PRINCIPLES OF WOUND REPAIR SURGERY

FLAPS & REGENERATIVE MATRICES

CONCEPTS & TECHNIQUES

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arimedica.com
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A GRAVE ON THE SANTA CRUZ ROAD.

CAVEAT FLAPTOR

THE ROAD TO GOOD RECONSTRUCTION IS LITTERED WITH DEAD SKIN

R.I.P.

RECONSTRUCTIVE LADDER

Wound Repair Surgery

PARADIGMS

0 - basic care

(in support of natural contraction)

1 - REPAIR

2 - GRAFTS

3 - FLAPS

4 - regenerative matrices

(in situ tissue engineering)

All wounds must be properly prepared prior to any form of closure.

NON-OPERATIVE REPAIR
0

Contraction and epithelialization.

Okay or preferable to treat this way.

WOUND REPAIR SURGERY
1

Simple repair.

Optional but desirable.

WOUND REPAIR SURGERY
1

Simple repair.

Not optional.

Wound Repair Surgery - 2

GRAFTS

A graft is a graft by virtue that it has no anatomical attachment to the host, no circulation of its own, and it is not capable of living independently away from a recipient wound.

(1) Grafts do not carry the cellular machinery of repair.

(2) Grafts depend on the recipient wound to heal.

(3) They do not survive if the wound is incompetent.

(4) The wound must be healthy and properly prepared.

(5) The graft must be in firm contact with the wound.

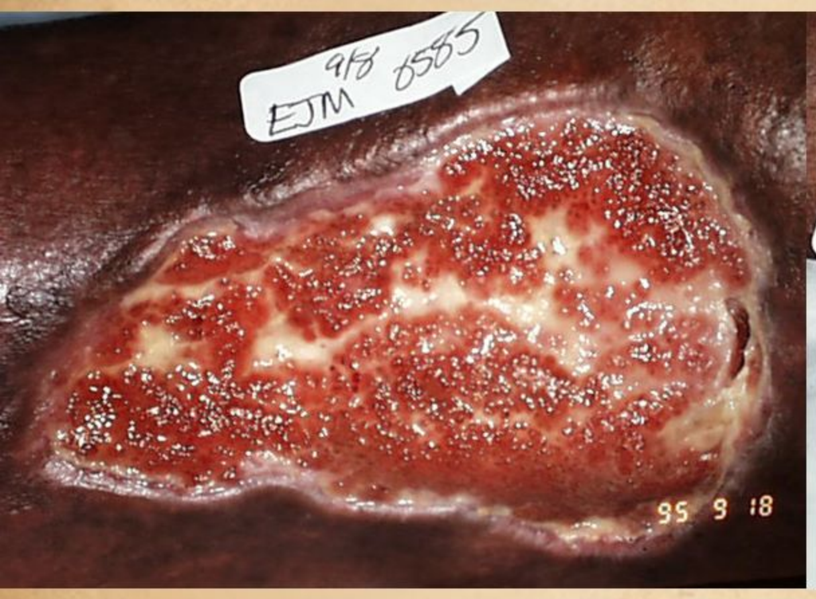
(6) The graft must be suitably thin to stay alive.

(7) A healed skin graft is epidermis on scar == problems.

(8) Grafts are technically simple but biologically complex.

Grafts are grafts because they are completely detached and have no circulation.

Grafts depend on the host.



Grafts have special requirements:

They must be thin.

They must be immobilized.

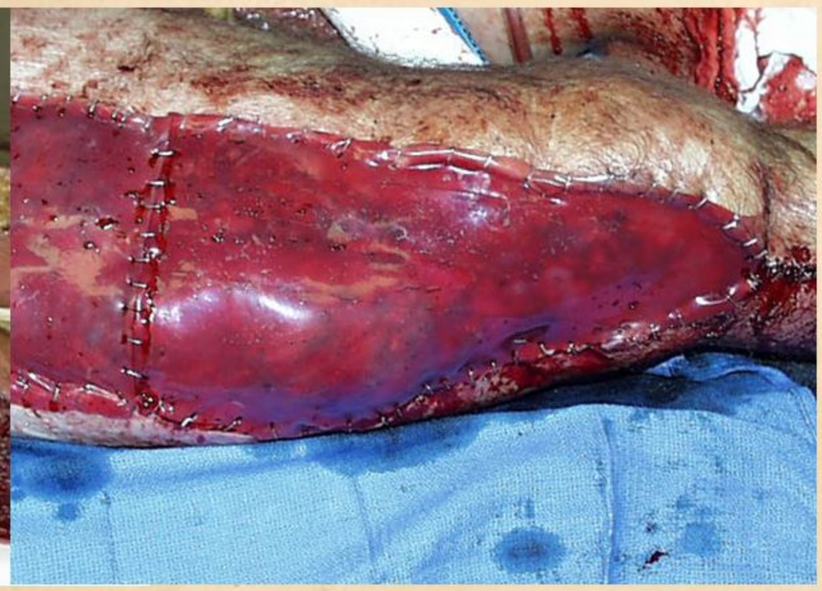
Grafts are technically simple but biologically complex.

They do not survive if the host wound cannot heal.

Reasons to use a graft

1

Convenient wound closure



Reasons to use a graft

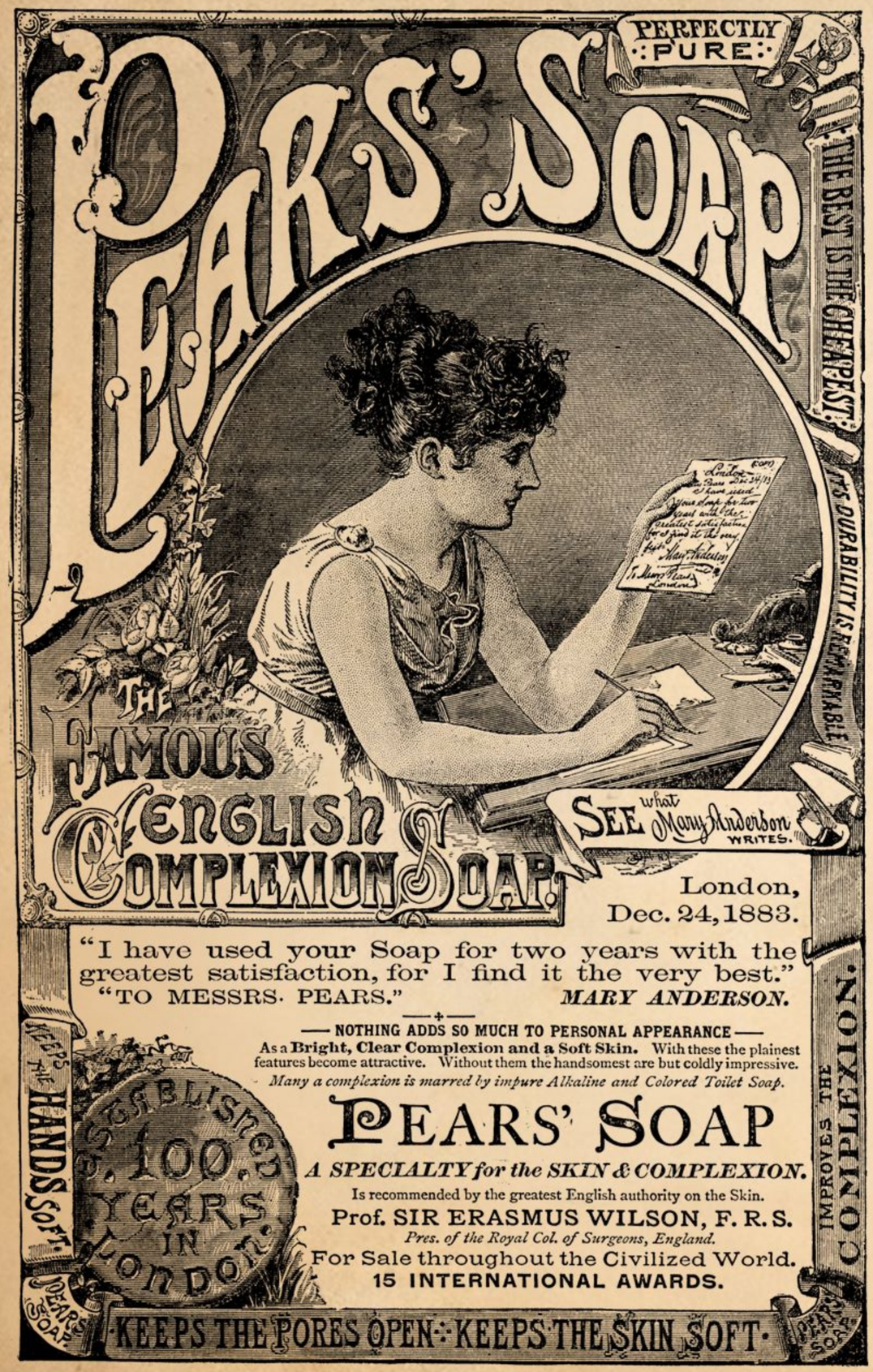
2

Biological dressing

Reasons to use a graft

3

Specialized reconstruction



Wound Repair Surgery - 3

FLAPS

A flap is a flap by virtue that it maintains an anatomical attachment to the host (the pedicle), carrying its own circulation, capable of living independent of any anatomy other than its pedicle.

(1) Flaps can transport large volumes of various tissues.

(2) Flaps retain original characteristics and mechanics.

(3) Healthy flaps do not depend on the target wound - The wound need not be intrinsically healthy.

(4) Flaps carry the machinery of wound repair – Flaps live and heal when the target is incompetent.

(5) Flaps can be technically elaborate, but - a healthy flap is biologically simple.

(6) Flap surgery requires finesse – flaps are easy to kill by poor design, poor technique, or vascular disease.

Flaps are flaps because they remain attached and have circulation.

Flaps independently initiate and execute the repair process.

Flaps run a technical spectrum:

simple advancements of
adjacent tissue
through
remote transfers of
micro-revascularized islands.

Flaps can be technically complex,
- but -
they are physiologically simple:

They do not know they have
moved, just that they are
injured & must heal.

Reasons to use a flap

1

Convenience

2

General reconstruction

Reasons to use a flap

3

Essential coverage

Reasons to use a flap

4

Wound healing incompetence

FLAPS - GENERAL PRINCIPLES

Flaps need finesse.

Good results are technique-dependent, otherwise . . .

The flap may not live.

The flap may not reach.

Unlike grafts, flaps are a big investment,

- so - don't mess them up.

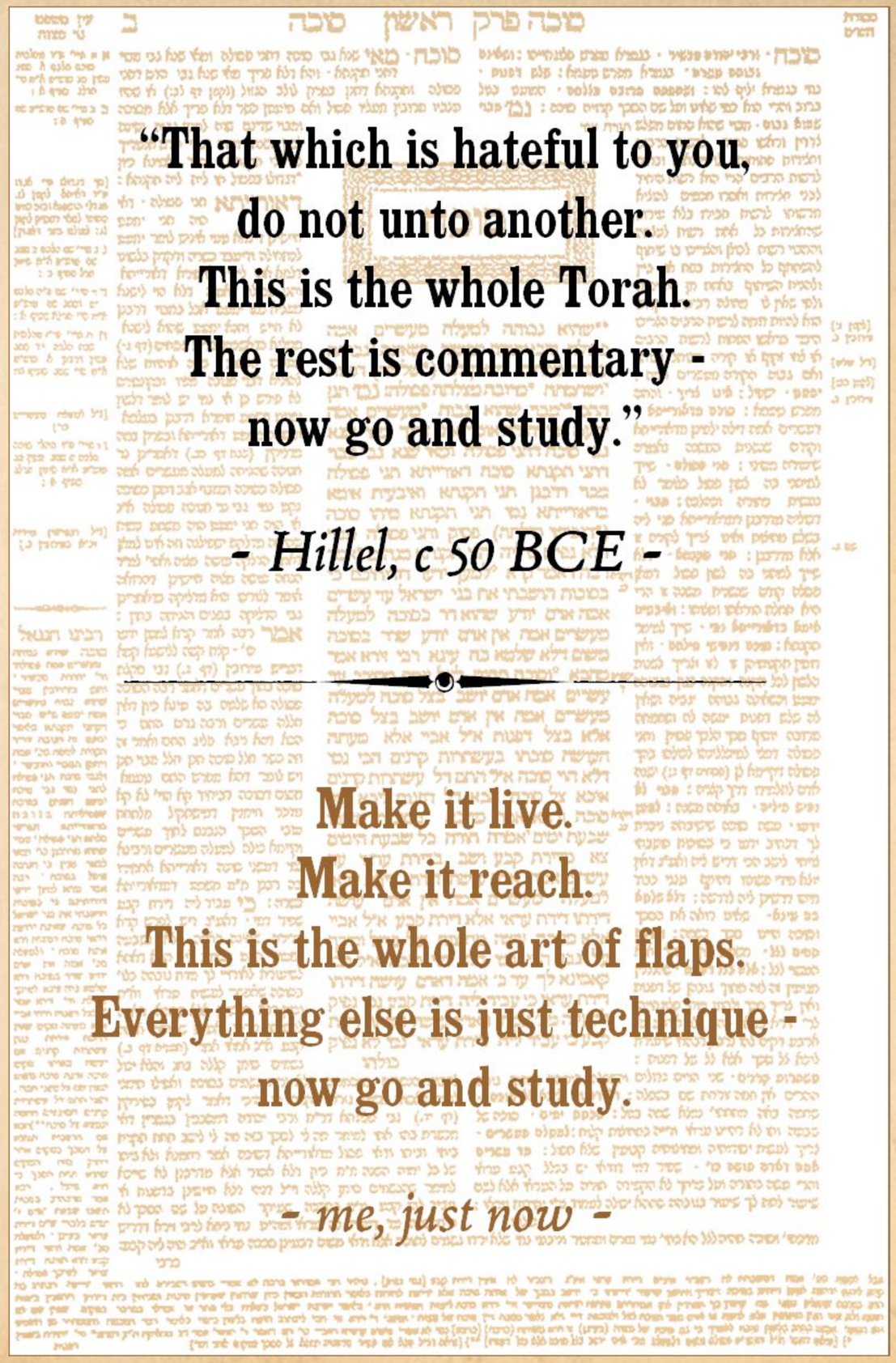
Two general designs of flaps:

Random

Based on geometry and mechanics.

Anatomical (Angiosomal)

Based on vascular anatomy & embryonic angiosomes.



PRINCIPLES OF DESIGN

Purpose & Goals

Essential health = anatomical-angiosomal.
Quality recon = random, geometry & mechanics.

General Design

Blood supply - random - angiosomal.
One target – one vs multiple flaps.
Composite techniques and methods.
Mechanics and design.
Only take what you need. Don't waste anatomy.

The Pedicle

Finesse the pedicle.
One flap – multiple pedicles.
Free flaps – microvascular transfer.

Staged Reconstruction

Staged & intermediate transfers.
Delay. Don't be greedy.
Time, judgment, planning.

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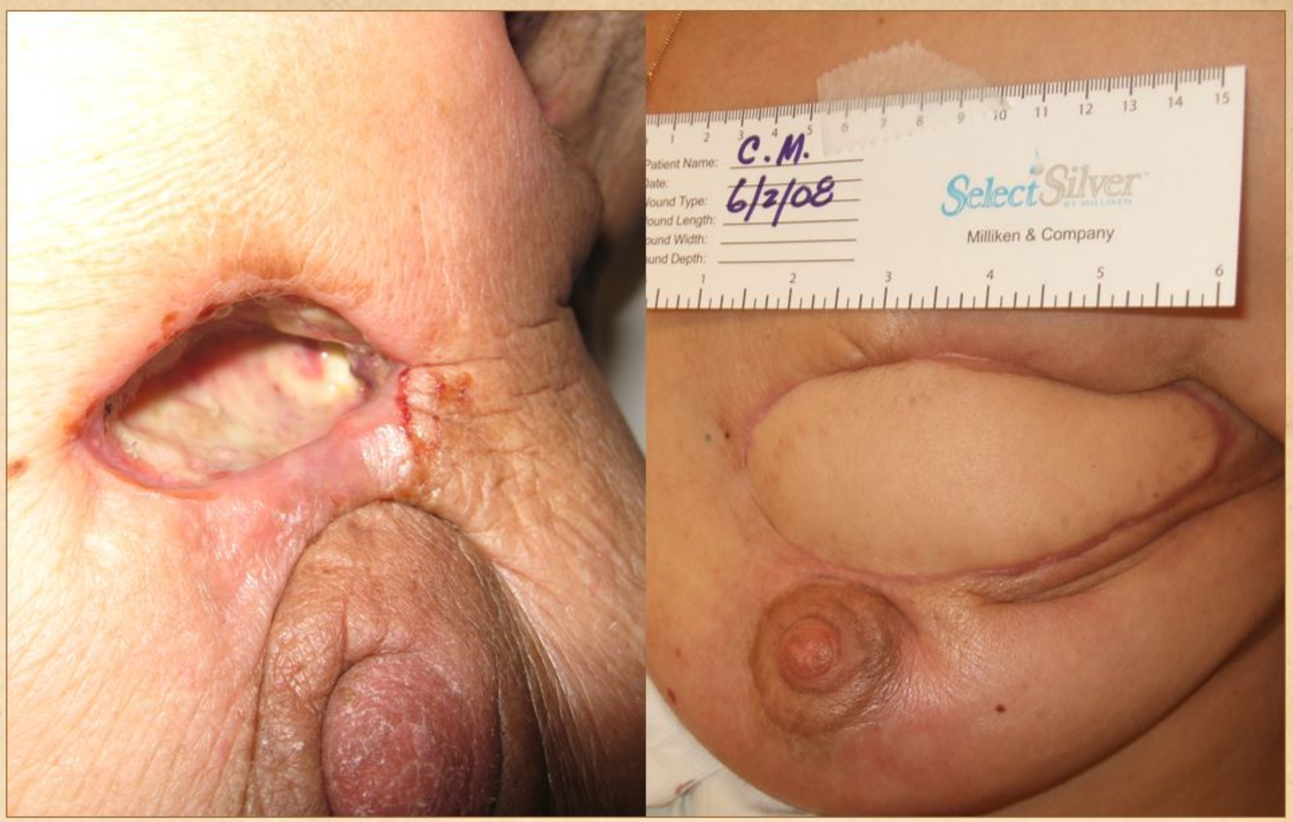

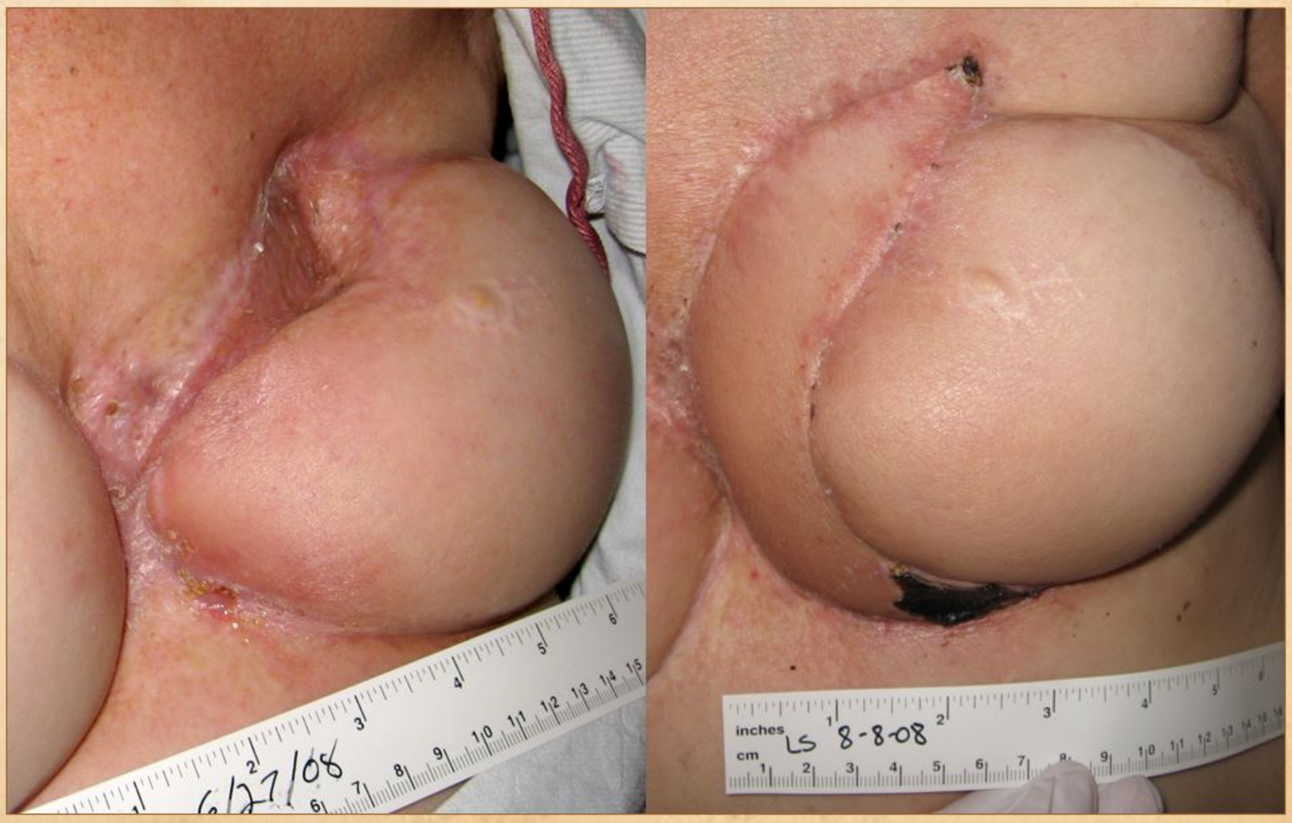

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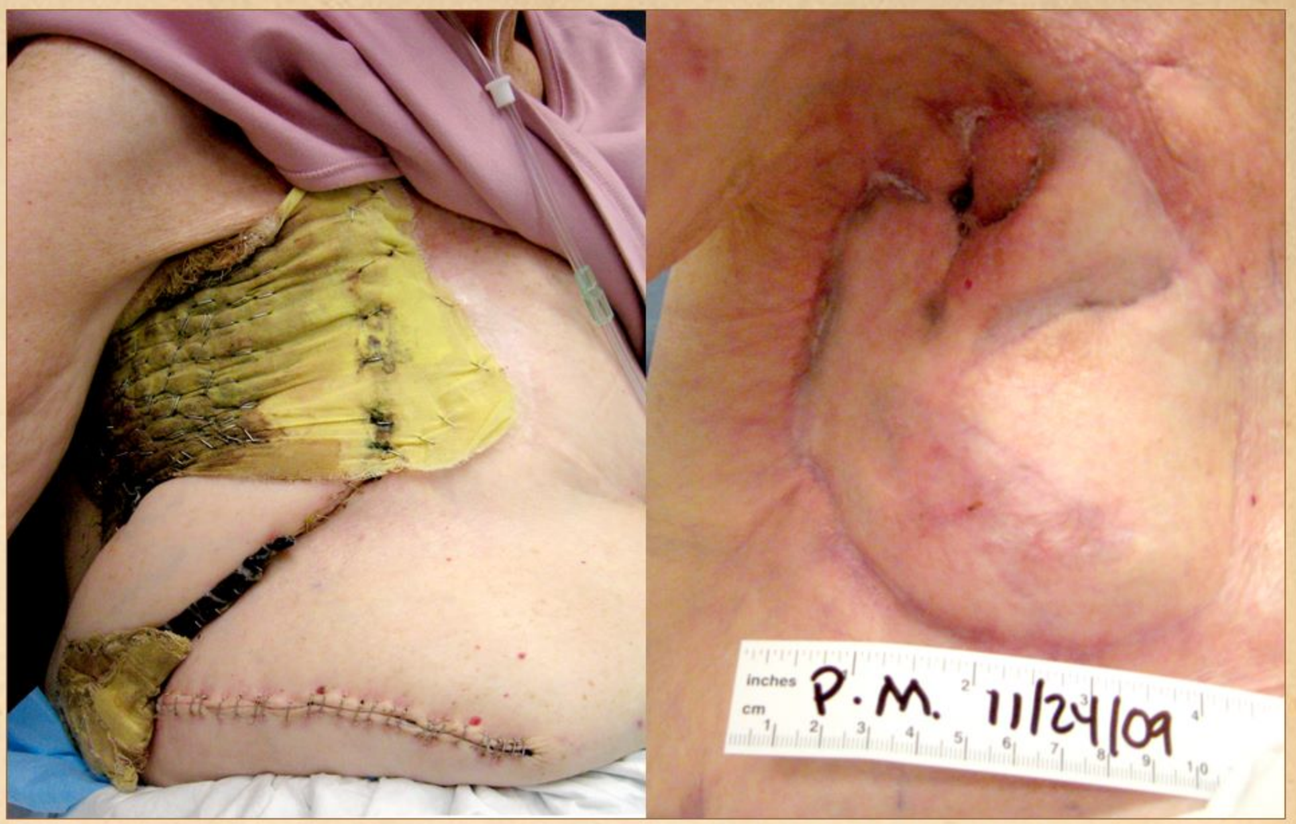

"MAKE IT LIVE": STRATEGIES & TECHNIQUES

Staged Reconstruction

The Law of Accountable Destiny.
Don't be greedy.
Live to fight another day.

Delay & Physiological Adaptation

Plasticity of tissues and circulation.
Delay.
Force your delay.
Protect your delay.

Plan B

Put it back.
Parking.
Intermediate transfers.
Ditch the stitch.
Sacrifice and expendability for the greater good.
Adjunct supportive therapies.
(best "adjunct" = make a good flap).

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Source inflow = 65u/min
Healthy flow = 10u/vox/min
Marginal critical flow = 8u/vox/min
10 vox healthy flow = 10x10 = 100u/min
10 vox marginal flow = 10x8 = 80u/min
10 vox actual flow = 65u/min

Sacrifice and expendability for the greater good.

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BROWNOUT :: THIN YOUR FLAP

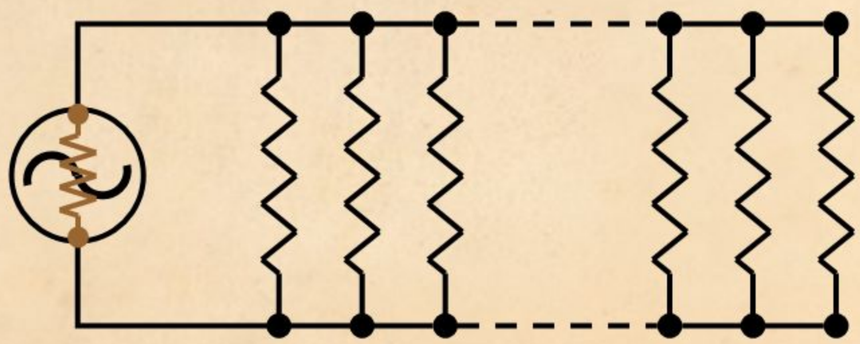
Compare a brownout to a rolling blackout.

V = voltage (pressure)
I = current (flow)
R = resistance

Ohm's Law **I = V/R V = I·R**

For parallel loads:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$



Generator or input impedance:
If current is limited,
voltage decreases as load increases.

What would you do?

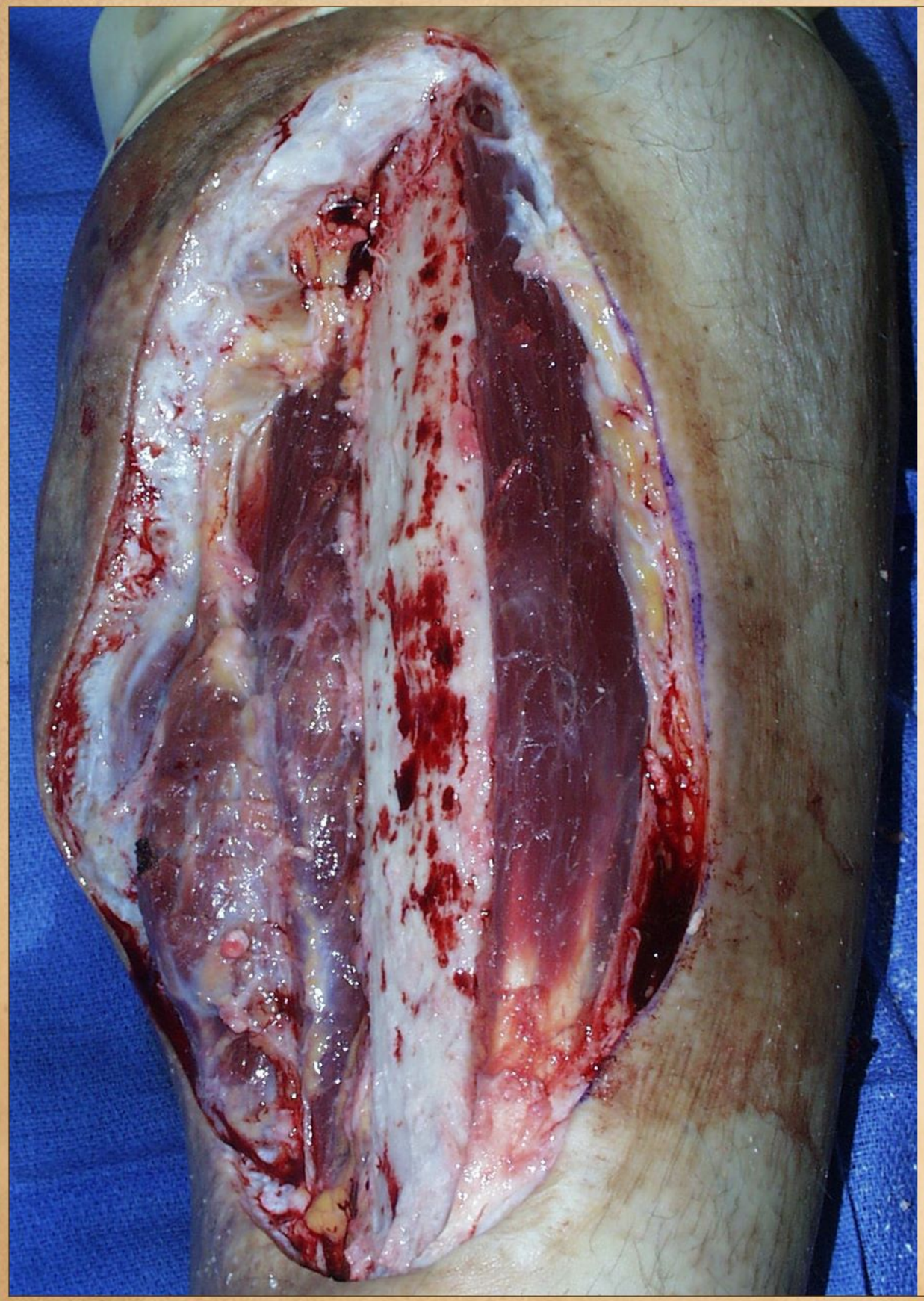
55 f

fall

impact injury

lacerations and hematoma

52 f puncture wound



33 m

machinery
versus
pedestrian

avulsion –
injury

39 m

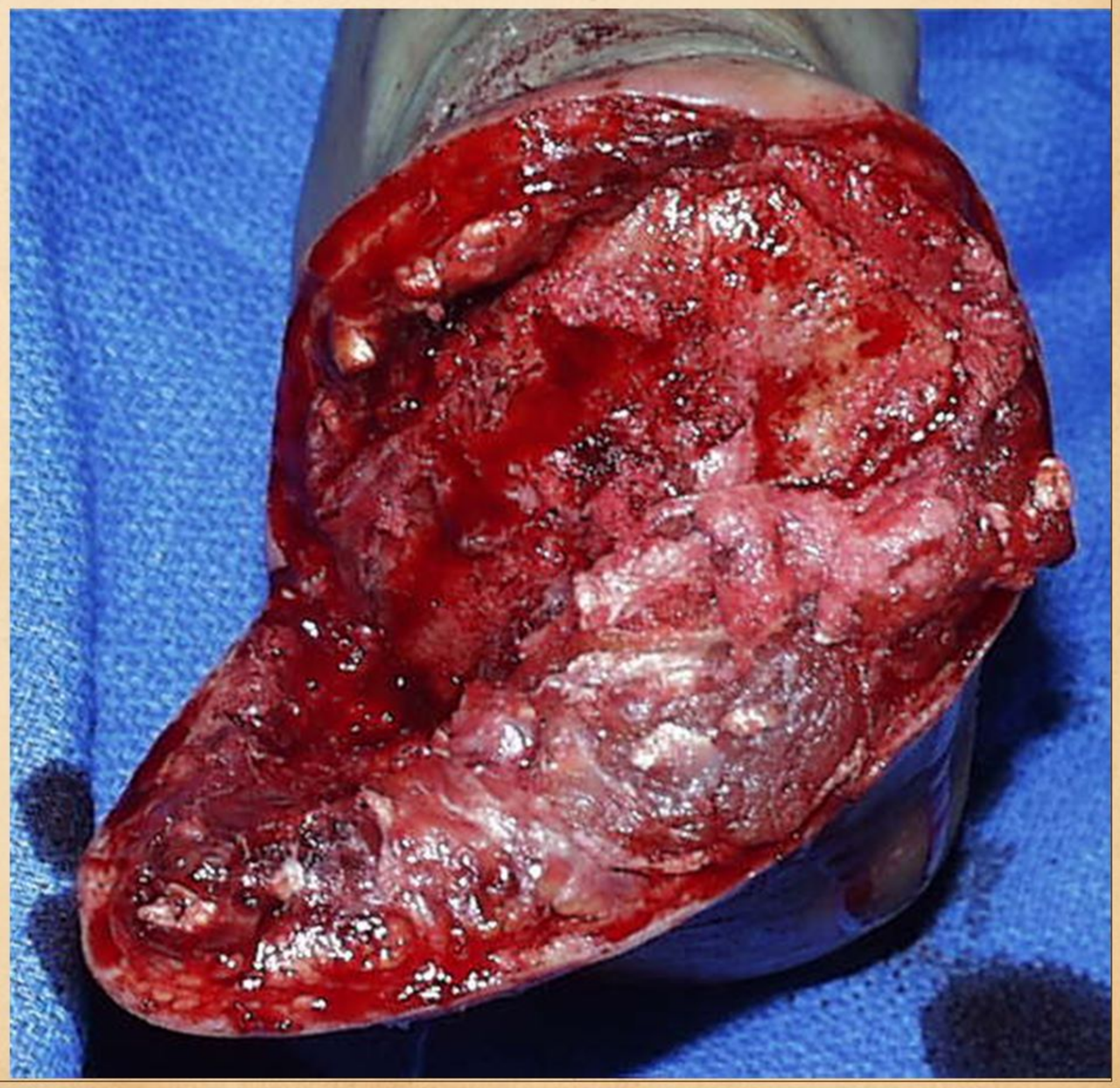
recurrent fibrosarcoma of knee

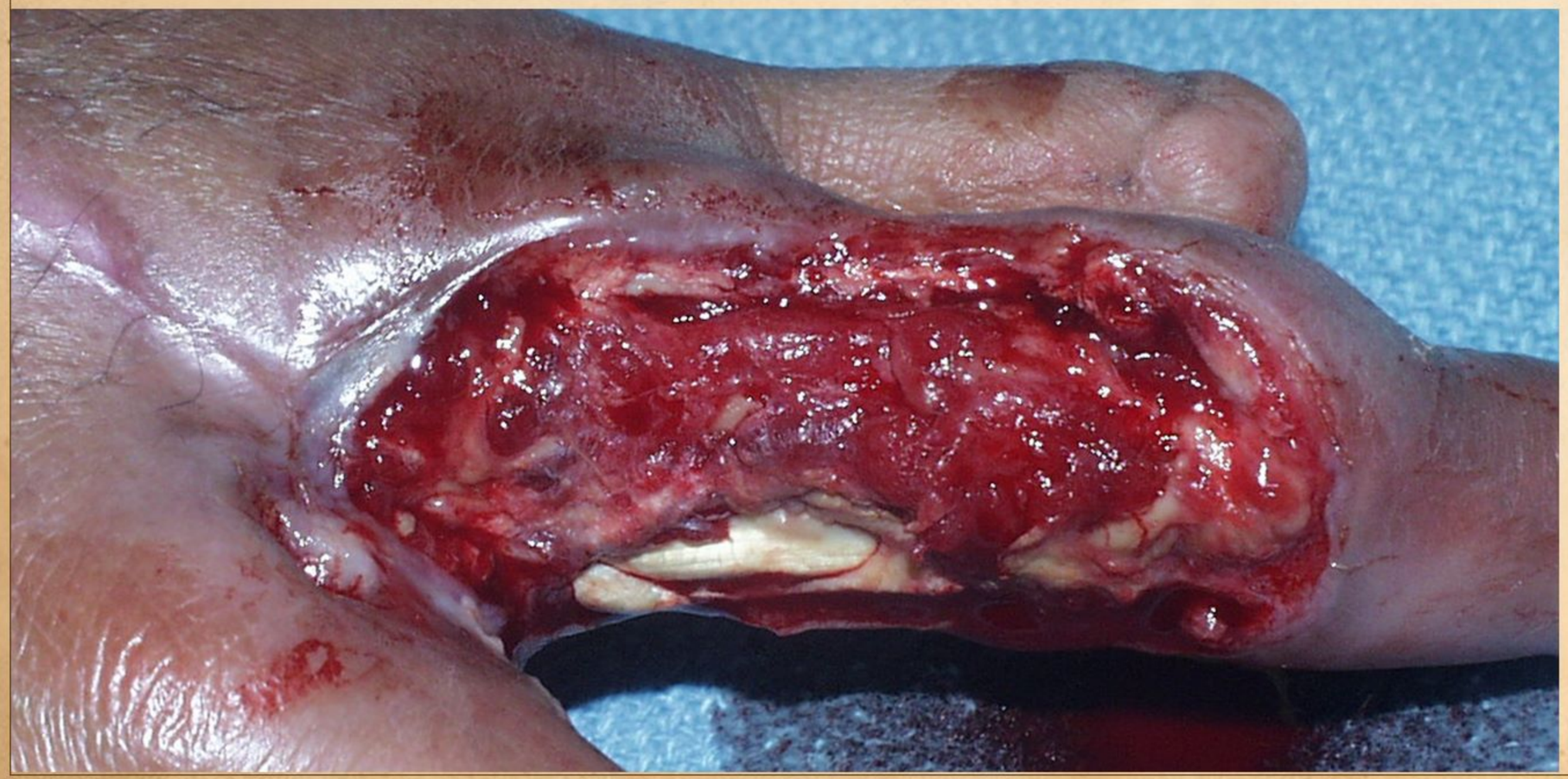
thin flaps

radiation

28 m

traumatic crush of forefoot





42 f

human
bite
injury

tenosynoviti

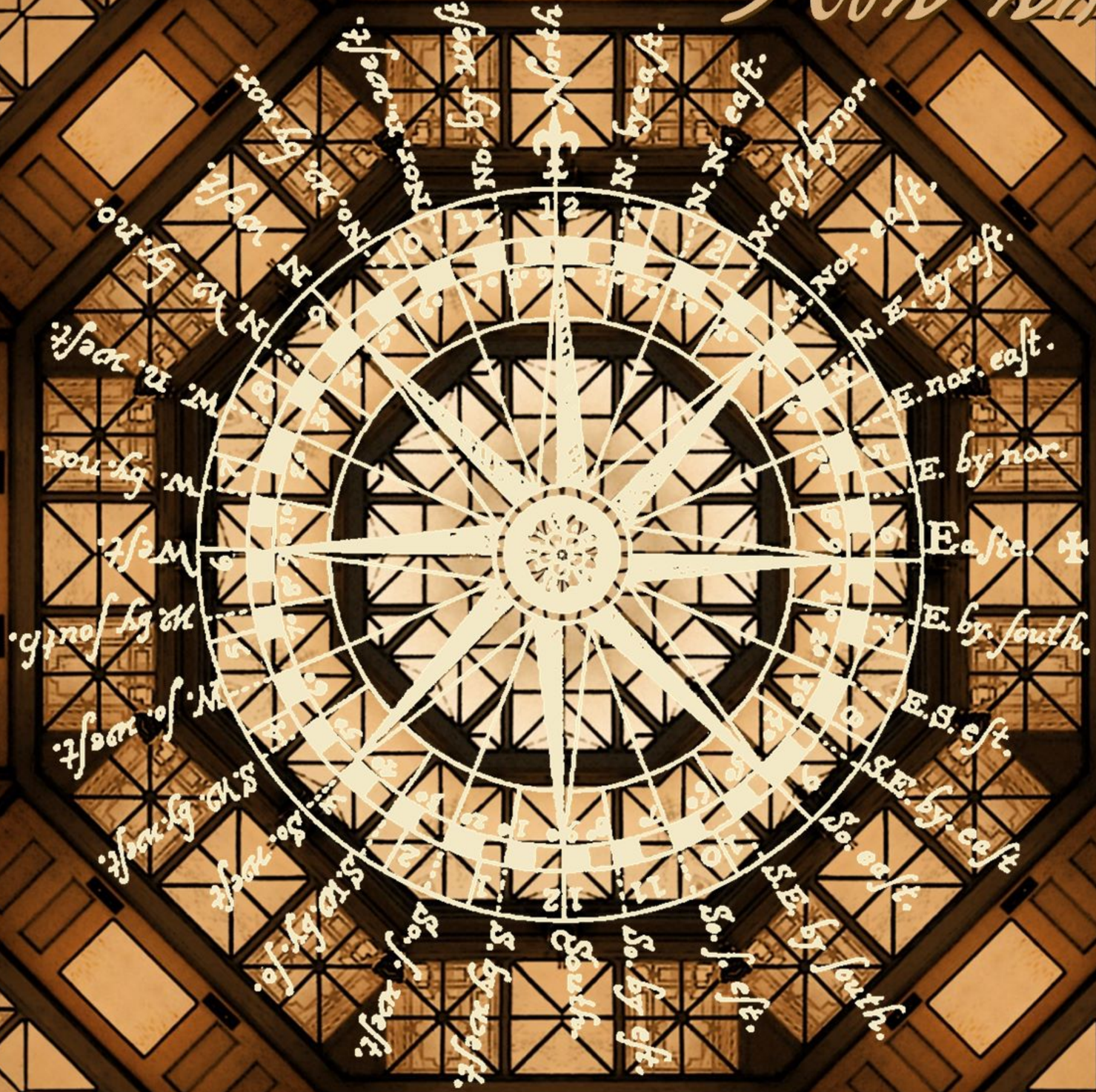
43 m

motorcycle injury

hand

fractures

Now which way?



65 f

Wegener's granulomatosis

Caveats

Active immunopathy puts wounds and autogenous repair at risk.

Patient's severe pulmonary disease prevents any prolonged surgery and anesthesia.

55 f

fall

impact injury

lacerations, hematoma

67 f

ischemic infarction

Caveats

No local flaps.

Skin grafts ineligible over bone and joint.

Potential free flap, into the bypass graft, but inadvisable due to cardiovascular risks.

52 f

puncture wound

abscess

33 m

venous hypertension

Factor V Leiden

Caveats

Skin grafts have failed. Local flaps too small.

Latissimus f.f. disabling in a working man.

Omentum and rectus abdominis f.f. prone to ventral herniation in an obese patient.

High risk of any flap thrombosis.

33 m

machinery versus pedestrian

avulsion – degloving

64 m

aorto-iliac occlusive disease

39 m

knee fibrosarcoma

thin flaps

radiation

Caveats

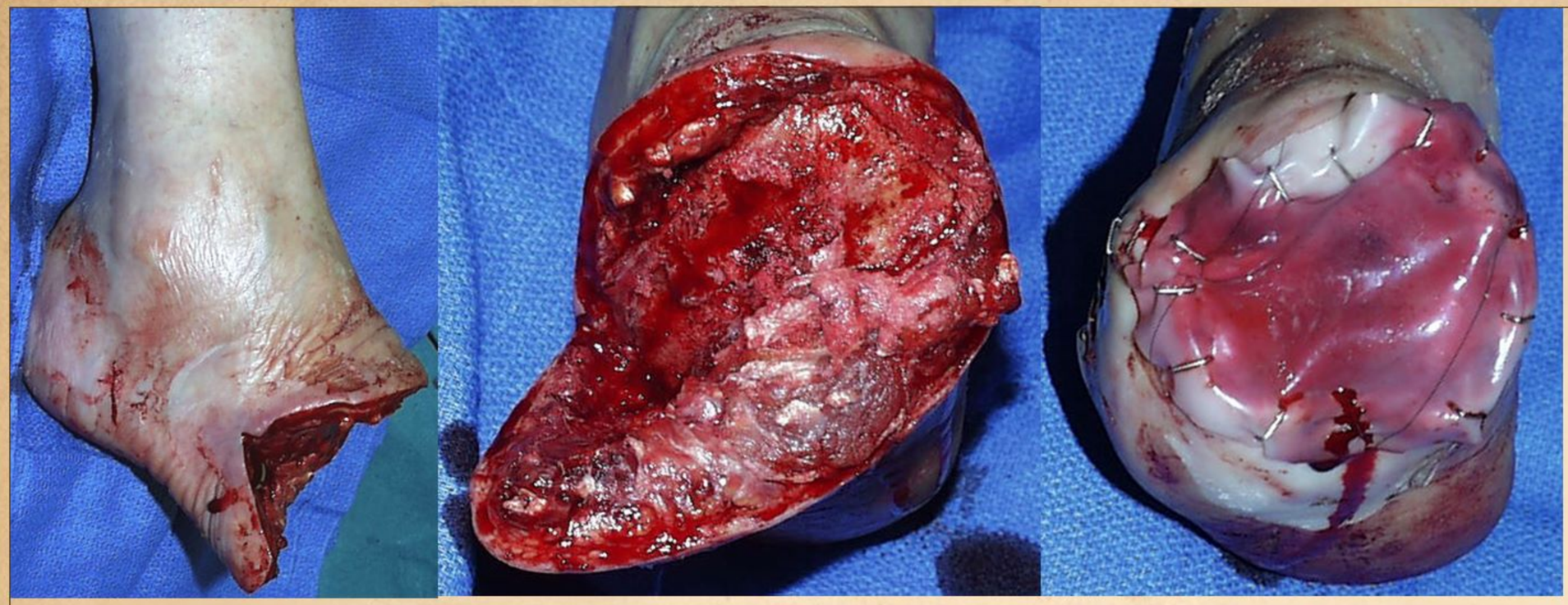
Any incision on this thigh is prone to pathergy and necrosis.

Local flaps and repair will die.

Abdominal flaps (e.g. rectus abdominis) will fail from ischemia

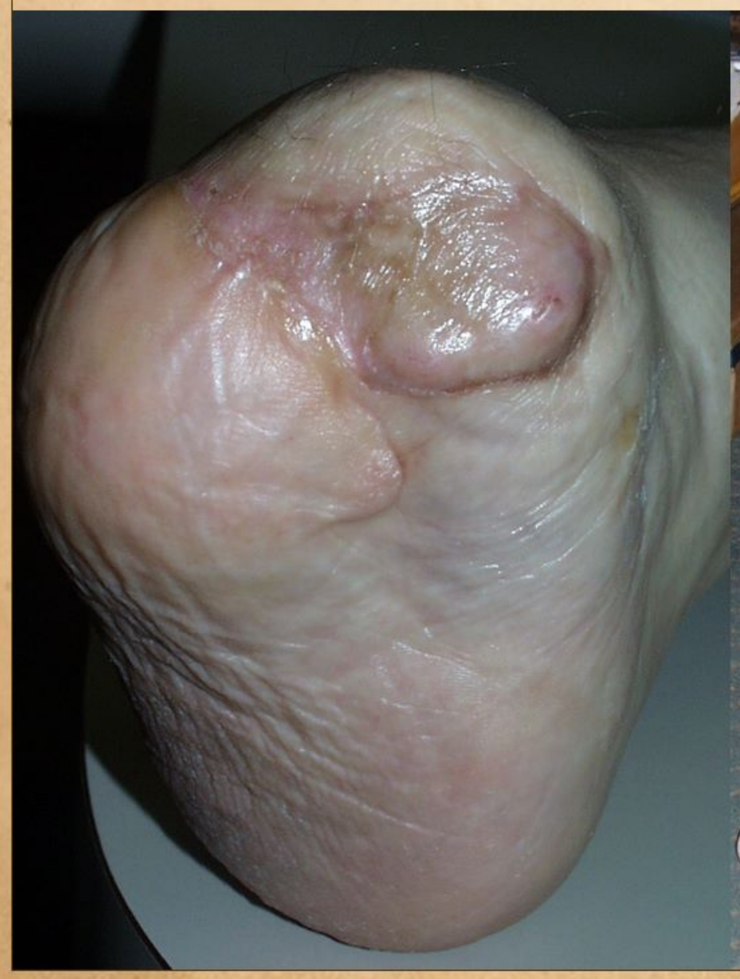
Latissimus free flap contraindicated in a wheelchair bound patient . . .

but moot because there is no connection for a free flap.



28 m

traumatic crush of forefoot



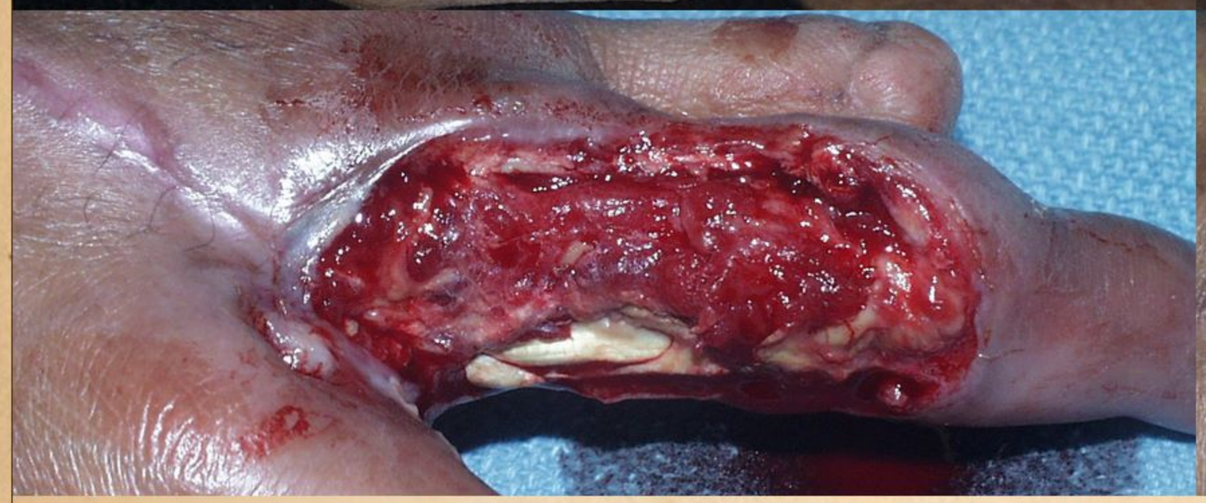
73 m
embolic necrosis

Caveats

No local flaps.

Skin grafts ineligible over bone and joint.

Free flaps precluded by vascular disease and cardiovascular risks.



Caveats

42 f

diabetes

atherosclerosis

Local flaps are not big enough.

Flap failure likely due to vascular disease.

No recipient vessels for a free flap.

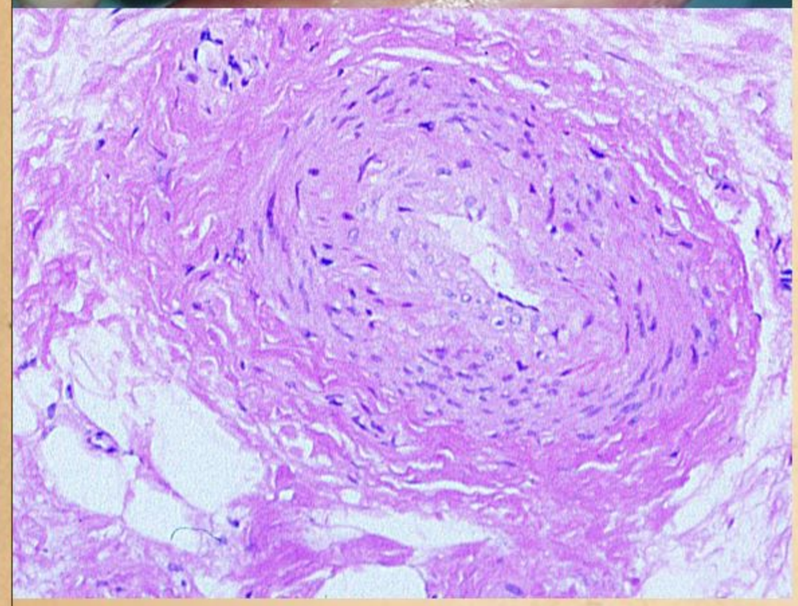
Any incision prone to pathergy and necrosis
(why the hand is this way to begin with).

Patient cannot afford to lose more of the hand.

42 f

human bite

tenosynovitis



43 m

scleroderma

vasculopathy

43 m

motorcycle injury

hand abrasion

Caveats

Any incision prone to pathergy and necrosis.

Flaps will not move properly due to sclerotic skin.

Hand is severely disabled, and cannot afford further loss.

Active immunopathy puts wounds and repair at risk.

INTEGRA VERSUS CONVENTIONAL SURGERY

In each of these cases, conventional plastic surgery rules dictated a flap to close exposed essential structures, restore function, or salvage limbs.

In each, caveats of disease and local anatomy militated against flaps.

Because Integra can circumvent most of these exceptions,

each case had a successful outcome by reconstructing skin with Integra.

Integra: Successful Surgery when other Options Fail

There are problem wounds that conventional surgery cannot solve.
There are times when flaps cannot be done or will not survive.

Then what ?

Understanding when a flap should be used, but cannot be used,
is to understand when Integra should be used in lieu of conventional surgery.

Wound Repair Surgery

Axiom 1: There are three conventional paradigms of wound repair surgery: simple repair, grafts, and flaps.

Axiom 2: These paradigms have a common biological basis: all three depend on normal healthy wound healing (the physiological process of reactive post-inflammatory fibroplasia and contraction.

Axiom 3: Simple repairs and grafts succeed when host & target are healthy and wound healing is competent.

Axiom 4: If the target is pathological and incompetent to heal, but the host is generally healthy, then repair and grafts will fail, but healthy flaps succeed.

Axiom 5: When systemic illness or wound healing pathologies are the basis of the chronic wound, then none of the classic paradigms of surgery will work.

Clinical Effects of Integra

Integra has remarkable properties:

Single device has dual role:
- first, it is a high grade acute artificial skin
- it then becomes the agent of skin regeneration and reconstruction

Not alive, so tolerant of adverse wound conditions.
"Hides" the wound from the host.
Complete suppression of inflammation.
Controls pathological behavior & chaotic dynamics.

No inflammation >> no wound healing >> no scar.
Embryonic dermatogenesis >> dermal equivalent.
No contraction.
Tangential histoconduction.

Effects on chronic wounds:

Integra can survive and tame harsh wound conditions. By closing defects, and suppressing inflammation and recognition of the wound, Integra eliminates inflammatory stressors on the wound, thereby allowing chaotic dynamics to stabilize in a benign state, permitting pathological wounds the chance to recover and regenerate.

Reasons why flaps, grafts, and other repairs cannot or should not be done.	Reasons why Integra can trump the caveats of flaps, grafts, and other repairs.
Persistent disease or inflammation prevent repair.	Not alive; tolerates harsh conditions. Suppresses residual inflammation.
Local conditions will not support a graft.	Not alive at the outset - it survives where grafts fail.
Flaps not large enough or may not reach the target.	Not autogenous; quantity and procurement irrelevant.
Local vasculature precludes flap design or execution.	Not alive, so it endures ischemia, survives, and is completely safe. ***
Illness and comorbidities make surgery too risky.	Placing Integra is simple, with no physiological tax.
Flaps can sacrifice useful parts and function.	No autogenous tissue donation.
Failed flaps waste anatomy and limit further options.	No autogenous tissues. No failures, no waste.
Inflammation and disease can threaten a flap.	Not alive, tolerant, suppresses inflammation - so preferred in these conditions.
Vascular disease can kill a flap.	Circulation-independent, survives where flaps cannot.
Hematological disorders can kill a flap.	Not alive, tolerant of incidental pathology and injury.
Connective tissue disorders and wound pathologies will prevent healing or cause progressive ulceration.	Tolerant of incidental pathology and injury; potent ability to withstand effects of connective tissue immunopathy and pathology.
Any disorder which caused the pathological wound will cause comparable problems for the repair.	Integra not dependent on normal wound repair physiology – regenerative matrix - suppresses repair - induces histogenesis.
Similar risks for the donor site, enlarging the problem.	No donor sites, no risk.
Risk of contractures after grafts.	Regenerates dermis, not scar. No contractures.
Normal repair cannot bridge across voids and alloplastics.	Tangential histoconduction can bridge voids.

Example, suppress inflammation.

Advanced rheumatoid arthritis, factor V Leiden, and low proteins C & S. Ankle wound refractory to multiple therapies. Complete arrest of inflammation with Integra. The healed reconstruction endured disease flare-up, even as other areas ulcerated (opposite ankle).

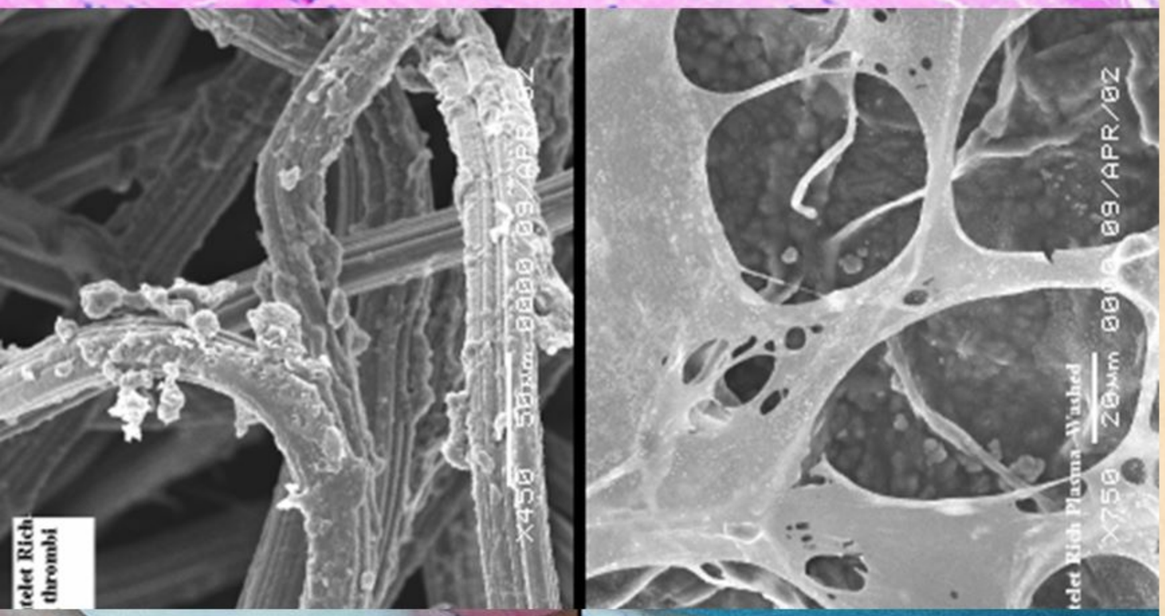
Example, control pathological behavior.

Granulomatous panniculitis of leg, of uncertain etiology. Many failed skin grafts, with persistent inflammation, exudates, and marginal necrosis. Complete arrest of pathology after Integra. Healed reconstruction after epidermal overgrafts.

Example, tangential histoconduction.

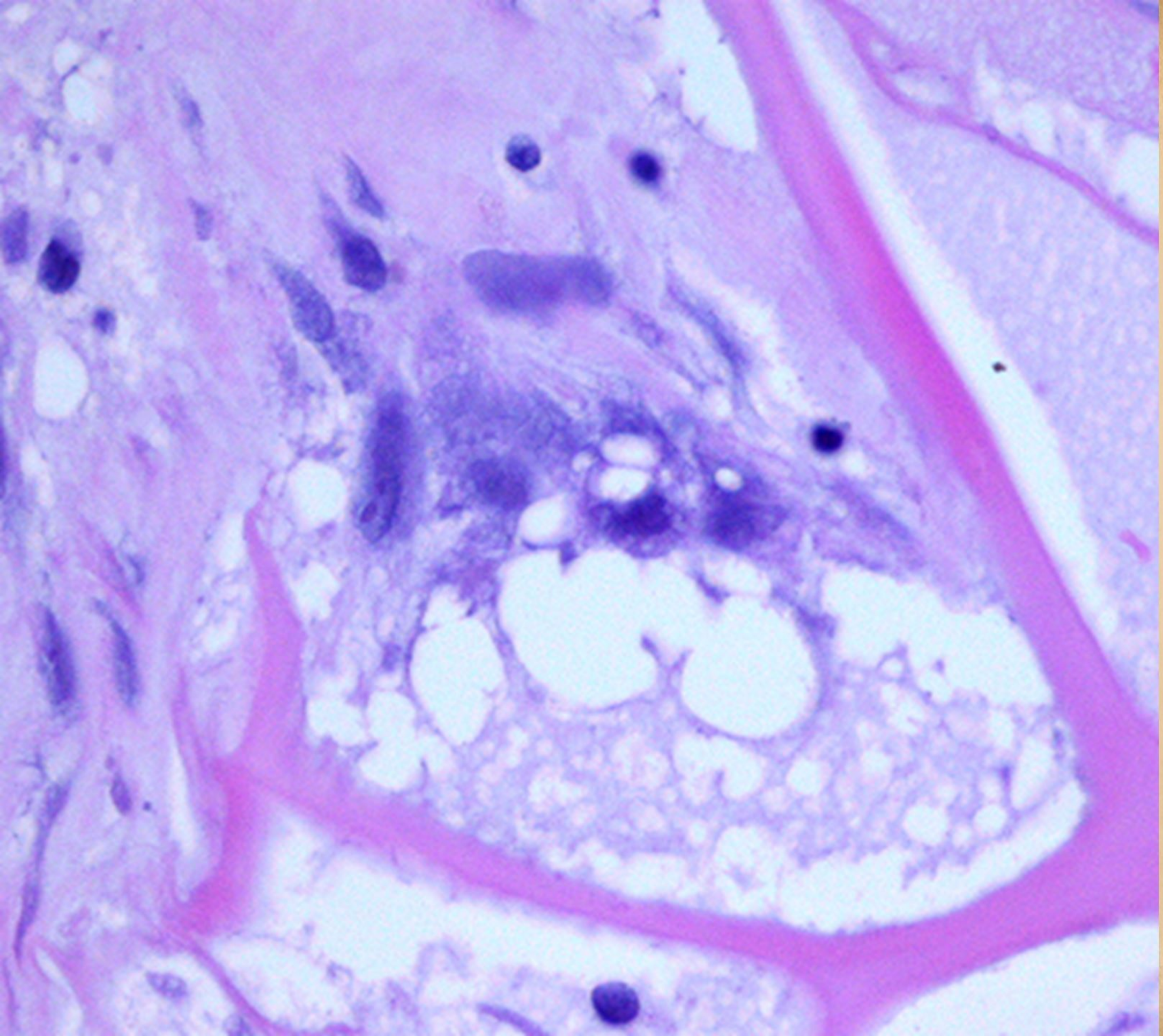
Open plate and ankle fracture. Standard care" requires flaps, but multiple free flaps failed. Integra matrix supports horizontal histoconduction, used to here grow new tissue over the open structures. Long term stable healed result, plate still in.

Arrest of inflammation

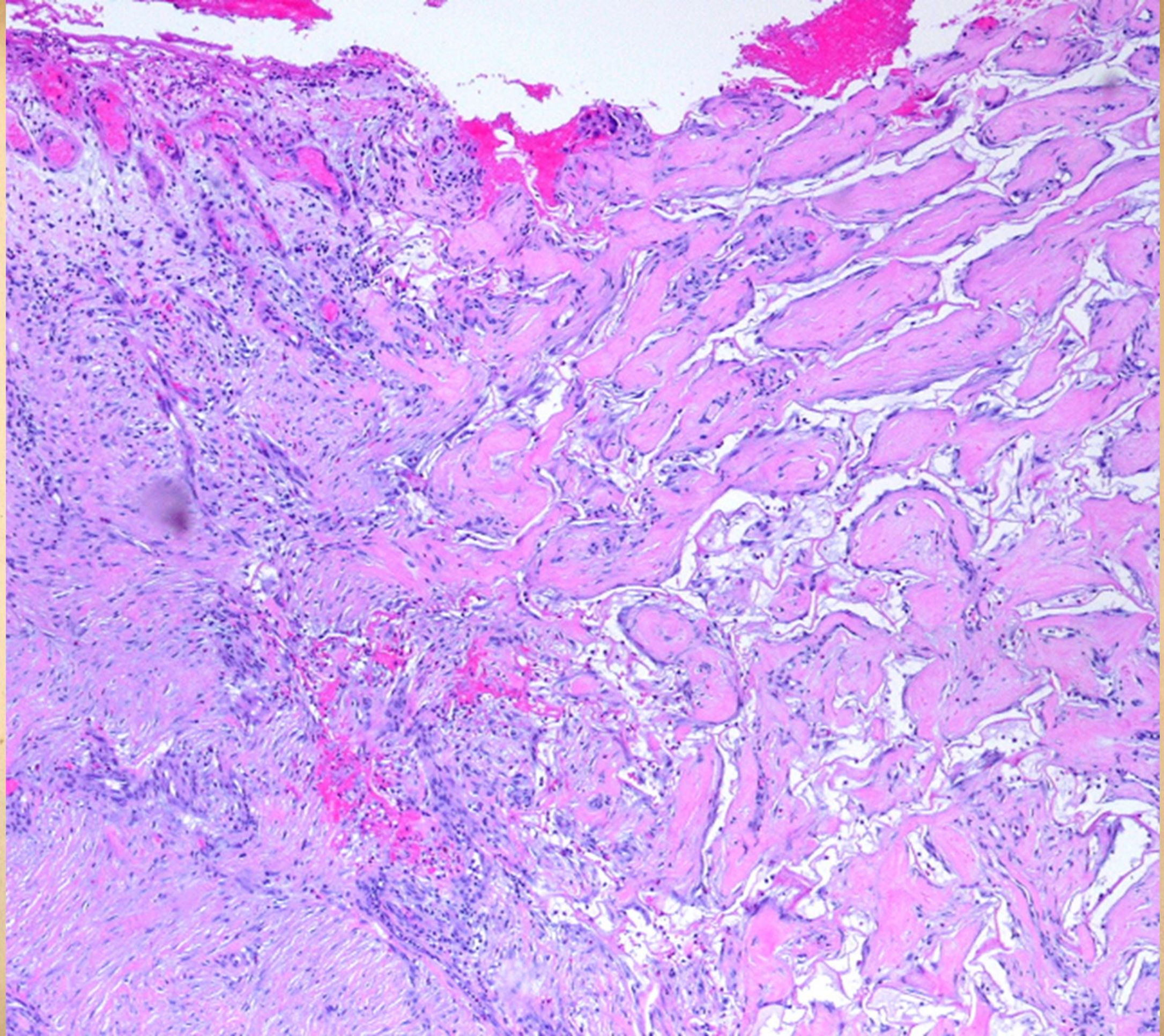


Pioneer cells: matrix recognition

Transition



Syncytial fibroblasts = the embryonic dermatoblast



About Surgery . . .

Surgery cures many problems.
It should be used when appropriate.

For some problem wounds, conventional surgery can solve the problem, but it might be best avoided due to unreasonable risks of failure or risk to the patient.

There are some problem wounds that conventional surgery simply cannot solve.

About Flaps . . .

Flaps are the romantic heroes of reconstructive plastic surgery. They have a pivotal role in the closure of complex wounds.

When the stakes are high for successful closure, good flaps get the job done.

. . . BUT . . .

There are times when flaps simply cannot be done or will not survive.

. . . THEN WHAT ? . . .

Sir Flapalot

Understanding when a flap should be used, but cannot be used, is to understand when Integra should be used in lieu of conventional surgery.

Integra for chronic pathological wounds - Outcomes, by diagnosis

Diagnostic category (% of patients per category)	fully healed	> 2/3 healed	< 2/3 healed	failed
Macro-arterial	58	8	16	18
Immunopathic	74	16	5	5
Venous / lymphedema	88	---	6	6
Hypercoagulable	86	---	14	0
Mechanical / anatomical	88	12	---	0
Radiation / malignancy	72	28	---	0
Diabetes / neuropathy	0	20	40	40
Unknown	60	20	20	0
Micro-occlusive	100	---	---	0
Trauma / surgery	100	---	---	0
Granulomatous / infectious	50	50	---	0
Adjunct	100	---	---	0
Total	**71**	**10**	**10**	**9**

Integra used to close chronic wounds.

120 patients.

90%
of exposed bones, joints, tendons and organs were successfully closed.

If patients now recognized as poorly selected are excluded (extreme arterial insufficiency, and diabetic plantar ulcers), the success rate for healed wounds was 92%.

Gottlieb ME, Furman J: Successful Management and Surgical Closure of Chronic and Pathological Wounds Using Integra®. Journal of Burns & Surgical Wound Care, 3:2, 2004. (journalofburnsandwounds.com).

Gottlieb ME. Management of Complex and pathological Wounds with Integra. In: Lee BY, ed. The Wound Management Manual. New York, McGraw-Hill, 2004: 226-289. (ISBN 0-07-143203-5).

77 m *rheumatoid*

No Integra.

Flaps and grafts.

71 f rheumatoid

77 f sjogren's

11 f
burn contractures

44 m necrotizing fasciitis

61 f keloid

WOUND & SCAR

HOW DO YOU OVERCOME WOUND & SCAR?

58 m intra-arterial injection

53 m

diabetes

atherosclerosis

90 f

aso /
pvod

84 f

diabete

aso /
pvod

60 m diabetes,

50 f

tibia fracture

hyper-coagulable ???

failed free flaps

About Surgery . . .

Surgery cures many problems.
It should be used when appropriate.

For some problem wounds, conventional surgery can solve the problem, but it might be best avoided due to unreasonable risks of failure or risk to the patient.

There are some problem wounds that conventional surgery simply cannot solve.

About Flaps . . .

Flaps are the romantic heroes of reconstructive plastic surgery. They have a pivotal role in the closure of complex wounds.

When the stakes are high for successful closure, good flaps get the job done.

. . . BUT . . .

There are times when flaps simply cannot be done or will not survive.

. . . THEN WHAT ? . . .

Sir Flapalot

LE MORTE DE
Flapalot

A FOURTH INDEPENDENT PARADIGM OF SURGERY

In-Situ Tissue Engineering

Integra is a distinct new paradigm of surgical wound closure, in-situ tissue engineering. Unlike repairs, grafts, flaps, it does not depend on normal wound repair. On the contrary, it suppresses normal repair, initiating embryonic histogenesis. It succeeds where conventional modalities fail.

Integra: not an Alternative, the Indicated Option

In the cases presented, Integra was the preferred option, not just because flaps and grafts would not have worked, but also because it was the most suited modality – superior results with less risk.

The Knight of Pathological Wounds

There are many chronic wounds that conventional surgery simply cannot solve. Flaps remain the heroes of reconstructive plastic surgery. But for closing problem pathological wounds, Integra is the modern Excalibur.

REGENERATIVE MATRICES AND IN SITU TISSUE ENGINEERING

THE FOURTH PARADIGM OF WOUND REPAIR AND THE DAWN OF REGENERATIVE SURGERY

Understanding when a flap should be used, but cannot be used, is to understand when Integra should be used in lieu of conventional surgery.

A cure for chronic and pathological wounds.

A cure for scar and wound healing related problems.

A better option than conventional wound-healing-dependent surgery for many problems of acute coverage and reconstruction.

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PRINCIPLES OF WOUND REPAIR SURGERY

FLAPS & REGENERATIVE MATRICES

CONCEPTS & TECHNIQUES

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