



Flaps, VACs and Reconstructive Surgery:

A Plastic Surgeon's Perspective

Noah Prince, MD

Chief Resident

University of Florida Plastic and Reconstructive Surgery



Introduction

Who is this guy?

- Originally from PA
- Worked as an EMT and Paramedic while in school (PA, NC, VA)
- Medical school at EVMS and Tufts
- First Integrated (6-year) Plastic and Reconstructive Surgery Resident
 - A lot of time with our Wound / Ostomy Team
- Graduating in 1 month and heading back to PA
- Interested in all aspects of plastic surgery
 - Wound care, craniofacial, breast reconstruction, hand, microsurgery, lower extremity reconstruction, aesthetic surgery



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UF Wound and Ostomy Team

Jennifer Bart, MSN, RN, CWOCN



Michele Barrios, BSN, RN, CWOCN



Randy Brian, BSN, RN, CWON



Aimee Sheddin, BSN, CWOCN, CFCN



Laura Brezinski MSN, ARNP



Mary Coons, MSN, RN, CWCN, COCN



(Back by popular demand) PBN

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Introduction – Pressure Wounds – Abdominal Wall – Skull Defects – Conclusions

Three different body regions...

Three different forms of reconstruction...

Pressure wounds → Flap based coverage

Abdominal wall reconstruction → Rebuilding after loss-of-domain

New innovations for VAC therapy → Open calvarial (skull) wounds

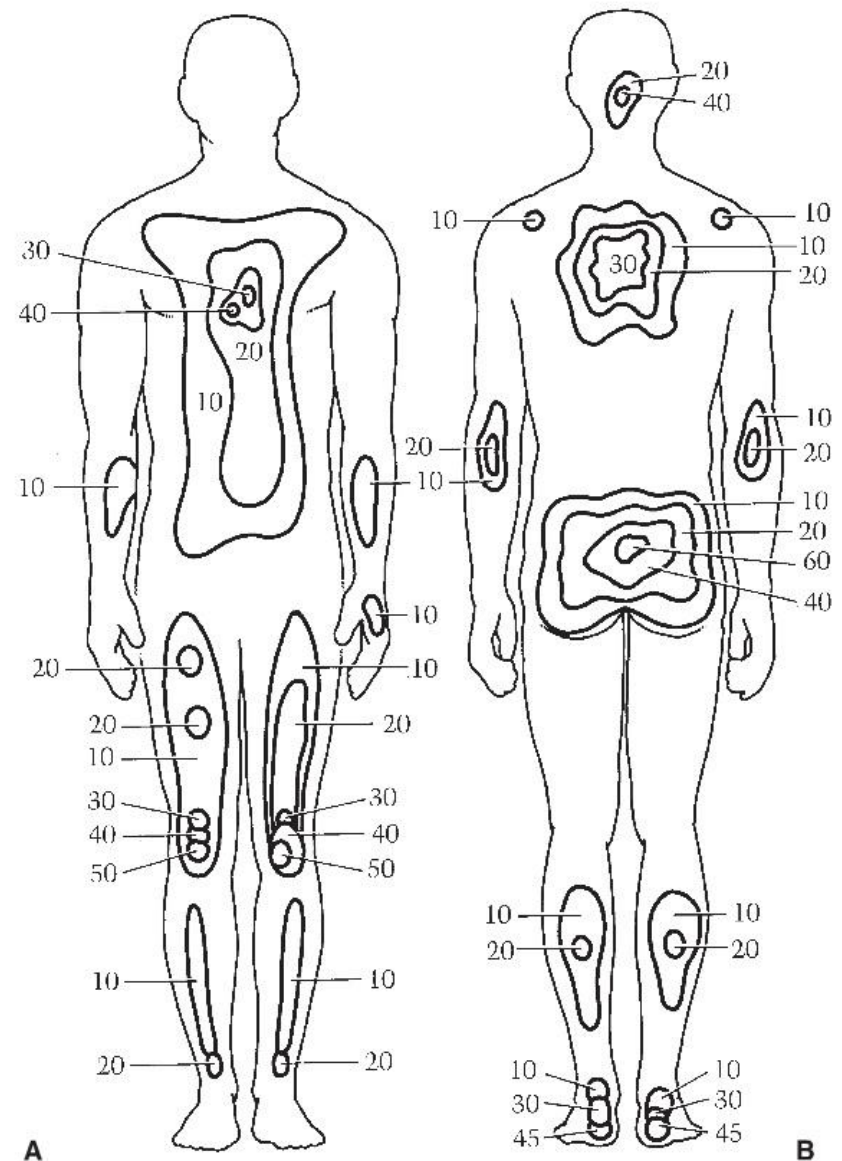












Pressure Wounds

Risk Factors For Pressure Wounds

- Hospitalized patients (9%)
- Paraplegia / Immobility
- Nursing home patients
- Increased age
- Male sex
- Impaired sensory perception
- Moisture
- Arkansas registry study: smoking, suicidal behaviors, EtOH / drug use, underweight
- Relationship between time and pressure.
- Norton and Braden scales 70-90% sensitivity for patient identification



National Pressure Ulcer Advisory Panel - Classification

DEFINITION	SCHEMATIC DRAWING	EXAMPLE
<p>STAGE 1 PRESSURE INJURY Non-blanchable erythema of intact skin Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes. Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury.</p>		
<p>STAGE 2 PRESSURE INJURY Partial-thickness skin loss with exposed dermis Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present. These injuries commonly result from adverse microclimate and shear in the skin over the pelvis and shear in the heel. This stage should not be used to describe moisture associated skin damage (MASD) including incontinence associated dermatitis (IAD), intertriginous dermatitis (ITD), medical adhesive related skin injury (MARSi), or traumatic wounds (skin tears, burns, abrasions).</p>		
<p>STAGE 3 PRESSURE INJURY Full-thickness skin loss Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present. Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds. Undermining and tunneling may occur. Fascia, muscle, tendon, ligament, cartilage or bone are not exposed. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury.</p>		
<p>STAGE 4 PRESSURE INJURY Full-thickness loss of skin and tissue Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury.</p>		

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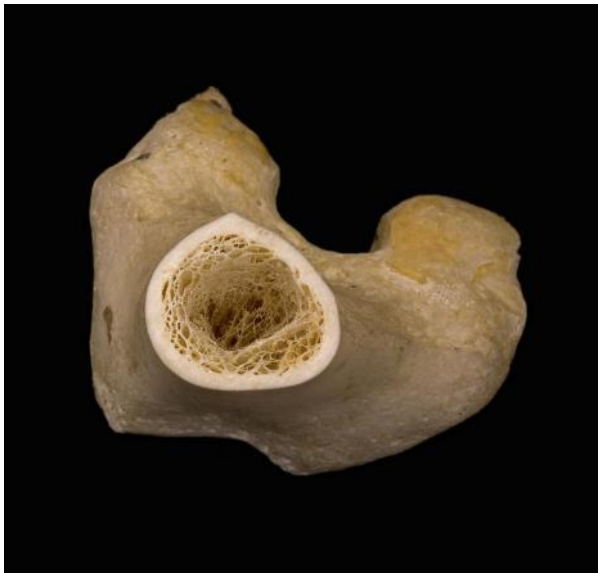
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Treatment

- Stage 1 & 2 → Pressure relief, local wound care
- Stage 3 & 4 → Pressure relief, local wound care, surgical management
- Adjuncts
 - Nutrition: albumin >2, micronutrients, adequate protein and caloric intake
 - Control of infection: Impaired immune function, tissue ischemia, lymphatic flow
 - **Relief of Pressure**
 - Glucose control: A1c >6 associated with dehiscence and recurrence
 - Moisture control, fecal control

To Biopsy or Not to Biopsy?

- Bone biopsy is the gold standard to diagnose osteomyelitis
- Considerations
 - Access to bone
 - Ability to reconstruct defect
 - Violation of cortical integrity
 - IR guided biopsy?



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Preoperative Considerations

- Patient expectations, compliance, and ability to care for wounds
 - Otherwise left with larger wounds, less treatment options available
 - Failed reconstruction makes future reconstruction more difficult
 - No blood flow across scars
- Fully counsel patients on what to expect, so there are no surprises
 - Before surgery, must talk about After surgery
- Compliance is a must



Post-Operative Course

- Continue nutrition, moisture, pressure offloading as before
- Ostomy may be helpful
- Bedbound
 - Clinitron / Envella **x 3 weeks**
 - Laying on stomach is ideal
- Progressive sitting or activity
 - Over **3 weeks**, especially for ischial wounds
- Follow up intra-op cultures (bone usually)
- Provena / Dry dressing
- Drains for dead space evacuation
- **Continuous pressure relief at home afterwards**



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Preoperative Considerations

- Patient expectations, compliance, and ability to care for wounds
 - Otherwise left with larger wounds, less treatment options available
- Optimize nutrition and comorbidities
 - DM, smoking, etc.
- Maximize local wound care options
- Treatment of infection and bacterial load
- Deep cultures before or at time of flap
- Maximize changes for flap success
- Pressure relief going forward



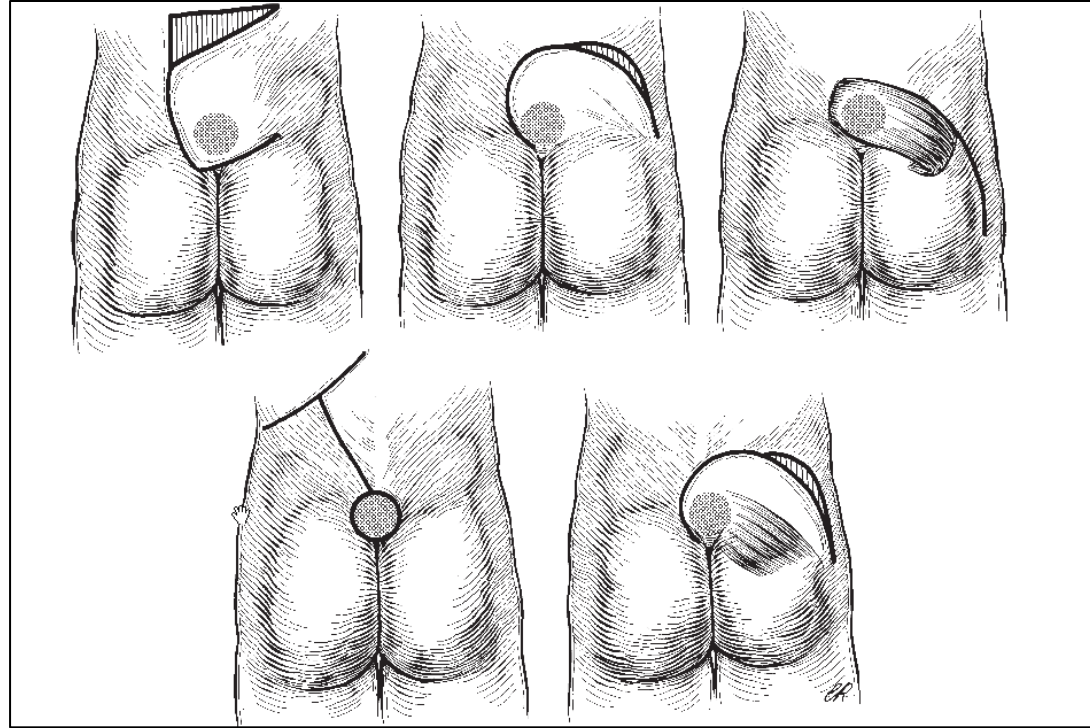
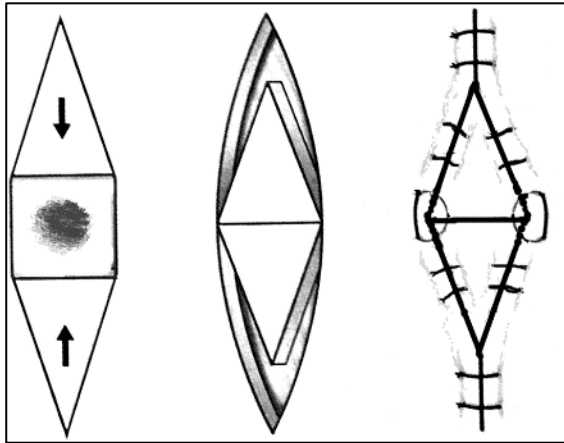
Flaps

- What is a flap?
- What is the goal?
 - Bulk
 - Coverage
 - Healthy tissue, abx delivery
- Avoid incisions over bony prominences
- Always plan for the next step
- Advance old flaps when possible (burns no bridges)
- Never operate on a patient who is not optimized



Sacral Pressure Wounds

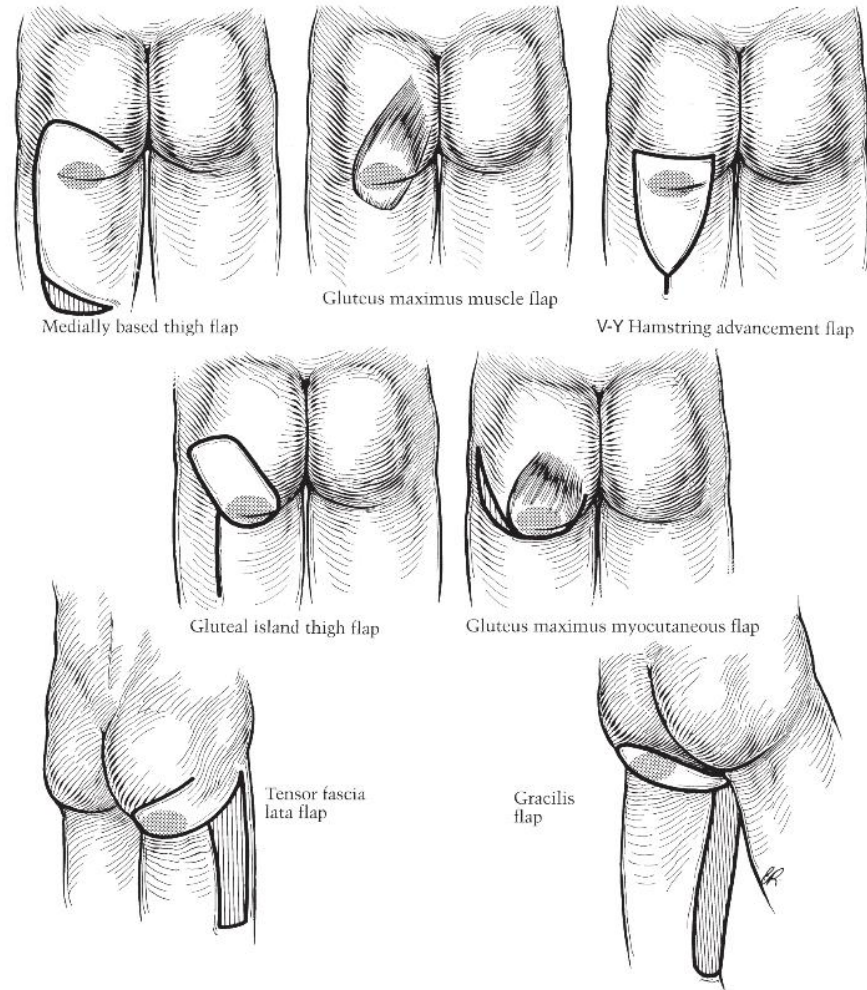
- At risk patients: supine, chronic illness
- Treatment options:
 - Local tissue rearrangement
 - Gluteus maximus musculocutaneous flap
 - Latissimus turnover flaps
 - Caution with muscle use
 - When is it advantageous



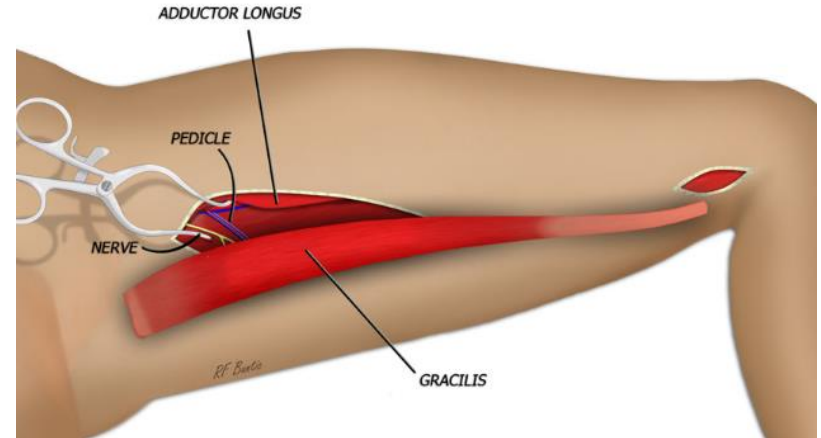
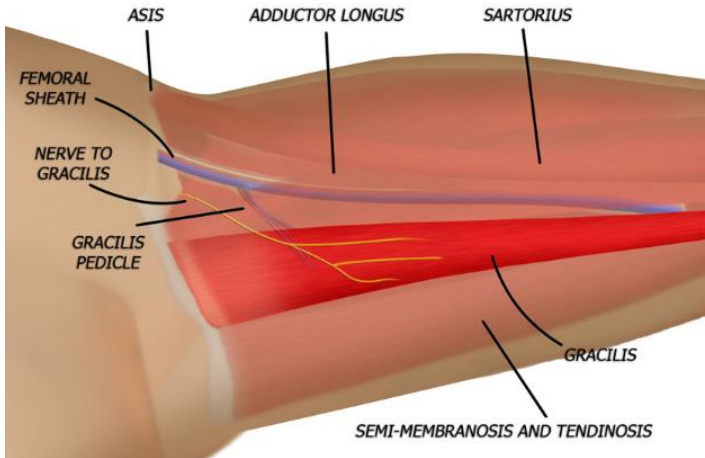
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Ischial Pressure Wounds

- Generally seated positions put patients at risk
- Especially high recurrence after repair (19-77%). Usually late recurrence



Ischial Pressure Wounds

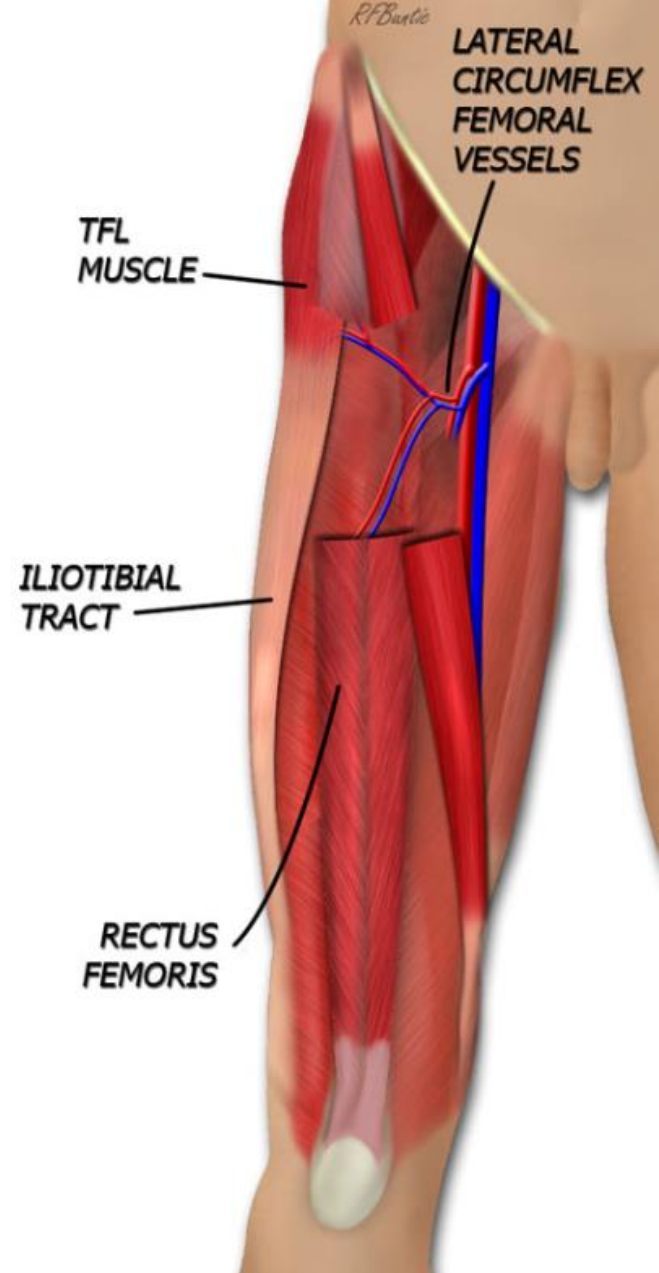
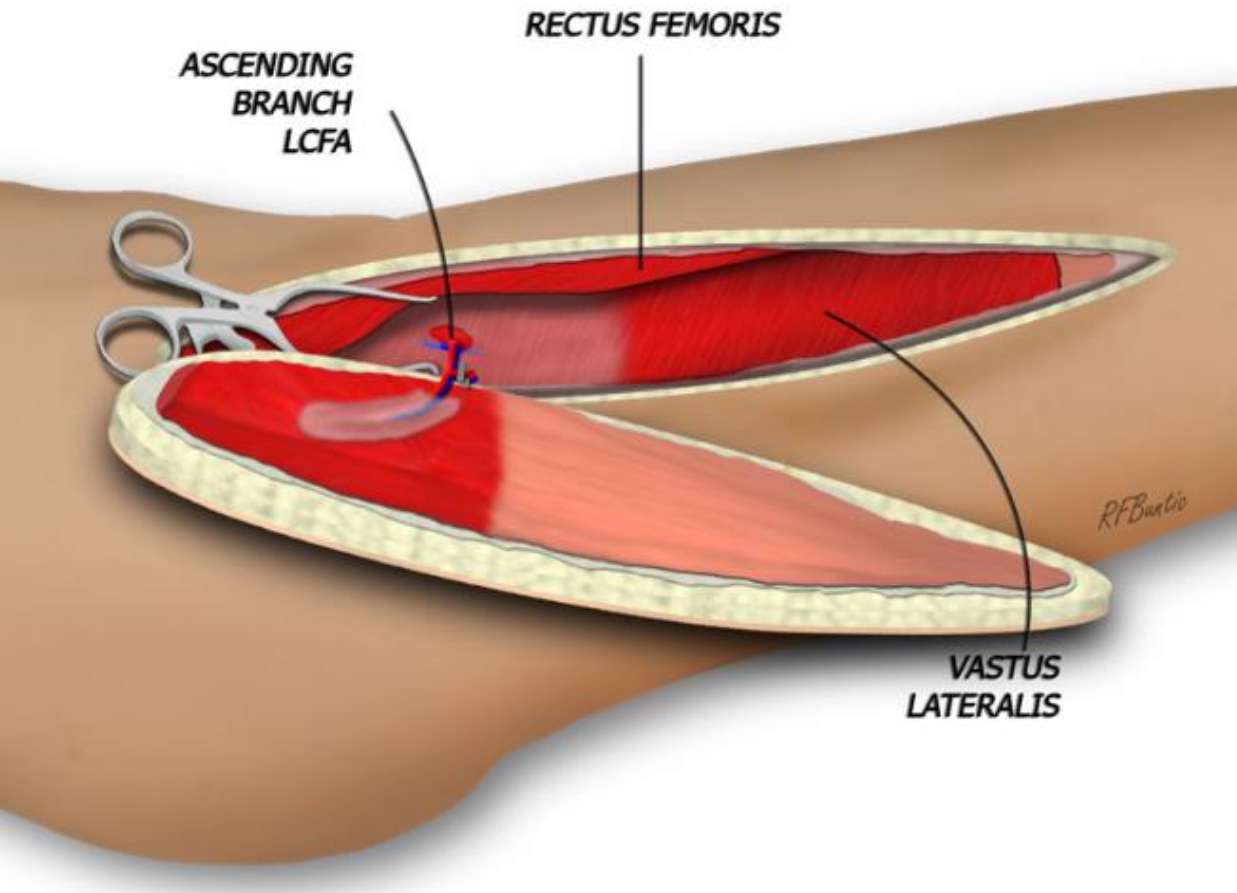


Trochanteric Pressure Wounds

- Least common
- Usually in patients laying in lateral position (think hip flexion contractures)
- Treatment options
 - Tensor fascia lata is most common



Tensor Fascia Lata Flap



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Complications

- Recurrence
 - As high as 91%
 - Surgical wounds are much larger than initial pressure wound
 - Blood flow across scar
 - Limiting future reconstruction options
 - The right time and patient for surgery
- Factors associated with dehiscence
 - Age < 45
 - Hx of prior surgery and failure
 - Albumin < 3.5
 - A1c >6
- Factors associated with recurrence
 - Ischial wounds
 - Prior surgical failure
 - Poorly controlled DM



Summary

- Optimize patients first
- Ensure post operative compliance
- Avoid recurrence
- Plan for future problems
 - Advance old flaps
 - Consider your incisions
 - Life long problem
- Bring healthy tissue and bulk to the wound
- Pressure relief after surgery

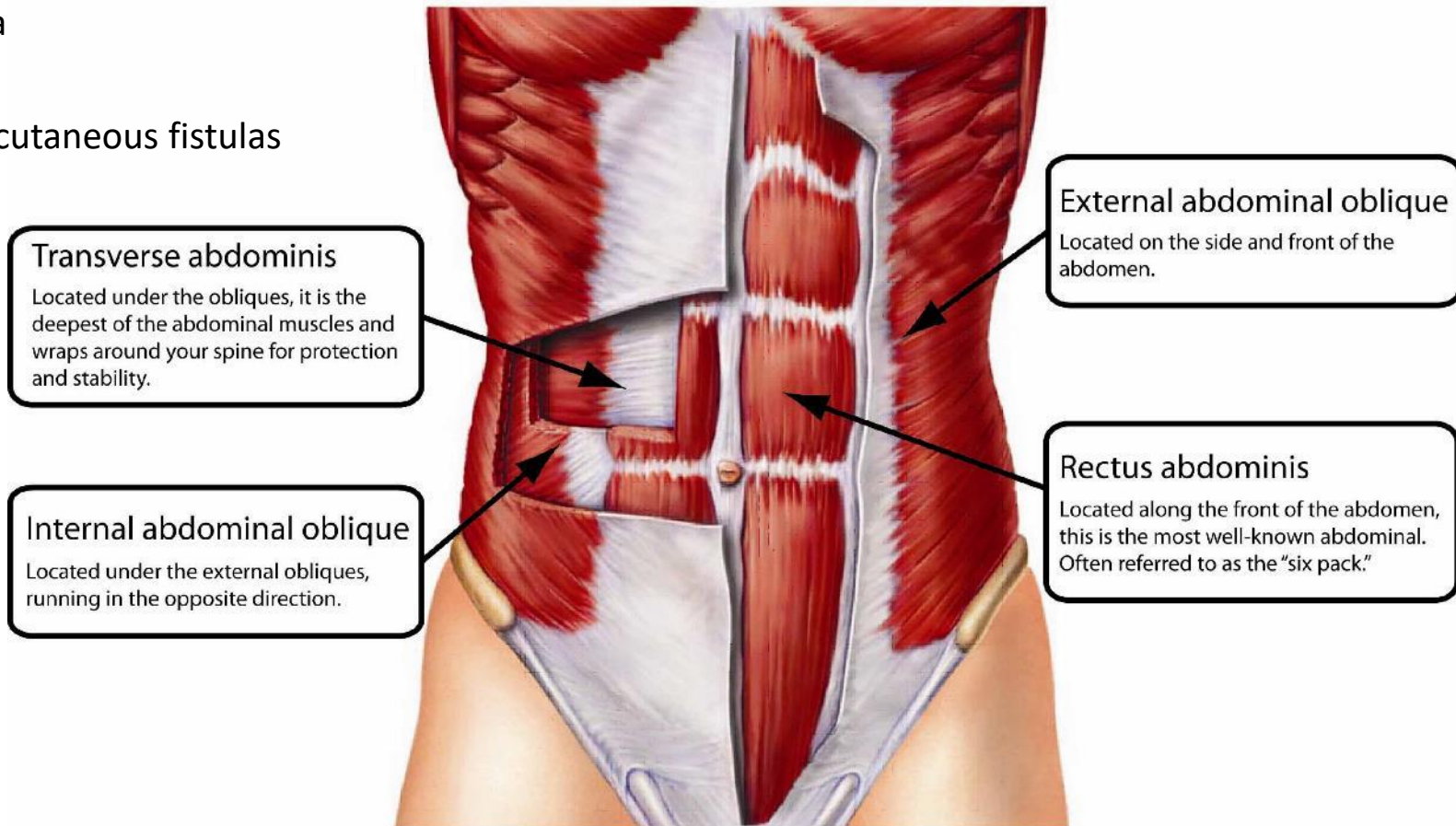




Abdominal Wall

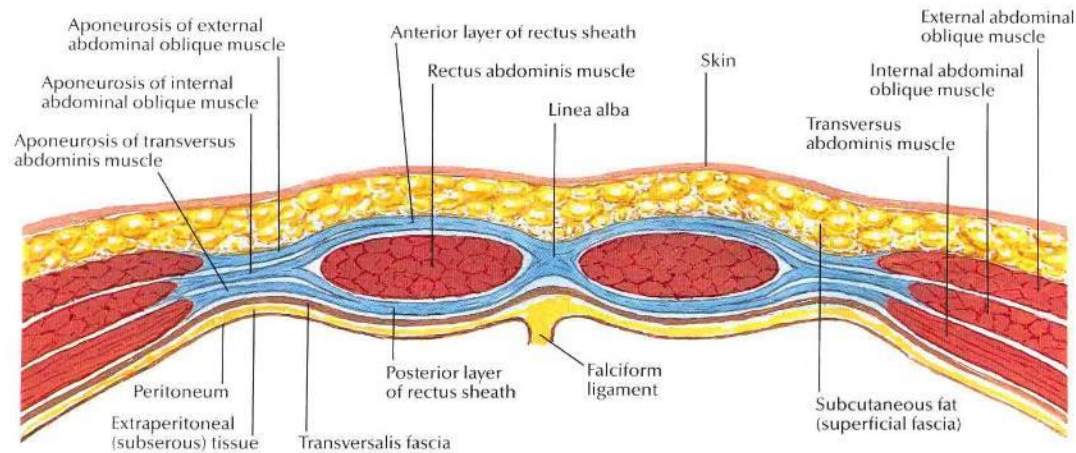
Abdominal Wall Defects

- Hernias
- Trauma
- Enterocutaneous fistulas



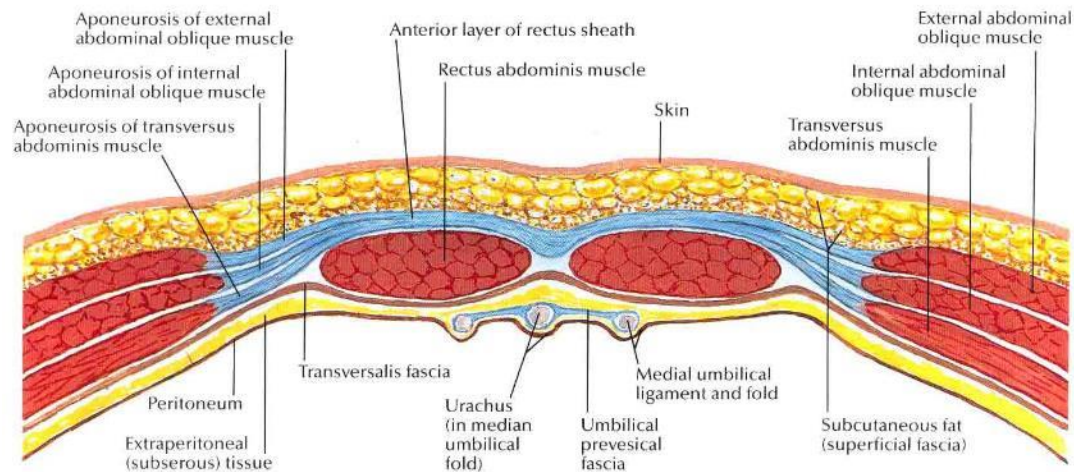
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Section above arcuate line



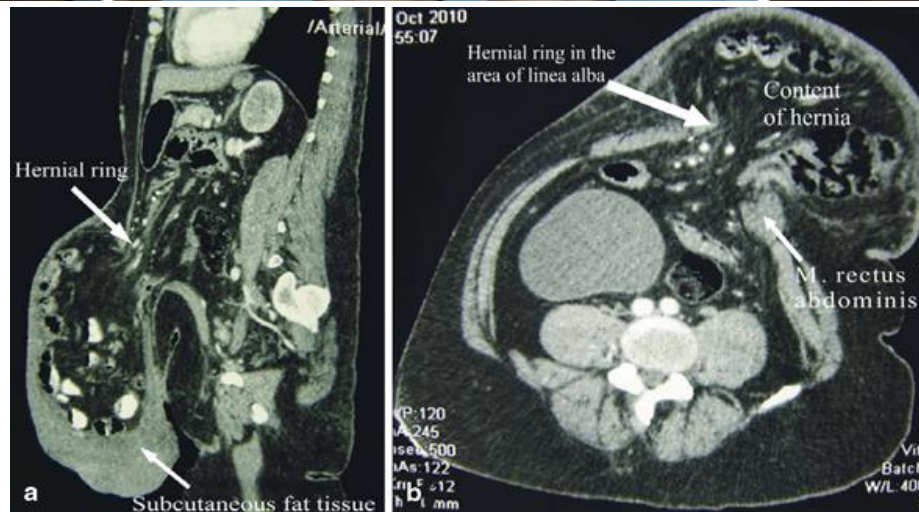
Aponeurosis of internal abdominal oblique muscle splits to form anterior and posterior layers of rectus sheath. Aponeurosis of external abdominal oblique muscle joins anterior layer of sheath; aponeurosis of transversus abdominis muscle joins posterior layer. Anterior and posterior layers of rectus sheath unite medially to form linea alba

Section below arcuate line

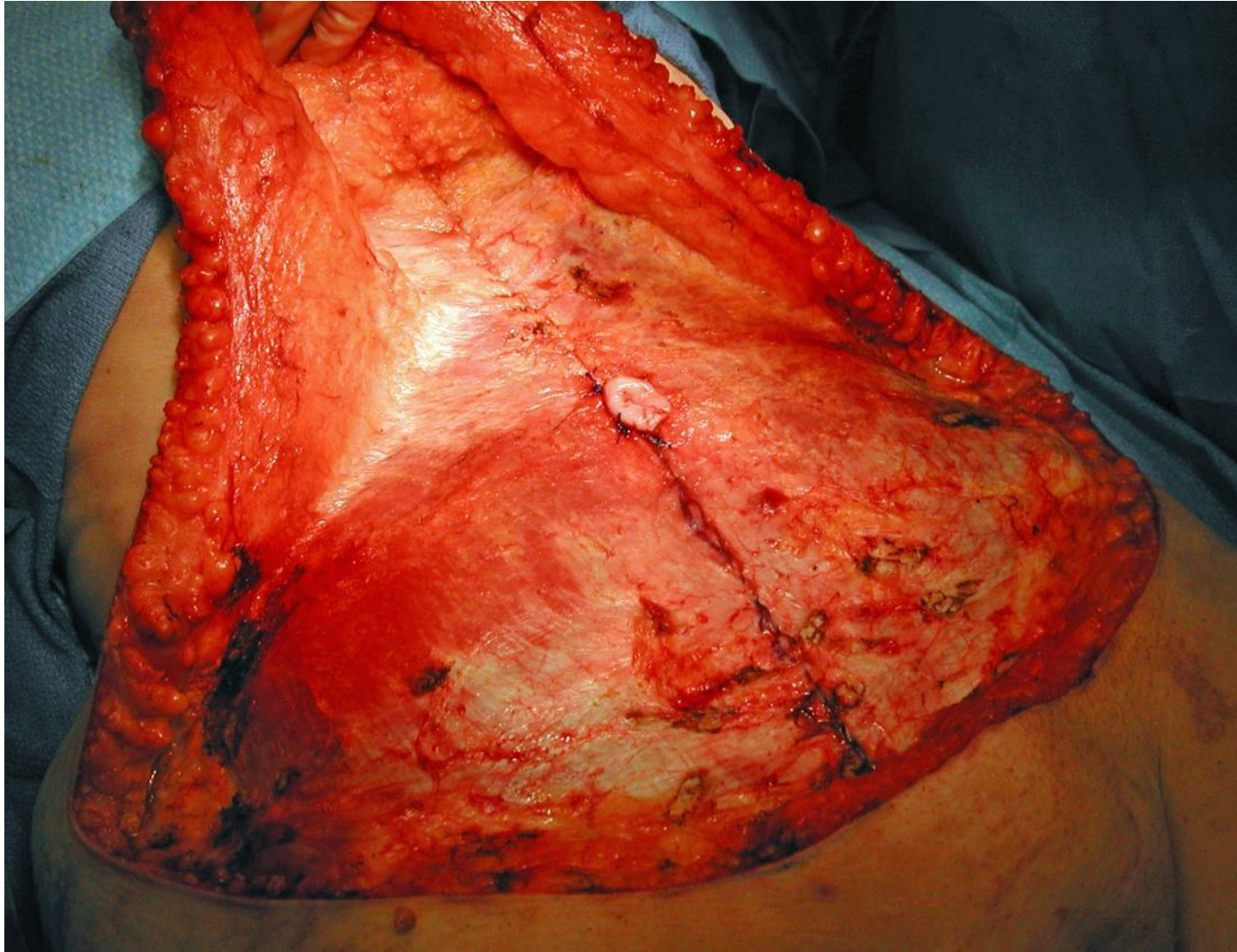


Aponeurosis of internal abdominal oblique muscle does not split at this level but passes completely anterior to rectus abdominis muscle and is fused there with both aponeurosis of external abdominal oblique muscle and that of transversus abdominis muscle. Thus posterior wall of rectus sheath is absent below arcuate line and rectus abdominis muscle lies on transversalis fascia

Hernia Patient

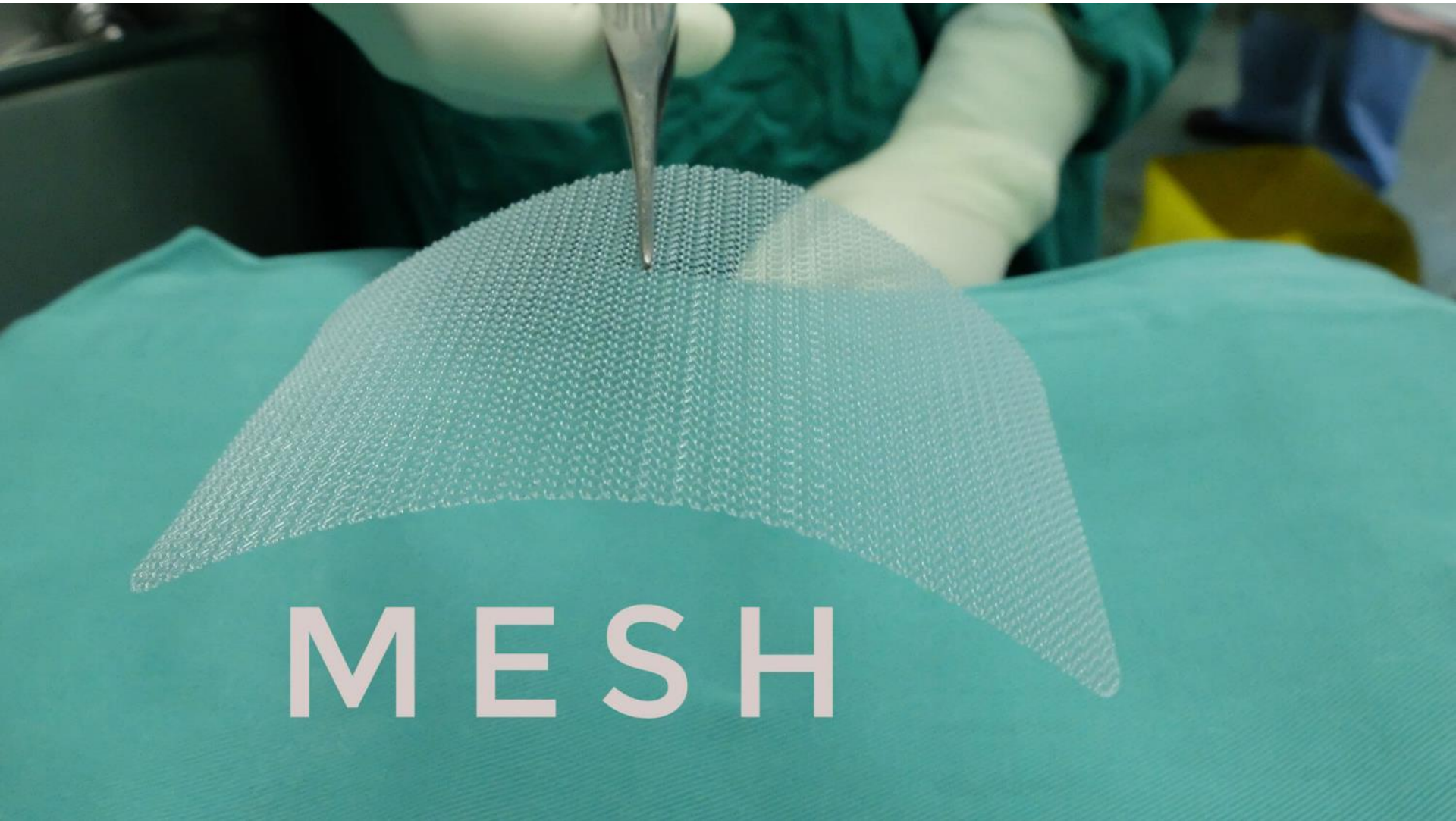


Close the Fascia Primarily



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Use Mesh to Prevent Recurrence (> 4cm)



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What if it just won't come together?

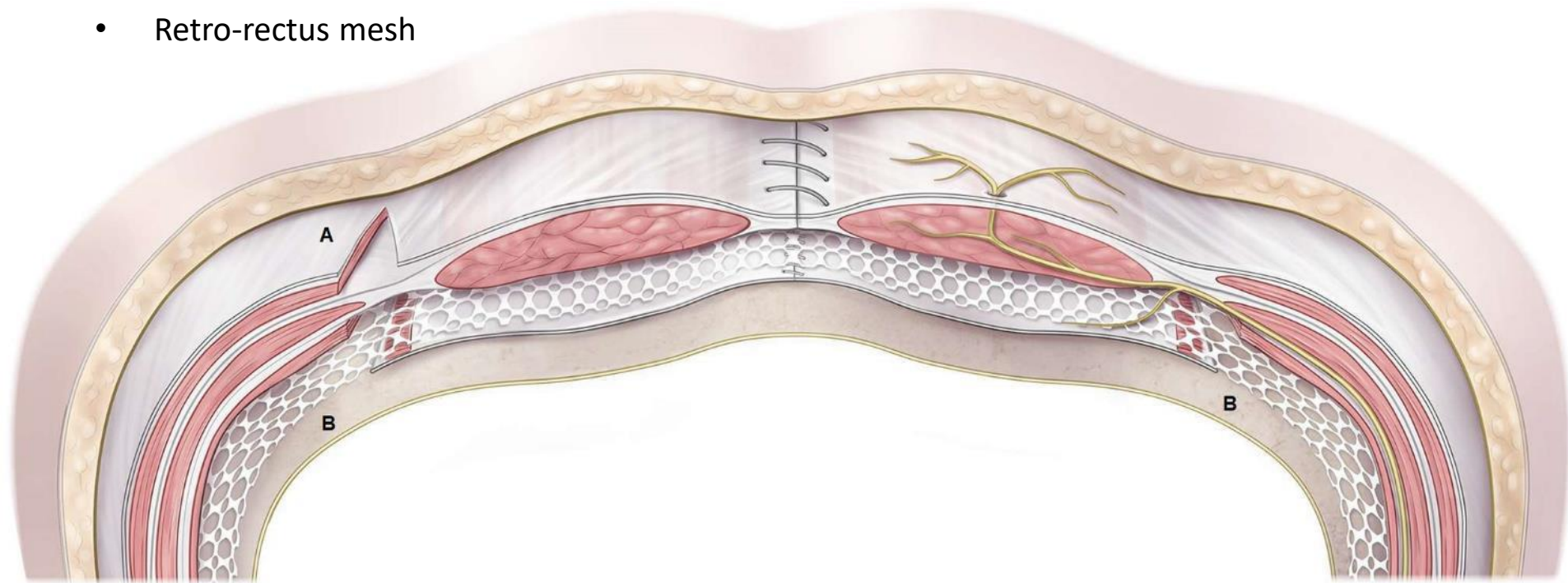


Separating into parts allows the pieces to travel farther...

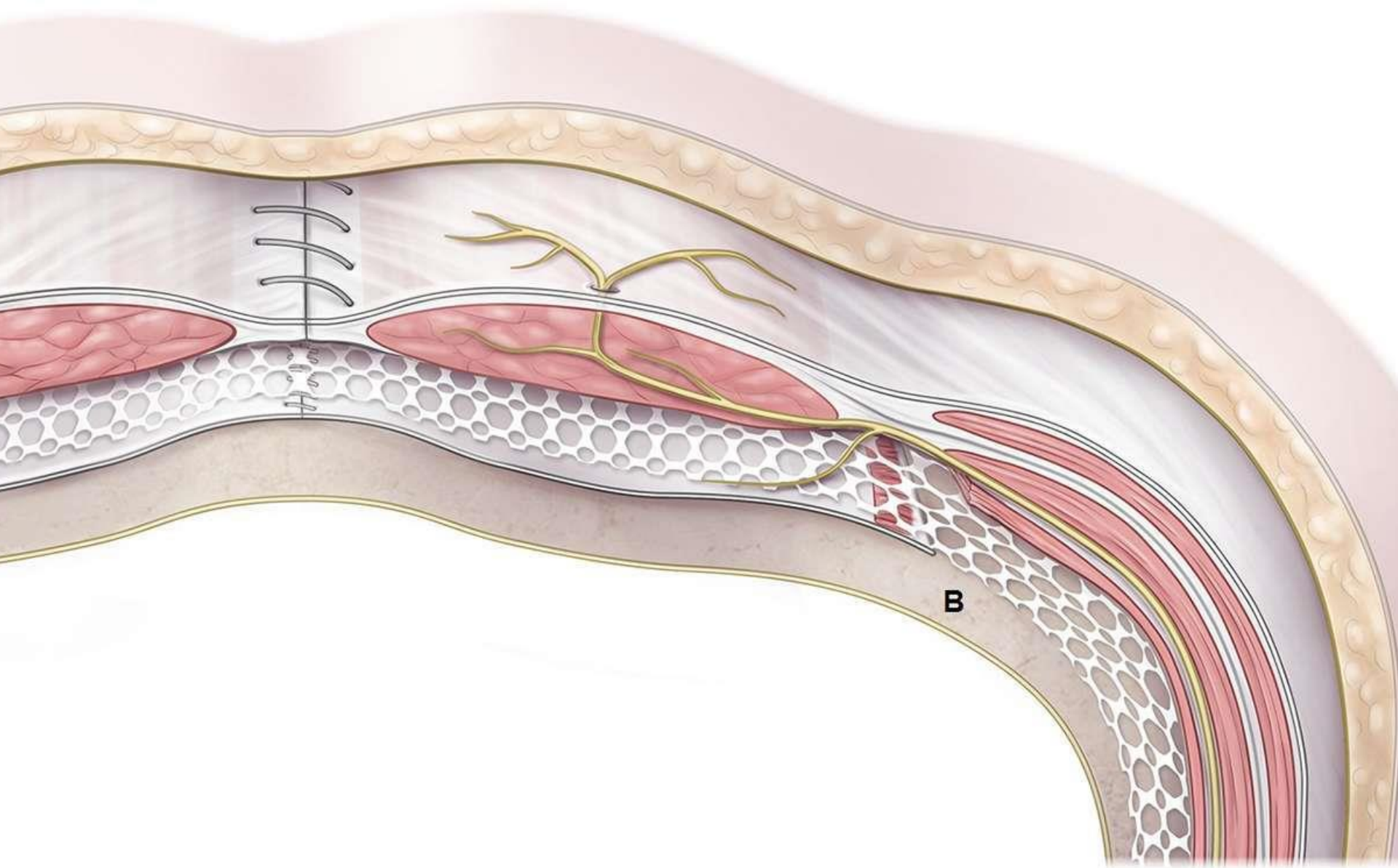


Separation of components

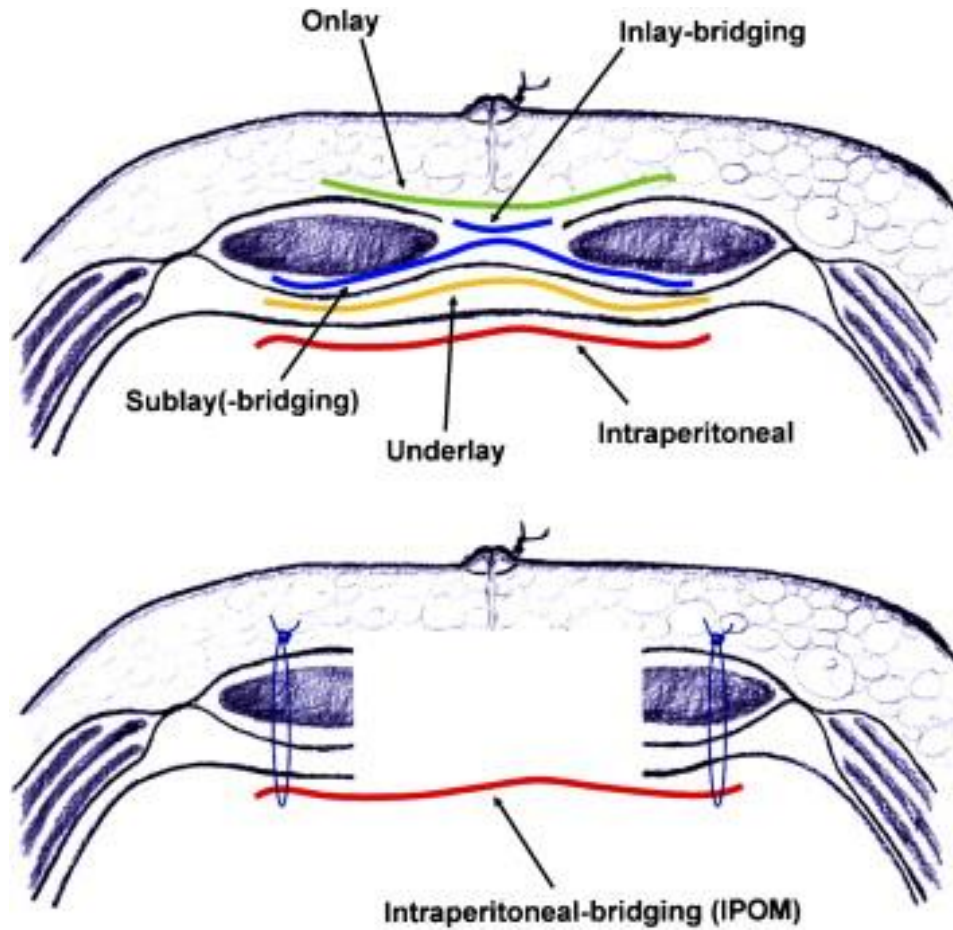
- Release 1cm lateral to linea semilunaris
- Nerve is between internal oblique and transversus muscle
- Coverage gained:
 - 10cm
 - 20cm
 - 6cm
- Retro-rectus mesh



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Bridging Mesh



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Bringing in New Tissue: Time to Get Creative



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Summary

- Preserve blood supply to existing tissue
- Close primarily
- Use mesh to prevent recurrence when > 4cm
- Separation of components for medium gaps
- Flaps for larger gaps
- Mesh can be used for bridging – beware of recurrence and infection





Skull / Calvarial Defects

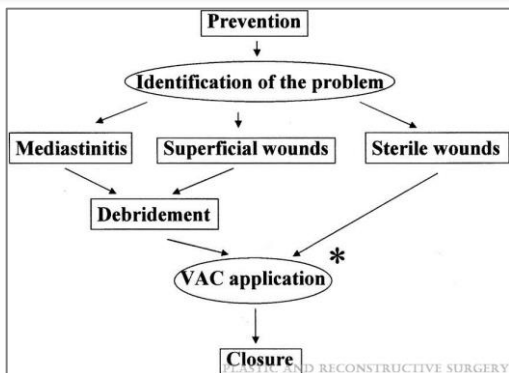
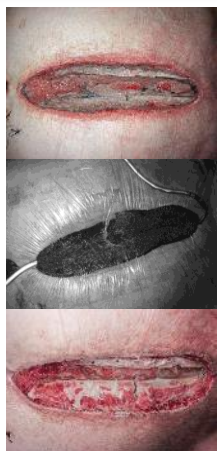


Principles

While early coverage of complex wounds minimizes post-operative complications

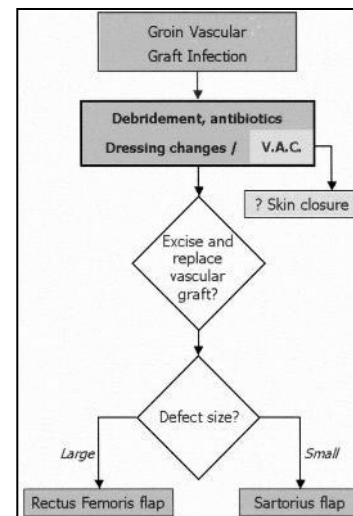
- Serial debridements
- Control of infection
- Obtaining clear oncologic margins

are paramount prior to definitive reconstruction



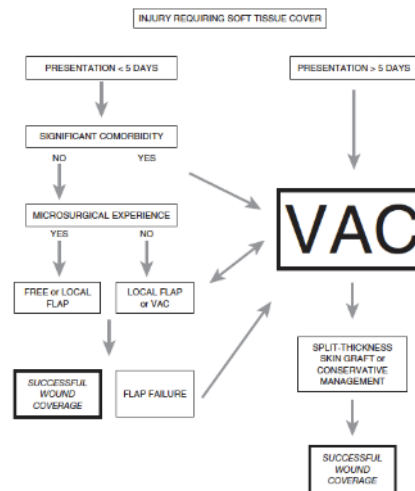
Vacuum-Assisted Closure for Sternal Wounds: A First-Line Therapeutic Management Approach

Agarwal, Jayant P. et al Plastic and Reconstructive Surgery. 116(4):1035-1040, September 15, 2005.



Management of Early Groin Vascular Bypass Graft Infections With Sartorius and Rectus Femoris Flaps.

Colwell, Amy; Donaldson, Magruder; Belkin, Michael; Orgill, Dennis; MD, PhD. Annals of Plastic Surgery. 52(1):49-53, January 2004.



Hardwicke, J., & Paterson, P. (2006). A role for vacuum-assisted closure in lower limb trauma: a proposed algorithm. *The international journal of lower extremity wounds*, 5(2), 101–4.



Hypothesis

When composite defects of the scalp, calvarium, and dura are accompanied by hostile wound environments, VAC therapy applied to the dura or cortical brain can act as a safe bridge to definitive closure.

Background

Abbas Khan (2010)

- Case report: 1 patient - VAC on Integra over intact Dura

Subotic (2011)

- Case Report: 1 patient - VAC on Tachosil over intact Dura

Powers (2013)

- Case Series: (5 patients)
 - 1 patient VAC on Dura
 - 1 patient VAC on a Pericranial flap
 - 3 patients VAC on Alloderm

Study Design

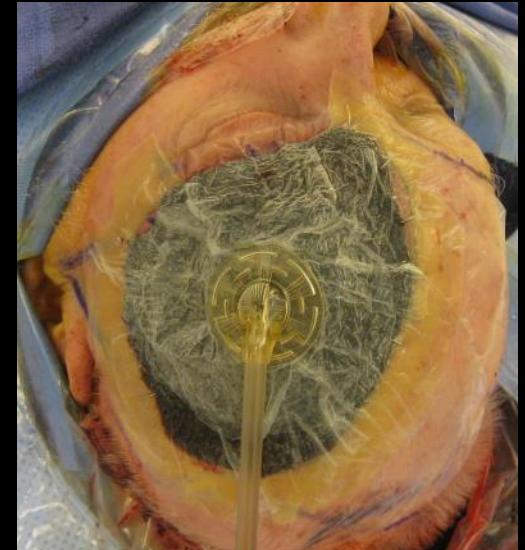
- Retrospective review
- Composite scalp and calvarial defects reconstructed by the senior author (D.S.)
- December 2012 – December 2013
- 10 patients identified – 5 patients bridged with VAC to closure
- Medical records reviewed



Exposed dura /
cortical brain



White sponge on
dura / cortical brain



Black sponge in
soft tissue defect
-50 mmHg

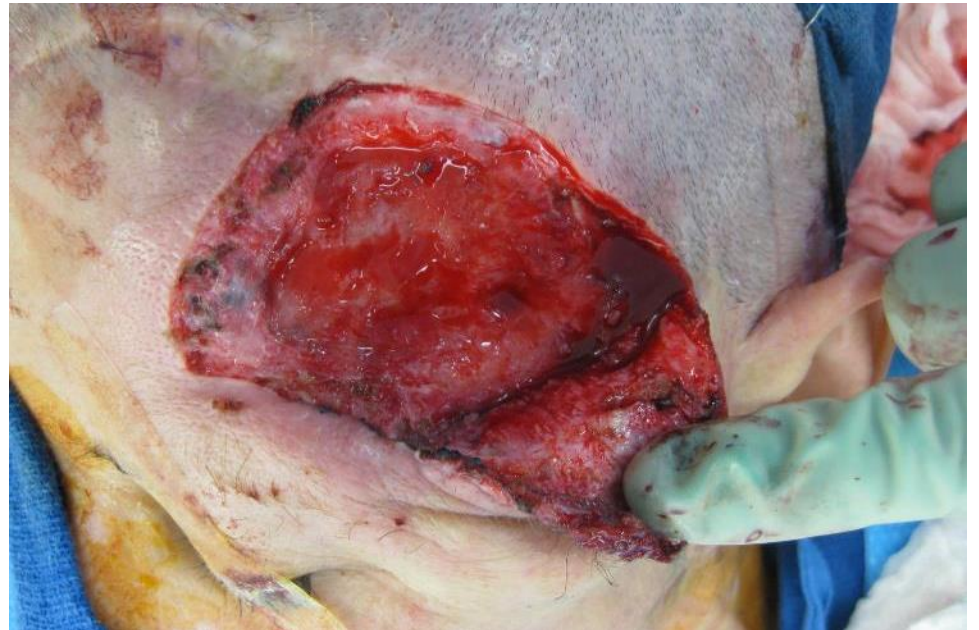
Results

Case	Age / Sex	Indication	Initial Pathology	Hx of Prior Radiation to Scalp	Location	Scalp Defect Size (cm2)	Calvarial Defect Size (cm2)	Evidence of Dural Defect/CSF Leak	Evidence of Infection Prior to VAC	VAC Duration	VAC Change	Interim Findings During VAC Therapy	Closure / Definitive Procedure	Average Daily VAC Output	Complications	Follow-up (weeks)
1	66 / M	Infection/ Exposed cranioplasty	Squamous cell carcinoma of scalp (Recurrent)	Yes	Anterior scalp	120	56	No	Yes (MSSA)	6 days	No	Appropriate antibiotics dosed for intraoperative cultures; overlying flap without ischemic margins	Replacement and repositioning of prior free radial forearm flap; local scalp flaps; incisional VAC	77 cc	Sub-centimeter wound breakdown, treated with incisional VAC	37
2	56 / M	Oncologic	Malignant peripheral nerve sheath tumor of scalp (Recurrent)	Yes	Left fronto-parietal scalp	112	50	No	No	3 days	No	Confirmed negative margins	Mesh cranioplasty; rotational advancement flaps; STSG	93 cc	None	16
3	78 / M	Oncologic / Infection	Squamous cell carcinoma of scalp (Recurrent)	Yes	Left frontal scalp	120	16	No	Yes (S. Aureus, Enterobacter, Citrobacter)	3 days	No	Appropriate antibiotics dosed for intraoperative cultures	Rotational advancement flaps; STSG	142 cc	None	25
4	75 / F	Infection/ Exposed cranioplasty	Basal cell carcinoma eroding frontal sinuses	Yes	Anterior scalp / forehead	216	72	Yes (25cm2)	Yes (Aspergillus)	5 days	No	Appropriate antibiotics dosed for intraoperative cultures; overlying flap without ischemic margins	Fascia lata dural graft; rotational advancement of prior anterolateral thigh flap; scalp advancement flaps	46 cc	Sub-centimeter wound breakdown, treated with local wound care	42
5	56 / F	Infection/ Exposed cranioplasty	Subarachnoid hemorrhage from ruptured left cerebral artery aneurysm	No	Left temporal scalp	49	49	No	Yes (MRSA, Pseudomonas, Achromobacter)	7 days	Yes - Day #3 (bedside)	Appropriate antibiotics dosed for intraoperative cultures	Free radial forearm flap	14 cc	None	40



Patient 1

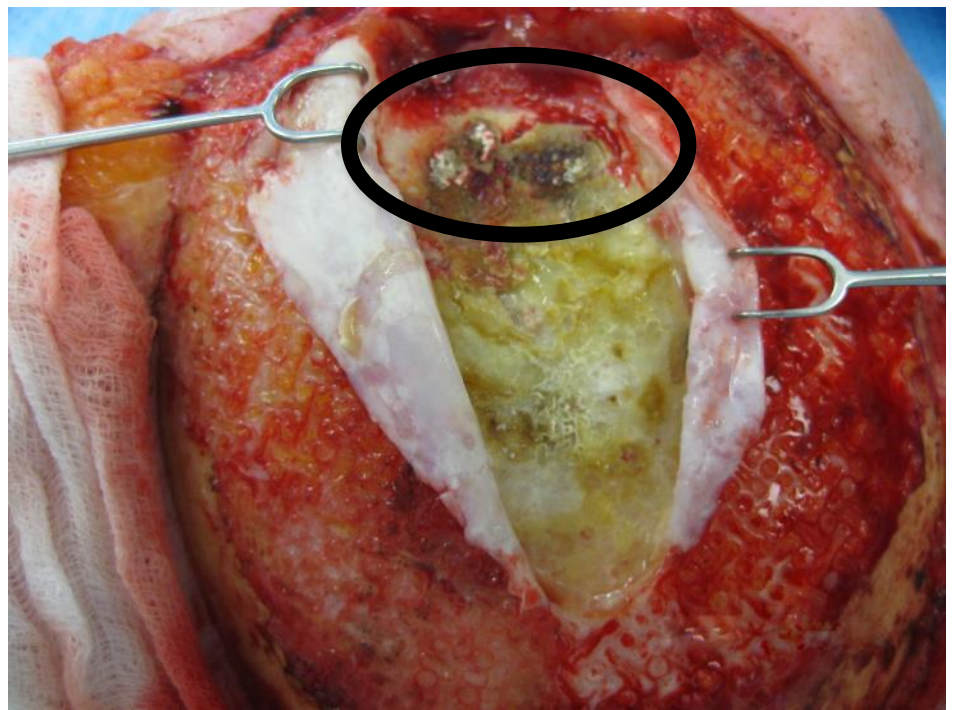
- Recurrent MRSA infections
- 10 months of exposed cranioplasty and underlying tissue
- 14 neurosurgical procedures with multiple incisions
- Active Smoker
- Difficult access to care (>500 miles)





- **Confirm cultures**
- **Initiate tailored antibiotics**
- **Assess for further debridement**





Patient 2

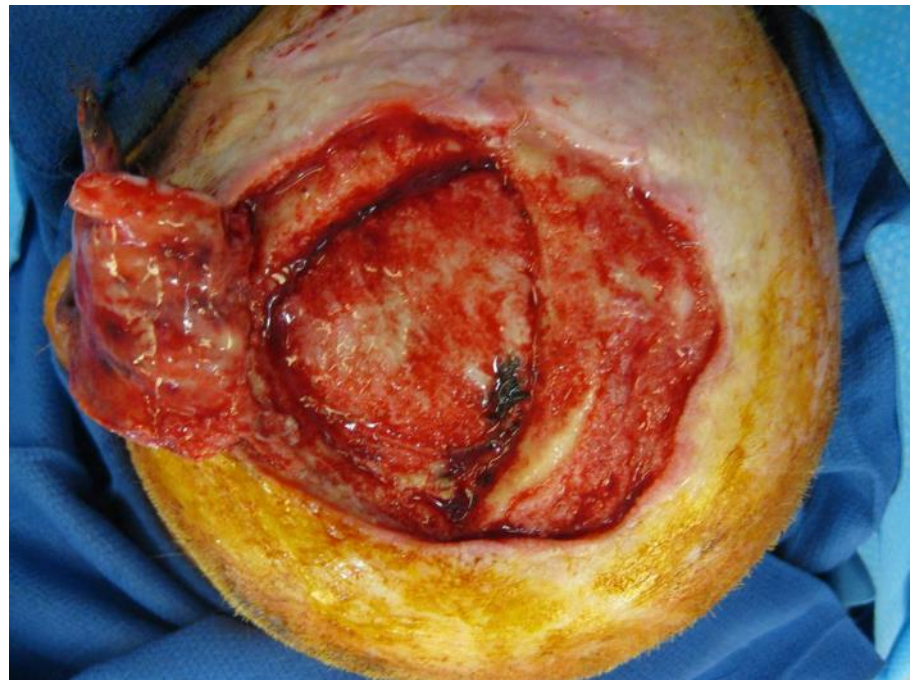
- Exposed dural graft/ cranioplasty for 18 months
- Radiated field including ALT flap
- Recurrent pseudomonas infections
- Encephalomalacia with recent seizures





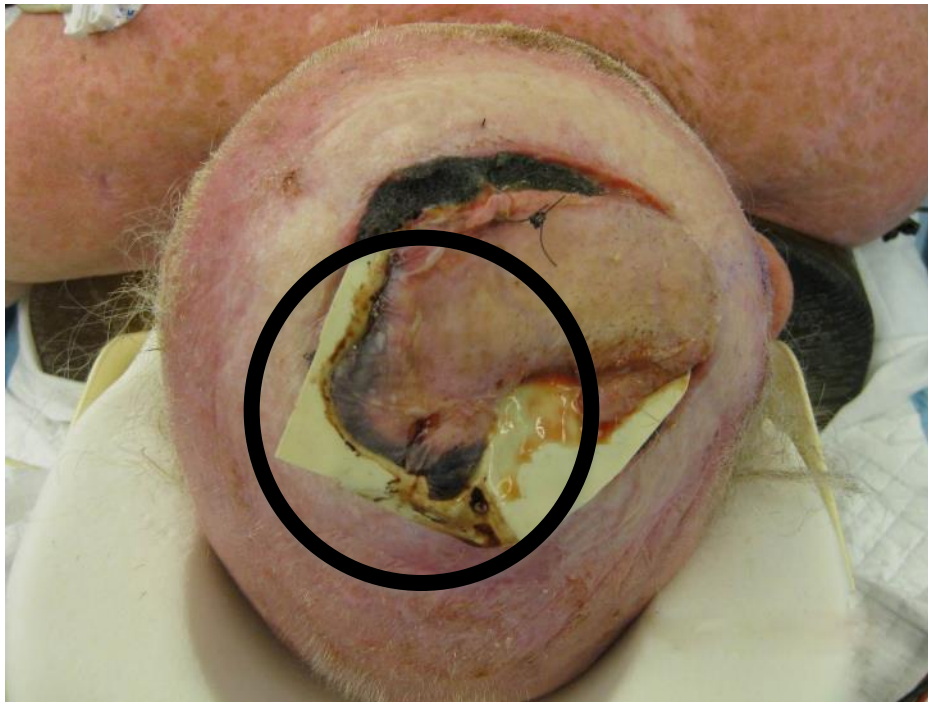
- Second look of subdural space
- Initiate tailored antibiotics
- Demarcation / debridement of prior ALT flap





Patient 3

- Previously Radiated
- Exposed cranioplasty and cranium for 9 months
- Prior radial forearm flap
- Prior rotational flaps with multiple incisions



- Demarcation of tissue
- Initiate tailored antibiotics





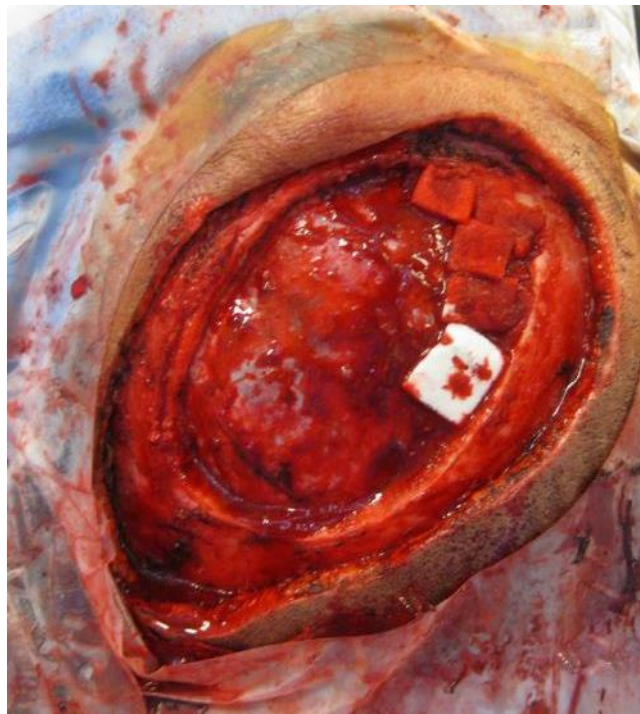
Patient 4

- Prior radiation therapy
- Purulent drainage and foul odor for 6 months
- Recurrent cancer
- Calvarial erosion on imaging with recent TIA symptoms





- Initiate tailored antibiotics
- Confirm pathologic review



Patient 5

- Peripheral nerve sheath tumor
- 4th recurrence
- Prior radiation therapy



- Confirmation of margins

Indication

	Indication for VAC	
1	Infection/ Exposed cranioplasty	
2	Oncologic	
3	Infection	Oncologic
4	Infection/ Exposed cranioplasty	
5	Infection/ Exposed cranioplasty	

Complex Wounds

	Hx of Prior Radiation to Scalp
1	Yes
2	
3	
4	
5	No

Complex Wounds

	Hx of Prior Radiation to Scalp	Evidence of Infection Prior to VAC
1	Yes	Yes (MSSA)
2		No
3		Yes (S. Aureus, Enterobacter, Citrobacter)
4		Yes (Aspergillus)
5	No	Yes (MRSA, Pseudomonas, Achromobacter)

VAC Therapy as a Bridge

	VAC Duration
1	6 days
2	3 days
3	3 days
4	5 days
5	7 days

Duration of treatment: 3 – 7 days

Definitive closure

	VAC Duration	Closure / Definitive Procedure
1	6 days	Replacement and repositioning of prior free radial forearm flap; local scalp flaps; incisional VAC
2	3 days	Mesh cranioplasty; rotational advancement flaps; STSG
3	3 days	Rotational advancement flaps; STSG
4	5 days	Fascia lata dural graft; rotational advancement of prior anterolateral thigh flap; scalp advancement flaps
5	7 days	Free radial forearm flap

All patients were successfully temporized to definitive closure procedures

Outcomes

	Evidence of Dural Defect/Cortical Brain Exposure	Average Daily VAC Output (Mean = 74.4)	Neurological Sequelae
1	No	77 cc	No
2	No	93 cc	
3	No	142 cc	
4	Yes (25 cm ²)	46 cc	
5	No	14 cc	

Complications

Complications	Follow-up (weeks)
Sub-centimeter wound breakdown, treated successfully with incisional VAC	37
None	16
None	25
Erosive dermatitis from patient' s wig, 2 months post-op	42
None	40

Findings During VAC Therapy

- **Confirmation of cultures**
- **Initiation of antibiotics**
- **Continued wound monitoring**
- **Tissue demarcation**
- **Confirmation of oncological margins**

Composite scalp / calvarial / dural defects



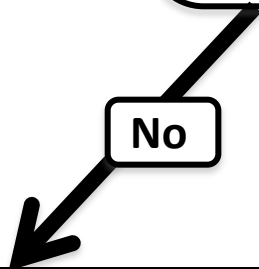
Hostile wound environment

- Infection
- Tissue awaiting demarcation
- Unconfirmed margins or pathology
- Unstable patient
- Trauma

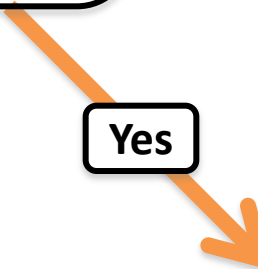
Re-evaluate Wound



No



Yes



Does the patient and surgery meet criteria for

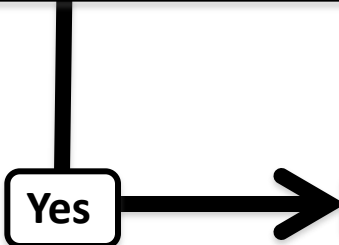
- Immediate operative planning
- Surgeon experience
- Patient and family expectations

No



VAC Therapy

Yes



Immediate reconstruction

Summary

- First study demonstrating VAC therapy as a bridge to definitive closure of composite scalp and calvarial defects
- VAC application to Dura is safe and, in select cases, consideration of VAC directly to cortical brain can be utilized
- In the future, VAC therapy as a bridge may allow for delayed immediate cranioplasty reconstructions, and its utility for trauma and other clinic scenarios remains to be seen.

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VAC Therapy to the Dura and Brain: A Safe Method for Wound Temporization in Composite Scalp and Calvarial Defects

Noah Prince, MD¹
Spiros Blackburn, M.D.²
Gregory Murad, M.D.²
Bruce Mast, M.D.¹
Christiana Shaw, M.D.³
John Werning, M.D.⁴
Dhruv Singhal, M.D.¹

1 Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Florida School of Medicine

2 Department of Neurosurgery, University of Florida School of Medicine

3 Division of Surgical Oncology, Department of Surgery, University of Florida School of Medicine

4 Department of Otolaryngology, University of Florida School of Medicine





Conclusions

- **Pressure Wounds**

- Flap based reconstruction is effective for well chosen surgical candidates
- Surgery on poor surgical candidates can compromise future reconstruction
- Several flap options are available for each pressure wound location
- Post operative course is long and high risk for complications

- **Abdominal Wall**

- Surgical repair goals: provide permanent reconstruction including autologous tissue
- Consider blood supply, need for reoperation
- Limitations exist for each technique

- **Skull / Calvarial Defects**

- VAC therapy indications are being adapted for new purposes
 - (*Discuss with risk management, IRB, this is one surgeon's experience)
- Wound temporization allows for clearance of infection, cancer margin confirmation, and surgical planning for complex procedures.





Flaps, VACs and Reconstructive Surgery:

A Plastic Surgeon's Perspective

*Noah Prince, MD
Chief Resident*

University of Florida Plastic and Reconstructive Surgery

