand J Obstet Gynecol. 2010;50:391-6.



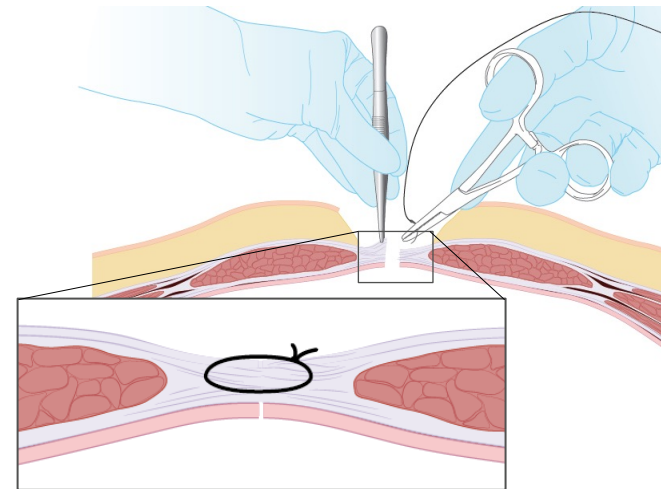


# Mass Closure vs. Aponeurosis Only Closure

- Clinical judgment is needed in between these approaches
  - Clinical evidence shows that for gynecologic cancer surgery, mass closure may be preferred due to lower pain and complication risks<sup>3,4</sup>



**Mass Closure**  
Closure of all layers of the abdominal wall together (except skin)



**Aponeurosis Only**  
Closure of aponeurosis alone

1. van't Riet M et al. Br J Surg. 2002;89:1350-6. 2. Cengiz Y et al. Eur J Surg. 2001;167:60-3.  
3. Weiland DE et al. Am J Surg. 1998;176:666-70. 4. Berretta R et al. Austral N Zealand J Obstet Gynecol. 2010;50:391-6.



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RSCM<sup>1</sup>

# Evidence-Based Best Practices In Fascia Closure

# Evidence-based Recommendations for Fascia Closure



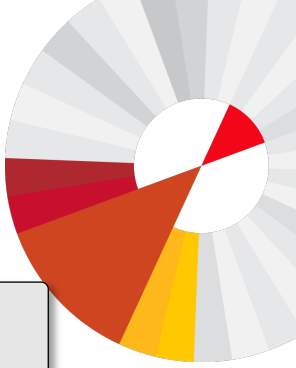
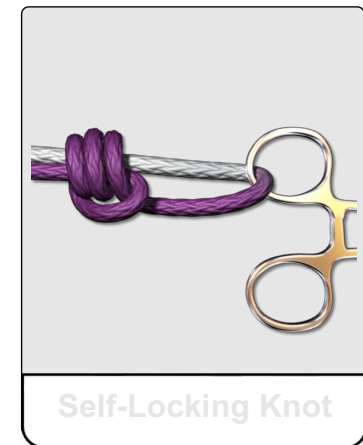
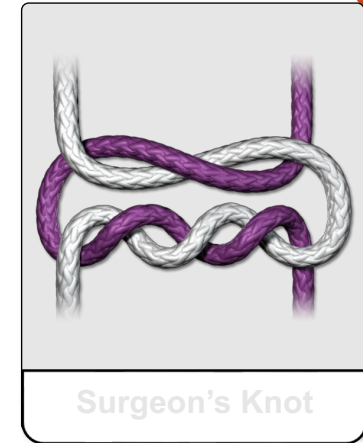
- Based on a rigorous review of the available clinical evidence, the ideal fascial closure method to optimize patient outcomes is composed of:
  - Continuous suture pattern
  - Slowly absorbable suture
    - Antibacterial suture to prevent colonization
- These methods represent the best choices for a surgeon to address the risk factors for a wound complication and maximize the potential for optimal clinical outcomes
- Additional refinements to fascial closure technique are currently being researched in the literature. However, no recommendations can be made.



# The Evolution of Wound Closure: Anchored Tissue Control Devices

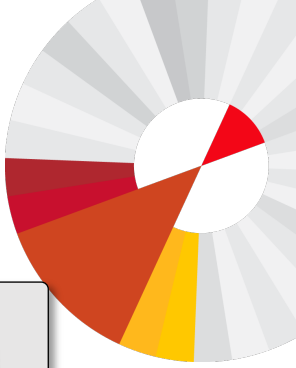
# Suture Knot: Site of Mechanical Weakness

- The knot is the weakest point of the suture line
  - In vitro testing found that a knot significantly reduces the tensile strength of a suture by up to 65%.<sup>1,2</sup>
  - Laboratory tests on hand-tied and arthroscopic knots have shown that suture failures occur at the knot (knot breakage or unraveling)<sup>3,4</sup>

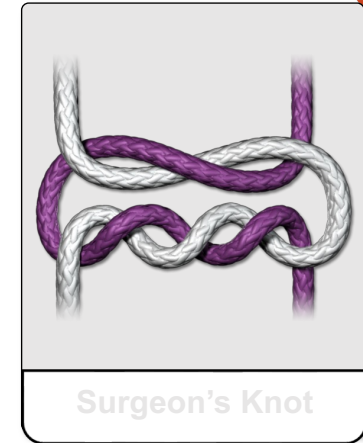


1. Trimpos, et al. Obstet Gynecol 1984;64:274-80.
2. Stone, et al. Surface Coatings Tech 1986;27:287-93.
3. Elkousy, et al. Arthroscopy 2005; 21:204-10.
4. Muffly, et al. J Surg Edu 2011;68:29-31.
5. Good, et al. J Surg Edu 2012, e-publication.
6. Van Sickle, et al. J Am Coll Surg 2008; 207:560-8.
7. Verdaasdonk, et al. Surg Endosc 2008; 22:1636-42.

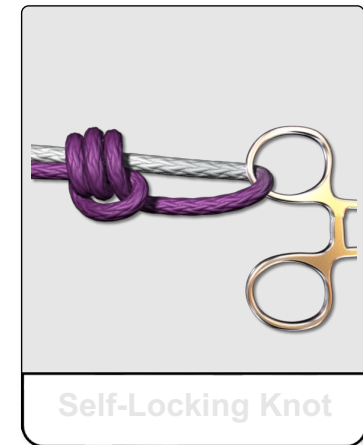
# Suture Knot: Site of Mechanical Weakness



- Different knots and inconsistent knot tying can further compromise mechanical strength
  - Quality of knot tying can vary with experience and practice<sup>5,6,7</sup>
  - The same knot may have different security in different suture materials<sup>2</sup>
  - Different endoscopic knots require different numbers of reinforcing half-hitches for maximal security<sup>3</sup>



Surgeon's Knot



Self-Locking Knot

1. Trimpos, et al. Obstet Gynecol 1984;64:274-80.
2. Stone, et al. Surface Coatings Tech 1986;27:287-93.
3. Elkousy, et al. Arthroscopy 2005; 21:204-10.
4. Muffly, et al. J Surg Edu 2011;68:29-31.
5. Good, et al. J Surg Edu 2012, e-publication.
6. Van Sickle, et al. J Am Coll Surg 2008; 207:560-8.
7. Verdaasdonk, et al. Surg Endosc 2008; 22:1636-42.

# Anchored Tissue Control Devices Remove The Need For Knots

- Anchored Tissue Control Devices have anchors (or “barbs”) engineered along the core, either pressed out of the core in a symmetric pattern or formed within the core in a pattern
- Anchors engage the surrounding tissue which secures the device in place on each pass and eliminates the need for knots
- Devices are deployed using a continuous technique, significantly faster than interrupted suturing



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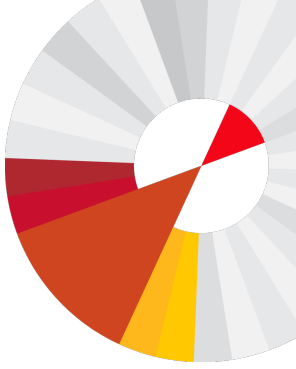
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# Conclusions

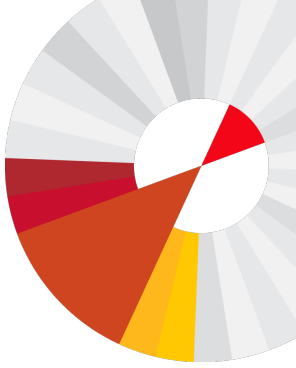




# Conclusions

- Choice of closure technique is one of the factors under a surgeon's control to improve healing and reduce the risk of wound complications
- The choice of fascia closure starts with an understanding of fascia healing and the critical healing period
- A continuous suturing pattern appears to represent the optimal suturing technique for abdominal fascia closure

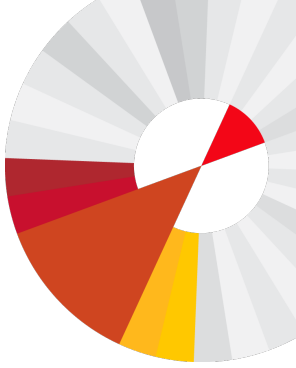




# Conclusions

- Slowly absorbable sutures offer wound support during and after the critical healing period, leading to:
  - Comparable outcomes to non-absorbable sutures
  - Reduced risk of pain and suture sinus vs. non-absorbable sutures
  - Reduced risk of incisional hernia vs. rapidly absorbable sutures
- Antibacterial sutures are another tool in the surgeon armamentarium to reduce microbial colonization, addressing a risk factor for surgical site infections
- Anchored tissue control devices are the next evolution of wound closure devices and offer new benefits over traditional sutures





# End of modules: Thank You

