Wound Healing & Dehiscence

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Case Presentation

- **HPI:** 87yo male with multiple medical problems presented to ED 1/26/2017 with left lower extremity weakness x 1 day. Patient reported recent fall 8/2016 requiring hospitalization at OSH, at which time 2 colonic masses were discovered on CT A/P. No further work-up was performed in light of his other co-morbidities.

- **PMHx:** TIA, anemia, GERD, depression, known colonic masses, and frequent falls
- **PSHx:** Cholecystectomy
- **Social Hx:** Former cigarette smoker and drinker, denies illicit drug use
- **Allergies:** NKDA
- **Medications:** Flomax, Citalopram, Finasteride, Omeprazole
Case Presentation

• **Vital Signs**: 98F 135/67 78 20 100%
• **Exam**:
  • General – cachectic, NAD
  • Abd – soft, NT/ND
  • DRE – no gross blood
• **Labs**:
  • 7.7>6.9/25.2<256
  • 146/4.5/113/25/27/0.9<96
  • 5.4/2.7/14/12/78/0.2
  • 14.4/1.1
Case Presentation

• CT A/P
  • Circumferential apple core lesion at cecum
  • Colo-colonic intussusceptions at hepatic flexure with a suspected leading mass
Case Presentation

• Anemia → 1U pRBC transfusion
• Colonoscopy
  • 7-8cm near-occlusive fungating mass 75cm from the anal verge
    • Bx – moderately differentiated adenocarcinoma
  • 3.5cm sessile polyp 65cm from the anal verge
    • Bx – tubular adenoma
Case Presentation

• OR: Exploratory laparotomy, right hemicolecotomy and ileostomy creation
  • Abdominal wall closure
    • #1 loop PDS in running fashion
    • Retention sutures
  • EBL 100cc, 1600cc IV fluids, UOP 150cc
  • Extubated
  • Transferred to the SICU
Case Presentation

• POD#1-2
  • NG tube removed
  • Clear liquid diet
  • Transferred to floor

• POD#3-4
  • Persistent nausea
  • Midline wound – serosanginous drainage
Case Presentation

• POD#5
  • 102.3F  HR 120’s → fever work up
    • UTI – E coli
    • CXR – left-sided patchy parenchyma
    • CT chest – pneumonia
    • CT A/P – ileus with minimal ascites
  • IV antibiotics
  • NG tube placed – 500cc bilious output
  • Return to SICU
Case Presentation

• POD#6-7
  • Intubated for respiratory distress
  • WBC 25
  • Anemia - Hb 10 to 6.8 → transfused 3U pRBC and 2U FFP
  • INR of 1.9 → Vitamin K

• POD#8
  • Bronchoscopy
    • BAL – MRSA and yeast
  • Low dose Levophed + Hydrocortisone
Case Presentation

• POD#10-15
  • Continued low-dose pressors + Hydrocortisone
  • High output ileostomy → fluid bolus replacements
  • Midline wound – copious serous drainage

• POD#16
  • WBC 34
  • CT chest/A/P
    • Left pleural effusion → pigtail catheter placement
    • Loculated RUQ 13.3x6.6x7.7cm fluid collection
  • Midline wound – Inferior retention appeared ischemic → removed at bedside
Case Presentation

• POD#17
  • Midline wound – evicерation
  • → bowel reduced and the skin overlying the bowel was closed at bedside
Case Presentation

• POD#18
  • OR – Exploratory laparotomy, abscess drainage, abdominal wall closure with mesh, tracheostomy, and PEG placement
  • Abdominal cultures – Acinetobacter
  • WBC normalized
Case Presentation

- **POD#25/7**
  - Coffee ground-like output noted in the NG tube
  - Anemia - Hb 9 to 6 → transfused 3U pRBC
  - Brown sputum from tracheostomy → bronchoscopy
    - BAL – Acinetobacter
- **POD#27-49/9-31**
  - Sepsis – febrile, WBC 11-17
  - CT chest – large pleural effusions
    - Pigtail/chest tube
  - CT A/P – multiple intra-abdominal abscesses
    - IR drainage
    - Antibiotics
  - JP drain – feculent output
Case Presentation

• POD#42/24
  • PEA → ACLS with ROSC
  • DNR
• POD#49/31
  • Expired
Case Presentation
Wound Healing & Dehiscence

- Terminology
- Clinical Presentation
- Etiology
- Wound healing
- Patient risk factors
- Post-operative risk factors
- Operative risk factors
- Management
Terminology

• **Incisional hernia**
  • Separation of fascia after skin is well-healed

• **Dehiscence**
  • To split along a natural or surgical line; separation of any or all 3 layers before skin is well-healed

• **Evisceration**
  • To disembowel; to protrude through a surgical incision or suffer protrusion of a part through an incision
Clinical Presentation

• 7-14 days post-op
• Salmon pink serous drainage 85%
• Reports ripping sensation
• Increased intra-abdominal pressure – coughing, vomiting, stooling
Etiology

• Failure of wound healing
Wound Healing

Day 1 to 3
- **Hemostasis**: Stop Bleeding

Day 3 to 20
- **Inflammation**: New frame work for blood vessel growth
- **Pulls the wound closed**

Week 1 to 6
- **Proliferation or Granulation**

Week 6 to 2 Years
- **Final proper tissue**
- **Remodeling or Maturation**
Wound Healing – Hemostasis

- 5-10 minutes
- Capillary dilation to increase blood flow to wound
- Then constriction of vessel
- Platelet aggregation and fibrin clot formation
- Complement cascade – CK and GF
Wound Healing – Inflammation

• Platelet granules
  • Alpha – PF4, beta-thrombomodulin, PDGF, TGF-beta
  • Dense – adenosine, serotonin, calcium

• PMN aggregation – day 0-2

• Macrophage aggregation – day 3-4
Wound Healing – Proliferation

• Day 3-60
• Neovascularization
• Epithelialization
• Collagen synthesis
  • Fibroblasts
  • Collagen type III
  • Peaks at day 21
  • Requires oxygen, vitamin C, iron, alpha-KG
• Myofibroblast
  • Contraction
  • Abundant actin microfilaments
Wound Healing – Maturation

- Day 7 – 1 year
- Continuous collagen deposition and replacement
  - Collagen type III $\rightarrow$ type I
    - 4:1 ratio
    - Same total collagen overall
  - Improve tensile strength
Wound Healing

**Inflammation**
4 - 6 Days
The body sends fluids to the injury site to clean and prepare for healing

**Proliferation**
4 - 60 Days
The healing phase, the body works to mend the injured area and grow new tissue

**Remodeling**
60 Days - 2 Years
New nerve endings grow, tissue continues to rearrange, scar regains ability to stretch
Wound Healing

• Strength
  • At 6 weeks
    • 80% of maximal strength
  • At 8 weeks
    • 80% of original strength
    • 100% maximal strength
• Retrospective multi-center review
• 429,906 operations 1985-2005
  • Excluded – appendectomy, non-surgical operations
• 363 cases of dehiscence
• 1089 selected control cases
• Management
  • 61 treated with NOM
  • 302 treated operatively
• Results
  • Occurrence
    • Mean - day 9 (0-32 days)
    • 90% prior to 15 days
  • Etiologies
    • Sutures tearing 29%
    • Infection 9%
    • Broken suture 8%
    • Necrotic fascia 6%
    • Loose knots 4%
    • Unknown 44%

• Outcomes
  • Prolonged hospital stay – 36 v 16d
  • Higher incidence of incisional hernias
  • Mortality – 22 v 9%
Abdominal Wound Dehiscence in Adults: Development and Validation of a Risk Model

Gabriëlle H. van Ramshorst · Jeroen Nieuwenhuizen · Wim C. J. Hop · Pauline Arends · Johan Boom · Johannes Jeekel · Johan F. Lange

• Independent risk factors
  • Age
  • Gender
  • Hypertension
  • COPD
  • Ascites
  • Uremia
  • Jaundice

• Anemia
• Emergency setting
• Type of surgery
• Operative time
• Post-operative coughing
• Wound infection
• Sepsis
• Steroids
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Risk model

\[ P = \frac{e^x}{1 + e^x} \times 100\% \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Risk score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age category, years</td>
<td></td>
</tr>
<tr>
<td>40–49</td>
<td>0.4</td>
</tr>
<tr>
<td>50–59</td>
<td>0.9</td>
</tr>
<tr>
<td>60–69</td>
<td>0.9</td>
</tr>
<tr>
<td>&gt;70</td>
<td>1.1</td>
</tr>
<tr>
<td>Male gender</td>
<td>0.7</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>0.7</td>
</tr>
<tr>
<td>Ascites</td>
<td>1.5</td>
</tr>
<tr>
<td>Jaundice</td>
<td>0.5</td>
</tr>
<tr>
<td>Anemia</td>
<td>0.7</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>0.6</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
</tr>
<tr>
<td>Gallbladder/bile duct</td>
<td>0.7</td>
</tr>
<tr>
<td>Esophagus</td>
<td>1.5</td>
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<tr>
<td>Gastroduodenum</td>
<td>1.4</td>
</tr>
<tr>
<td>Small bowel</td>
<td>0.9</td>
</tr>
<tr>
<td>Large bowel</td>
<td>1.4</td>
</tr>
<tr>
<td>Vascular</td>
<td>1.3</td>
</tr>
<tr>
<td>Coughing</td>
<td>1.4</td>
</tr>
<tr>
<td>Wound infection</td>
<td>1.9</td>
</tr>
</tbody>
</table>
• Risk model – EP
  • $1.1 + 0.7 + 1.5 + 0.7 + 1.4 + 1.9$
  • Total $(x) = 7.3$
  • $P = \frac{e^x}{(1+e^x)} \times 100\%$
  • $P = \frac{e(-8.37+(1.085\times7.3))}{(1+e(-8.37+(1.085\times7.3)))} \times 100\%$
  • $P = 61\%$ risk of dehiscence
Risk Factors – Patient

• Age
  • <45yo 1.3% versus >45yo 5.4%

• Gender
  • Males x 2> females

• Malnutrition
  • Albumin <3 mg/dl
  • Vitamin C deficiency - 8-fold risk

• Anemia

• COPD
Risk Factors – Patient

• Uncontrolled diabetes
  • Controlled DM is not a risk factor
• Malignancy
• Sepsis
• Renal failure
• Medications
  • Chemotherapy
  • Radiation – fibroblast function
  • Steroids
  • Immunomodulators – azathioprine
Risk Factors – Patient

• Steroids
  • Inhibition of inflammatory phase
  • Inhibit epithelialization and contraction
  • Reduce collagen synthesis
  • Reduce wound strength

• Radiation
  • Acute occlusion of small blood vessels
  • Permanent alteration of fibroblast function
  • Dose-dependent
    • <300cGy – insignificant
    • >1000cGy – impairs healing
    • >4500cGy – complications
  • Time-dependent
    • Pre-op WITHIN 1 week – insignificant
    • Post-op – acceptable
Risk Factors – Post-operative

• Wound infection
• Wound hematoma
• Intra-abdominal infection

• Intra-abdominal pressure
  • Aggressive resuscitation
  • Coughing
  • Vomiting
  • Straining
  • Urinary retention
  • Ileus
  • Edema
Risk Factors – Operative

- Intra-abdominal spillage/infection
- Incision
- Closure
Risk Factors – Operative

- Intra-abdominal spillage/infection
- Incision
- Closure
- Prolonged inflammatory phase of wound healing
- Continuous cytokine release
Risk Factors – Operative

- Intra-abdominal spillage/infecCon
- Incision
- Closure

- Less analgesia required
- Less pulmonary dysfunction
- Fewer wound dehiscence
- Fewer incisional hernias
- Transverse laparotomy?
Risk Factors – Operative

- Intra-abdominal spillage/infection
- Incision
- Closure

- Bite size
- Suture technique
- Suture material
- Suture length – Jenkin’s rule
- Layers
- Retention sutures
Closure

• Bite size – STITCH trial
  • Large 1cm bites 21%
  • Small 0.5cm bites 13%

• Suture technique – INSECT trial
  • Interrupted vicryl 15.9%
  • Continuous monoplus 12.5%
  • Continuous PDS 8.4%
Closure – Suture Material

• Abdominal wall healing time
  • 42 days – 50% original strength
  • 120 days – 70-80% original strength
  • 140 days – 73-93% original strength

• Non-absorbable
  • More pain and suture sinuses

• Absorbable – 180 days
  • Higher infection rates

• No difference in outcome
Closure – Jenkin’s Rule

• Length of suture must accommodate to incision size
  • Increase post-operatively

• 4:1 ratio suture-to-wound length
  • Do not tug!

• 1cm bites – 1cm apart.....
Closure – Layers

• Mass closure – 1% dehiscence
• Layered closure – 11% dehiscence
  • More adhesions
  • Longer operative time
  • Tension on each layer
• Peritoneal closure
  • No difference
Closure – Retention Sutures

- Wide interrupted bites
- Heavy non-absorbable suture
- 3cm from wound edge – 3cm intervals
- Plastic/rubber tubing to prevent suture erosion
- Not too tight!
- Leave for 3 weeks
Closure – Retention Sutures

• Outcomes
  • No difference in wound infection
  • No difference in incisional hernia
  • Prevents evisceration in high-risk patients
Management of Dehiscence

- Unstable + evisceration
  - OR
  - Gauze and sterile occlusive dressing, binder
  - Delayed hernia repair

- Unstable, no evisceration
  - OR
  - No problem

- Stable + evisceration
  - OR
  - No problem

- Stable, no evisceration
  - No problem
Summary

• 4 phases of wound healing are hemostasis, inflammation, proliferation and remodeling.
• First cell to appear in wound healing is platelet.
• First inflammatory cell to appear in wound healing is PMN.
• Wound healing is complex and delicate process and affected by many factors, including patients’ conditions and surgical decisions.
  • Bite size matters
  • Suture technique matters
  • Suture type does not
Which of the following statements about the effects of radiation therapy on wound healing is NOT true?

• A – Radiation therapy in an operative field give one week post-operatively increases the incidence of wound dehiscence.
• B – previously irradiated skin will blister if the patient is treated with Doxorubicin/Adriamycin
• C – single dose of 300 cGy given preoperatively does not significantly affect wound healing
• D – radiation causes occlusion of small blood vessels and permanently alters fibroblast function.
• E – patients treated pre-operatively with 4500cGy have a greater risk of wound complication than non-irradiated patients undergoing APR.
Which of the following has been shown to reverse the corticosteroid-induced inhibition of wound healing?

• A – Vitamin A
• B – Bromelian
• C – Eicosapentaenoic acid
• D – Garlic
• E – Vitamin E
Thank you!
References