Update on Open Fractures: Mainly Open Tibial Fracture

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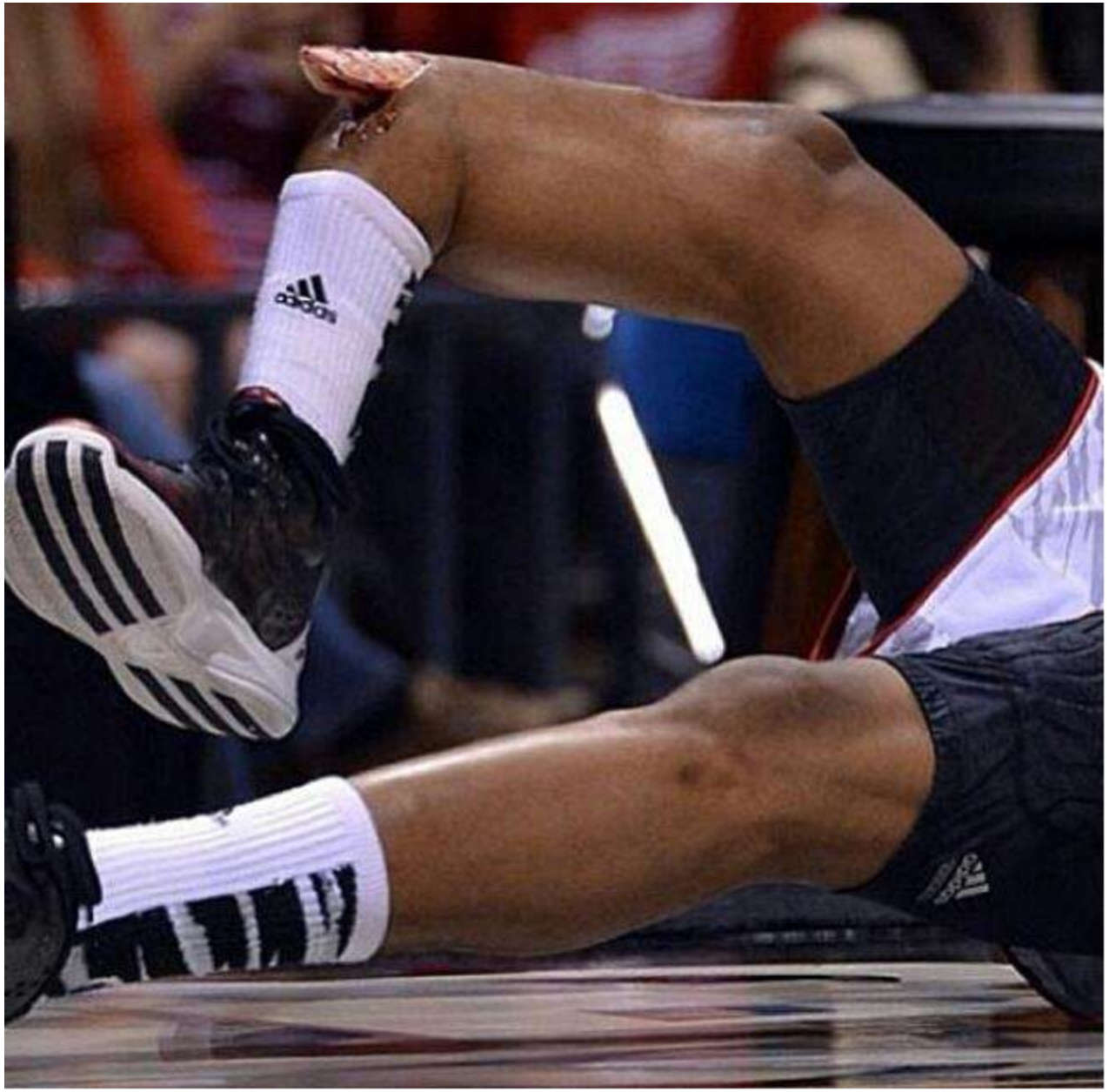


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SUMMARY

- TIMING OF INTRAVENOUS ANTIBIOTICS MATTERS (early > later)
- TIMING OF DEBRIDEMENT *MATTERS LESS*
- LIBERAL USE OF ANTIBIOTIC BEAD POUCHES , VAC DRESSINGS, COMPOSITE BIOLAYERS
- IMMEDIATE WOUND CLOSURE APPPEARS TO BE REASONABLE IF A THOROUGH DEBRIDEMENT WAS PERFORMED…..CULTURE - WOUNDS
- DURATION OF I.V. ANTIBIOTICS SHOULD PROBABLY CONTINUE TO BE AT LEAST 72 HOURS
- THE QUALITY OF THE DEBRIDEMENT PROBABLY MATTERS….*MOST*
- THIS IS MORE IMPORTANT THAN THE METHOD OF *STABILIZATION!!*

FACTORS FOR INFECTION
OPEN FRACTURES

- ANTIBIOTICS
- DEBRIDEMENT
- ROLE OF ANTIBIOTICS / BEADS
- WOUND MANAGEMENT
- FIXATION

WOUND MANAGEMENT PROTOCOLS

- WOUND / Fx STABILIZATION
- IRRIGATION AND DEBRIDMENT
- DEAD SPACE MANAGEMENT
- SOFT TISSUE COVERAGE
  - TEMPORARY
  - DEFINITIVE

Anglen, J. JAAOS,Jul-Aug;9(4):219-26, 2001

TIMING OF DEBRIDEMENT

- NO DIFFERENCE BETWEEN EMERGENT AND *EARLY* DEBRIDEMENT
- PATZAKIS CORR 243, 1989
  HARLEY JOT 16(7), 2002
  SKAGGS J PED ORTHO 20(1), 2000
  SKAGGS JBJS 87A 2005

TIMING OF DEBRIDEMENT

- NO STUDIES HAVE SHOWN A CLEAR BENEFIT TO EMERGENT DEBRIDEMENT OF OPEN FRACTURES
- TIMING OF INTRAVENOUS ANTIBIOTICS MAY BE MORE IMPORTANT

THE BONE & JOINT JOURNAL

■ TRAUMA

Delayed debridement of severe open fractures is associated with a higher rate of deep infection

P. D. Hull,
S. C. Johnson,
D. J. G. Stephen,
H. J. Kreder,
R. J. Jenkinson

From Sunnybrook Health Sciences Centre, Toronto, Canada

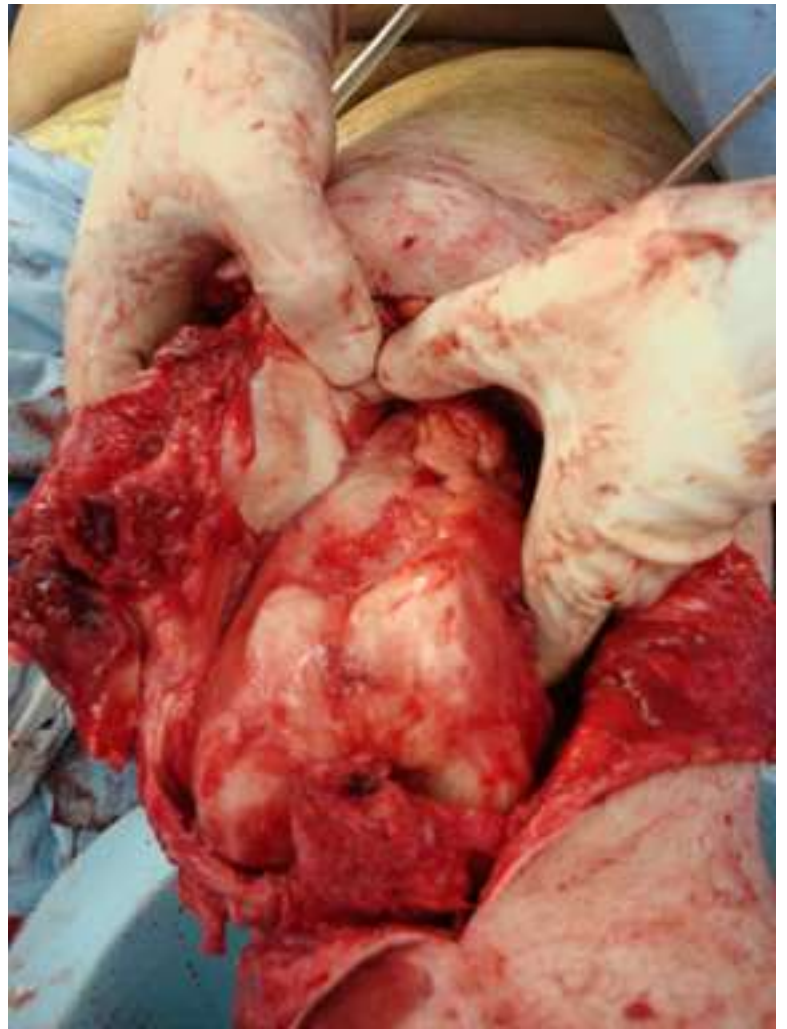
- Deep Infection Associated With Tibial Fractures
- Higher Gustilo-Anderson Grade
- Contamination Of The Fracture
- Factors Are Additive….. Delayed Debridement Will Have A Clinically Significant Detrimental Effect On More Severe Open Fractures.

HOW TO DEBRIDE

- NO TOURNIQUET
- SHARP DEBRIDEMENT FIRST
- START AT SKIN
- SUBCUTANEOUS FAT
- MUSCLE
- BONE, DELIVER ENDS, AND CURRETTE
- LASTLY, IRRIGATE AND RE-INSPECT….

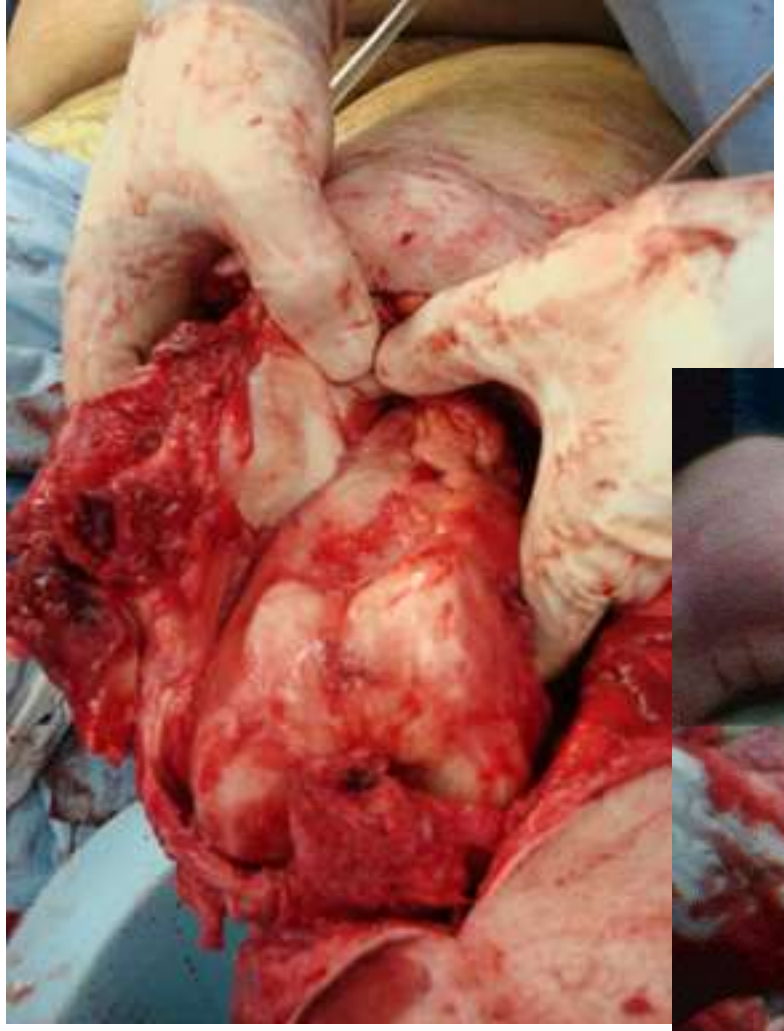
HOW TO DEBRIDE

- MUSCLE VIABILITY:
  - ❖ COLOR
  - ❖ CAPACITY TO BLEED
  - ❖ CONSISTENCY
  - ❖ CONTRACTILITY



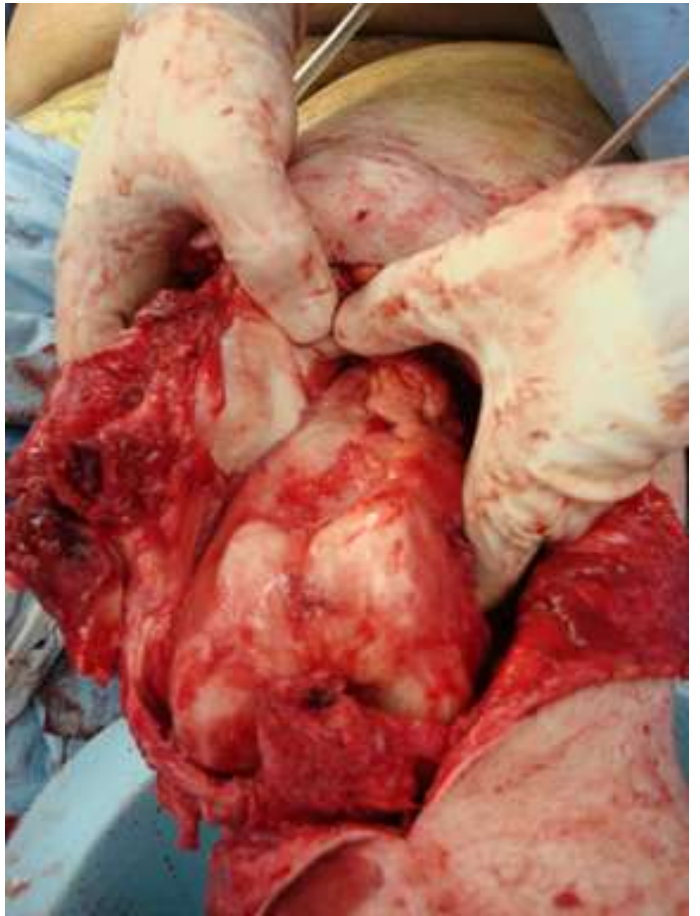
HOW MANY DEBRIDEMENTS?

- JUDGEMENT CALL
- AGGRESSIVE DEBRIDEMENT AND DEAD SPACE MANAGEMENT vs PRIMARY CLOSURE
- POST DEBRIDEMENT CULTURES
  - CONTINUE UNTIL CULTURE –
  - PROCEED WITH WOUND COVERAGE



SOFT TISSUE CLASSIFICATION

- GUSTILLO, TSCHERNE
  - ❑A GUIDE…..NOT A *COOKBOOK*
- CONTAMINATION
  - ❑NOT A CONTRAINDICATION TO HARDWARE Rx (ASSUMING A THOROUGH DEBRIDEMENT)
  - ❑UPPER EXTREMITY vs LOWER EXTREMITY



Soft Tissue Injury > Osseous Injury

Edwards, 1965

Bauer, 1962

Gustilo Open Fx Class

JBJS, 72A: 299-303, 1990

Fracture Type	Description	
Type I	Skin opening of 1 cm or less, quite clean. Most likely from inside to outside. Minimal muscle contusion. Simple transverse or short oblique fractures.	2%
Type II	Laceration more than 1 cm long, with extensive soft tissue damage, flaps, or avulsion. Minimal to moderate crushing component. Simple transverse or short oblique fractures with minimal comminution.	7%
Type III	Extensive soft tissue damage including muscles, skin, and neurovascular structures. Often a high-velocity injury with severe crushing component.	7%
Type III A	Extensive soft tissue laceration, adequate bone coverage. Segmental fractures, gunshot injuries.	**10-50%**
Type III B	Extensive soft tissue injury with periosteal stripping and bone exposure. Usually associated with massive contamination.	**25-50%**
Type III C	Vascular injury requiring repair.	

Open Fractures

CLASSIFICATION

wound **contamination** **Soft-tissue injury** Bone injury

- WHAT FACTORS ALWAYS MAKE AN OPEN Fx A Gd III?
  - SHOTGUN WOUND
  - HIGH VELOCITY GUNSHOT WOUND
  - SEGMENTAL Fx WITH DISPLACEMENT
  - Fx WITH VASCULAR INJURY REQUIRING REPAIR
  - FARMYARD INJURY
  - CRUSHING INJURY
  - OTHER HIGH ENERGY MECHANISM

IRRIGATION AND DEBRIDMENT

- PULSITILE JET LAVAGE
- BULB IRRIGATION
- FOCUSED FLUID JET DEBRIDMENT

IRRIGANT VOLUME

- INCREASED VOLUME
  - MORE PARTICLUATE / BACTERIAL REMOVAL
  - SYSTEM DEPENDENT
    - Gd 1 - 3 LITERS
    - Gd 2 - 6 LITERS
    - Gd 3 - 9 LITERS

IRRIGANT ADDITIVE

- ANTISEPTIC IRRIGATION
  - BETADINE
  - HIBITANE
  - DAKIN'S SOLUTION(SODIUM HYPOCHLORIDE)
  - BENZALKONIUM CHLORIDE
  - ALCOHOL ADJUVANTS
    - *NO CONVINCING EVIDENCE DEMONSTRATING DECREASE BACTERIAL LOAD*
    - *GOOD EVIDENCE FOR TISSUE DAMAGE TO OCCUR WITH THEIR USE*

IRRIGANT ADDITIVE

- SURFACTANTS
  - SOAP SCRUB / WASH
    - IMPROVES REMOVAL OF DIRT AND INTERFERES WITH BACTERIAL ADHESION

      LOW RISK TO PATIENT

    CLINICAL EFFICACY YET TO BE DETERMINED IN REDUCING INFECTION

IRRIGANT ADDITIVE

- ANTIBIOTIC IRRIGATION
  - ❑BACITRACIN
  - ❑POLYMYXIN
  - ❑NEOMYCIN
- PATIENT SAFETY
  - ❑ANAPHYLAXIS
  - ❑COST
  - ❑BACTERIAL RESISTANCE
- *NO PROVEN VALUE IN THE CARE OF OPEN FRACTURE WOUNDS*

NORMAL SALINE

J Bone Joint Surg Am. 2009 Jan;91(1):92-8.

Comparison Of Irrigation Solutions And Devices In A Contaminated Musculoskeletal Wound Survival Model.

Owens BD, White DW, Wenke JC.

- Pulse lavage vs bulb irrigation using various irrigant solutions…..
- At 48 hrs, the bacterial levels in the pulsed lavage group rebounded to 94%
- 48% in the bulb syringe group.(p =0.048).

- Normal saline solution, bacitracin solution, castile soap, and benzalkonium chloride
  - Greatest reduction 1)castile soap, 2)benzalkonium chloride, 3)bacitracin, and saline
- The highest rebound was measured in the castile soap group, which rebounded to 120% of the pretreatment level
- Normal saline solution lowest rebound at (68%)

- CONCLUSIONS:

  Approaches used to remove bacteria from wounds, such as irrigants (other than saline solution) or high-pressure devices, may not have the best clinical outcome. (potable water also effective)(71% REDUCTION)

J Orthop Trauma. 2012 Aug 7.

Comparison Of The Antimicrobial Effect Of Chlorhexidine And Saline For Irrigating A Contaminated Open Fracture Model.

Penn-Barwell JG, Murray CK, Wenke JC.

- No statistical difference detected between the subsequent presence or quantity of bacteria following irrigation with aqueous CHG at a range of concentrations compared irrigation with saline alone
- May be due to the anti-bacterial effect of CHG being offset by the associated host tissue toxicity.

IRRIGANT FREQUENTCY (PULSITILE)

- IN THEORY….. REMOVAL OF SURFACE DEBRI BY TISSUE ELASTICITY
- NOT ESTABLISHED….CONJECTURE ONLY
- NO CURRENT RECOMENDATINS AS TO (PULSE) BENEFITS (MAKES A NICE SQUIRT GUN IN YOUR POOL)

IRRIGANT PRESSURE

- INCREASE IN PRESSURES REMOVE INCREASED DEBRI AND BACTERIA
- HIGHER PRESSURES MAY DAMAGE BONE / SOFT TISSUES….(AIR INSUFFLATION)
  - ❑DELAY Fx HEALING
  - ❑INCREASE INFECTION RISK
- SELECT SYSTEM WITH VARIABLE SETTINGS
  - ❑LOW OR MIDDLE RANGE

HIGH VOLUME / LOW PRESSURE

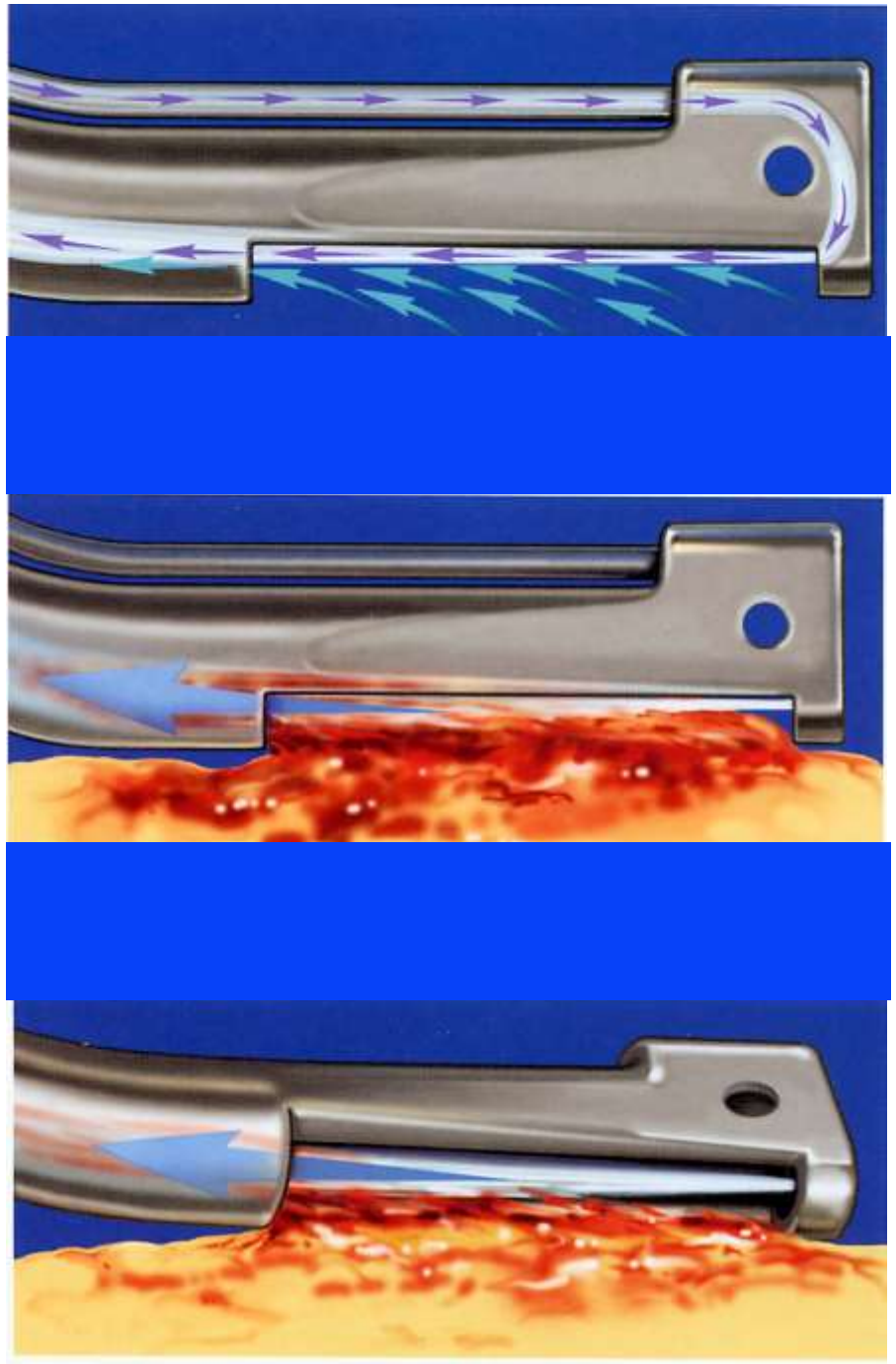
CONCLUSIONS

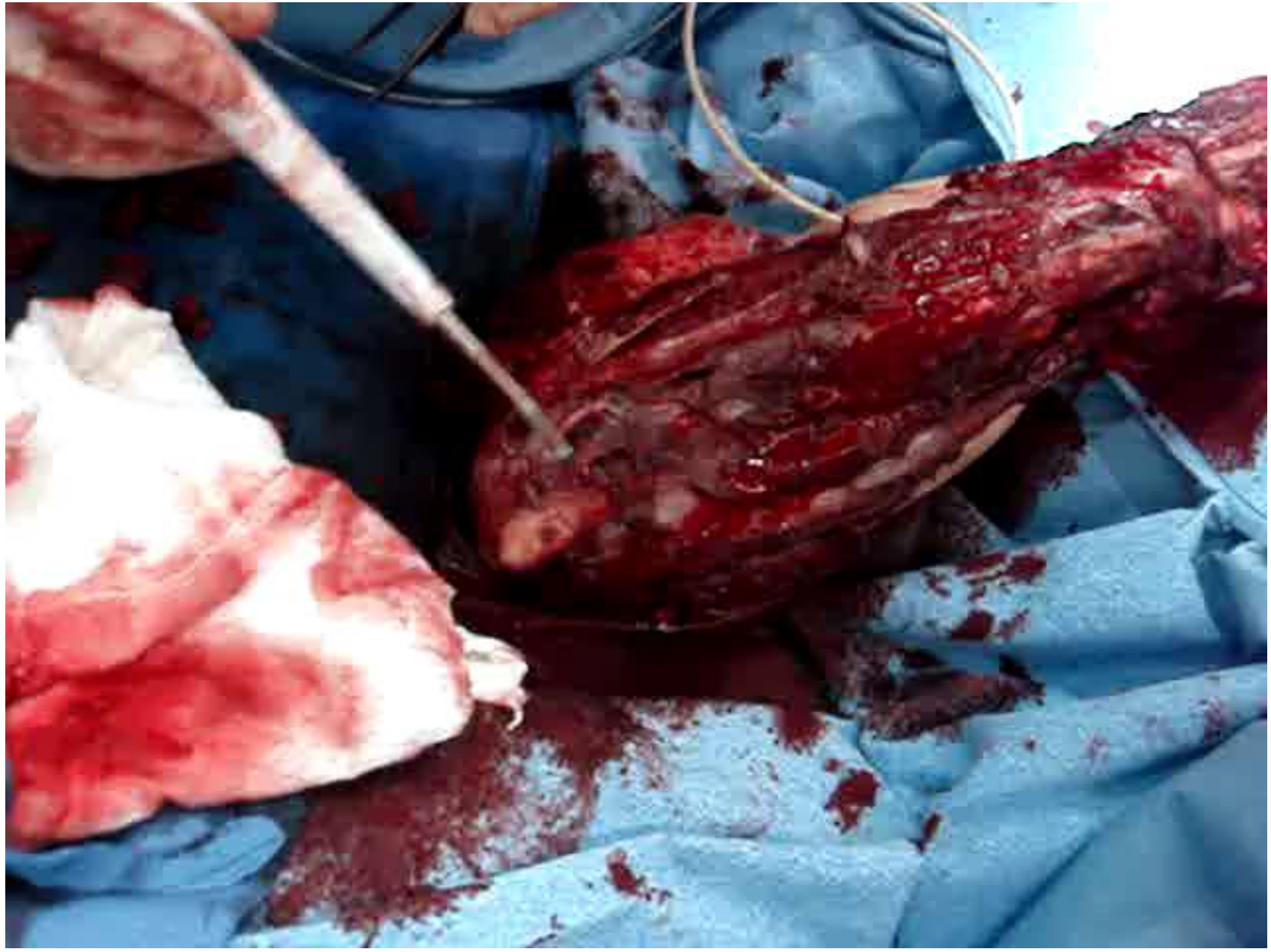
- Host tissue damage from high irrigation pressures and cytotoxic solutions have been shown to allow bacteria to thrive.
- This is due to a 're-bound' of bacteria growth in a wound bed containing small quantities of necrotic tissue damaged by cytotoxic solution exposure as well as the devitalization of the injury itself……..

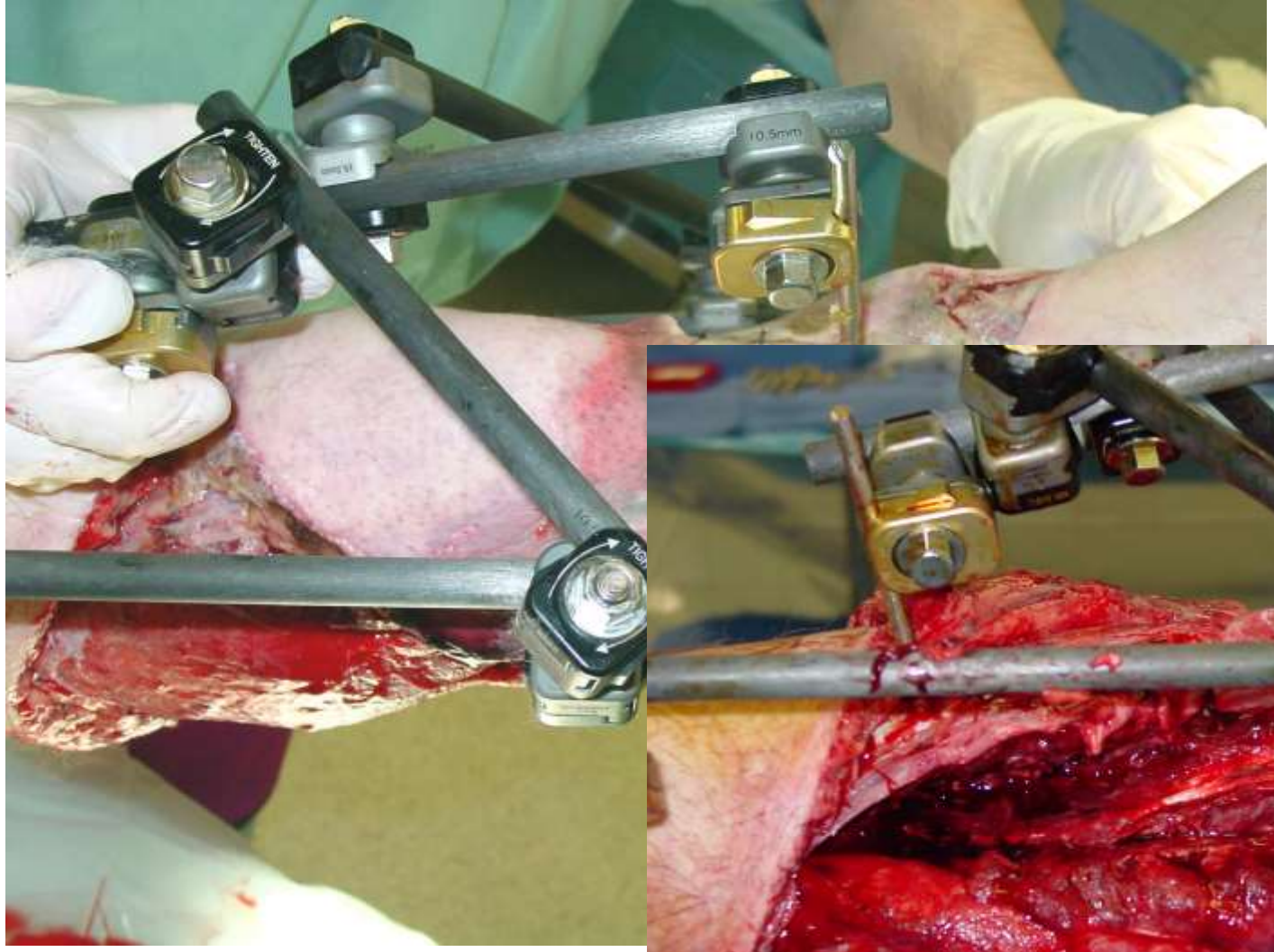
FOCUSED FLUID JET LAVAGE

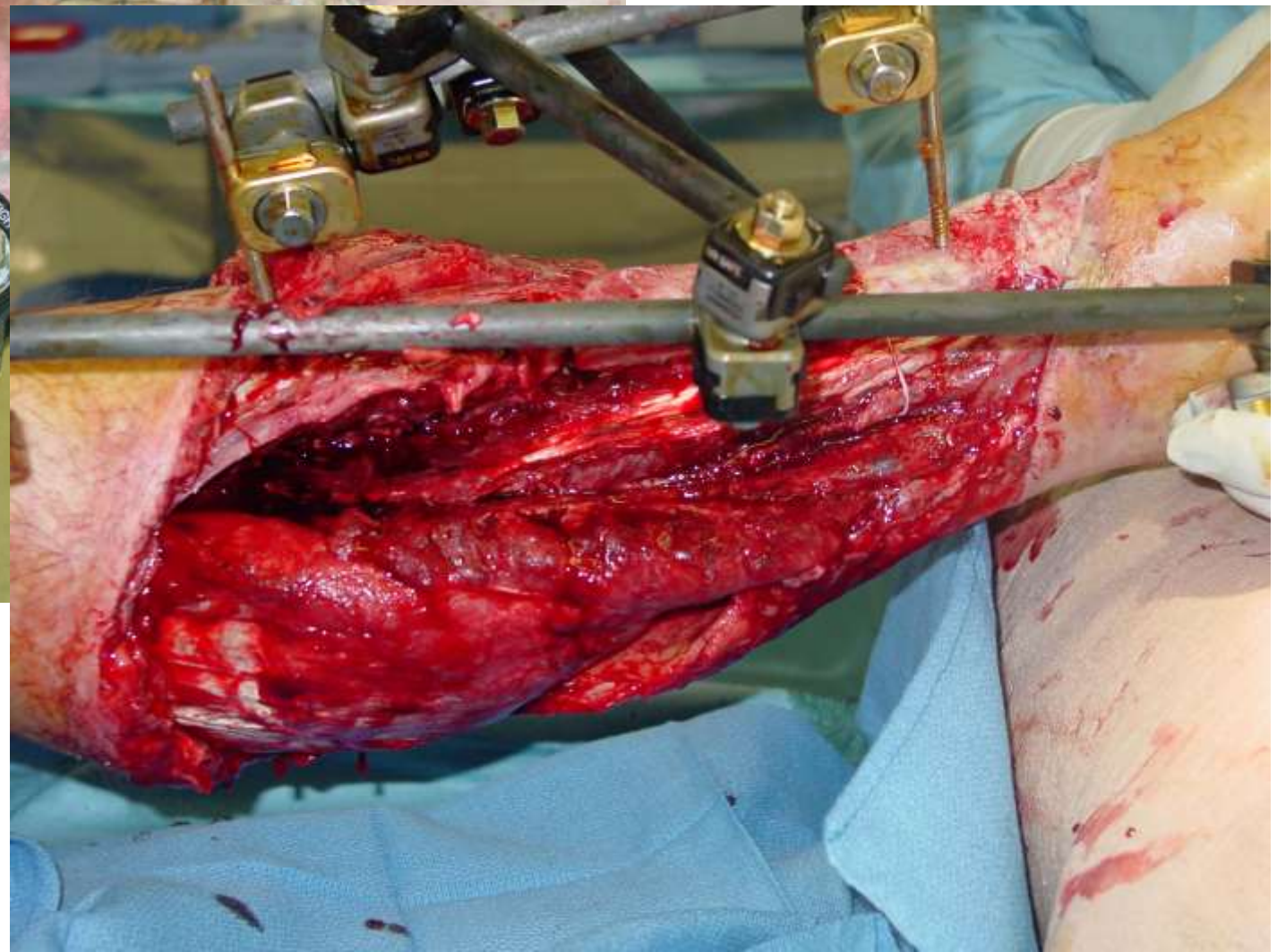
- HIGH PRESSURE VACUUM (VARIABLE)
- DRAWS NON-VIABLE TISSUE AWAY FROM HEALTHY
- “SURGICAL” ABLATION OF NON-VIABLE TISSUE
- CONTROLED FOCUSED VOLUME OF IRRIGANT DIRECTED TO SITE

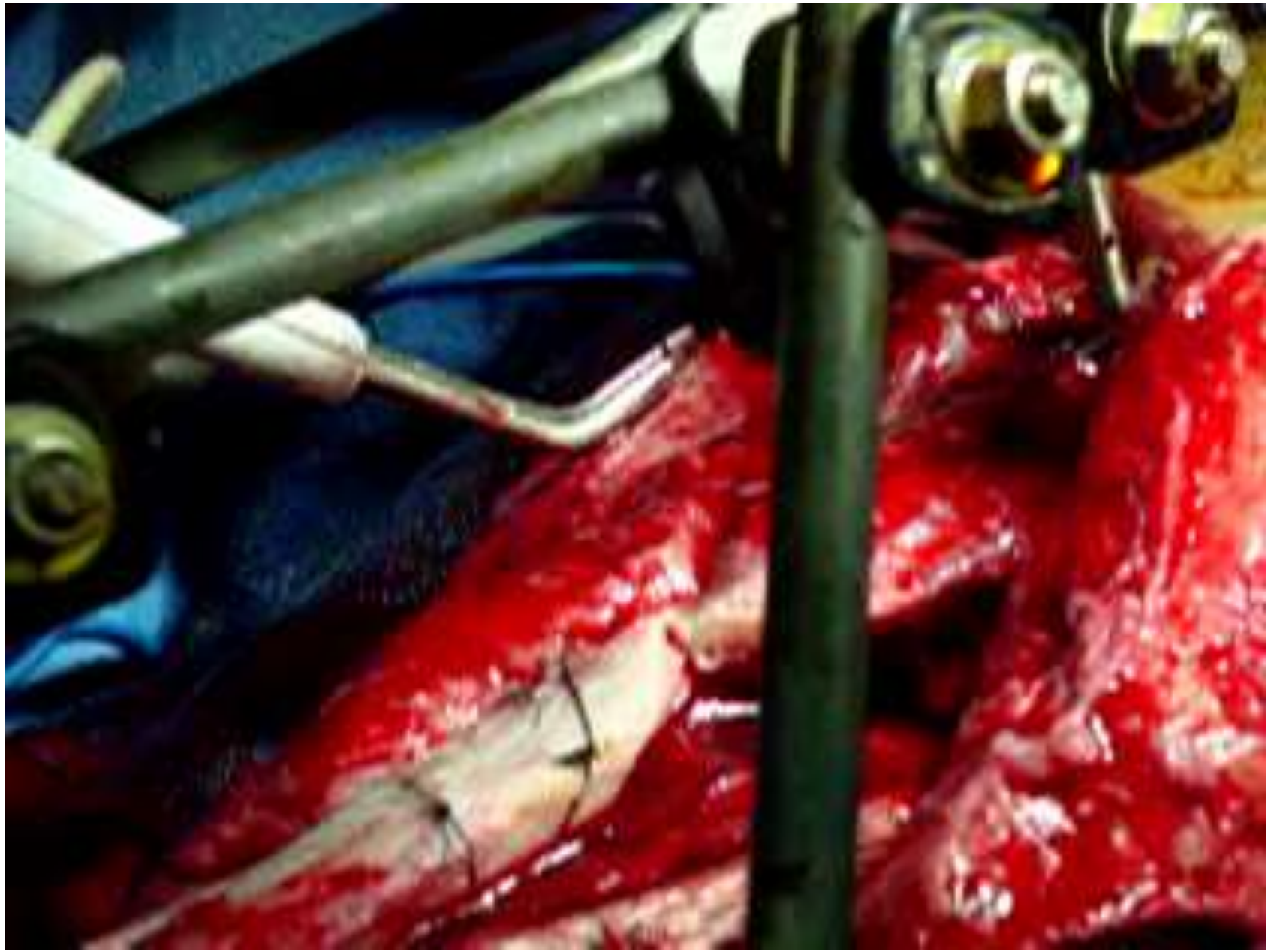
- VENTURI EFFECT LOCALIZED VACUUM TO TARGET TISSUE
- TISSUE EXCISION CUTTING HEAD EXCISION/ASPIRATION ANGLE DEPENDENT
- CONTAMINANT REMOVAL …..VACUUM AND IRRIGATION






TIGHTEN
10.5mm





VJL CLINICAL STUDY

- VJL vs HPPL IN OPEN FRACTURE DEBRIDEMENT
  - OVERALL DECREASE IN:
    - TIME
    - IRRIGANT USED
    - TIME TO DEFINITIVE CLOSURE
    - NUMBER OF PROCEDURES

WEBB, LX, et.al

VJL

- VJL REMOVED 88% OF PARTICULATE
- HPPL REMOVED 22% OF PARTICULATE
  - IN SHORTER TIME PERIOD WITH LESS INVASIVE “TISSUE DAMAGE”

ACUTE CONTAMINATED INFECTED FOREARM FRACTURES TREATED WITH VERSAJET HYDROSURGICAL DEBRIDEMENT

- RAPID, SELECTIVE, AND EFFECTIVE DÉBRIDEMENT, WHICH ALLOWED FOR EXPEDITIOUS RECONSTRUCTION WHILE AVOIDING INFECTION AND INJURY TO VITAL STRUCTURES.

Soong etal. Journal of Orthopaedic Trauma:
July 2010 - Volume 24 - Issue 7 - pp e66-e68

A Prospective Randomized Controlled Clinical Trial Comparing Hydrosurgery Debridement With Conventional Surgical Debridement In Lower Extremity Ulcers

- ($P < 0.008$) shorter debridement time (39% SHORTER).
- A significant reduction in use of pulsed lavage and saline ($P < 0.001$)
- Median time to wound closure 71 days (Versajet) vs. 77 days (conventional) ($P= 0.733$).
- Potential cost savings were identified from the use of VERSAJET through the shorter debridement time AT LESS COST

Caputo WJ etal. Int Wound J. 2008 Jun;5(2):288-94.

Orthopedics. 2012 Jul 1;35(7):e1046-50

Comparison Of Bulb Syringe, Pressurized Pulsitile, And Hydrosurgery Debridement Methods For Removing Bacteria From Fracture Implants.

Hughes MS, Moghadamian ES, Yin LY, Della Rocca GJ, Crist BD.

- 32 stainless steel, 4-hole, plates incubated with Staphylococus aureus
- Irrigation with 1 L of saline using
  - *A bulb syringe lavage,*
  - *pressurized pulsatile lavage,*
  - *hydrosurgery,*
  - *no irrigation*
- Hydrosurgery System was most the effective at bacterial removal, followed by the pressurized pulsitile and bulb syringe lavage techniques (P=.0002 to P=.0012,

ANTIBIOTICS IN OPEN FXS

- Why?
  - Treat bacterial contamination in traumatized tissue, *NOT* prophylaxis.

  Majority of organisms found in open fractures:
    - Aerobic gram-positive cocci

ANTIBIOTICS IN OPEN FXS

- When should they be given?
  - ❑ASAP
  - ❑Studies show significant reduction in incidence of infection if given early, irrespective of timing of debridement.
  - ❑14% to 3% for all comers, if use abx.
    - ❑ (Patzakis et al JBJS 56A;532, 1974)
  - ❑4.5% if <3hrs, 7.5% if >3hrs

    (Patzakis et al CORR 243;36,1989)

ANTIBIOTICS

- BEST TYPE AND DURATION REMAINS UNDEFINED
- WHAT IS DEFINED, HOWEVER, IS

THE EARLIER THE BETTER

< 1 HOUR

ANTIBIOTICS

- CEFAZOLIN TO COVER GRAM+
- AMINOGLYCOSIDE TO COVER GRAM-
- ADD PENICILLIN FOR SOIL OR STANDING WATER CONTAMINATION TO COVER CLOSTRIDIUM AND ANAEROBES

ANTIBIOTIC COVERAGE

- GD I
  - ANCEF 1 GM PRE-OP IV
    - Q 8 HRS POST OP X'S 3 DOSES
- GD II
  - ANCEF 1GM IV Q 8 HRS UNTIL WOUND CLOSED
  - ONCE CLOSED CONTINUE X'S 3 DOSES

ANTIBIOTIC COVERAGE

- Gd III
  - ANCEF 1 gm + GENTAMYCIN PRE-OP
  - ANCEF + GENTAMYCIN q 8 hrs UNTIL WOUND CLOSED
  - WITH EXTENSIVE CONTAMINATION / SOIL……..ADD PENICILLIN OR CLINDAMYCIN

  - **Cefotaxime 1gm q8hr**

ANTIBIOTICS

- CEFAZOLIN TO COVER GRAM+
- AMINOGLYCOSIDE TO COVER GRAM-
- ADD PENICILLIN FOR SOIL OR PUBLIC WATER CONTAMINATION TO COVER CLOSTRIDIUM AND ANAEROBES
- **Cefotaxime 1gm q8hr**

AN IMPORTANT FACTOR IN DECREASING INFECTION Rts IN OPEN Fxs

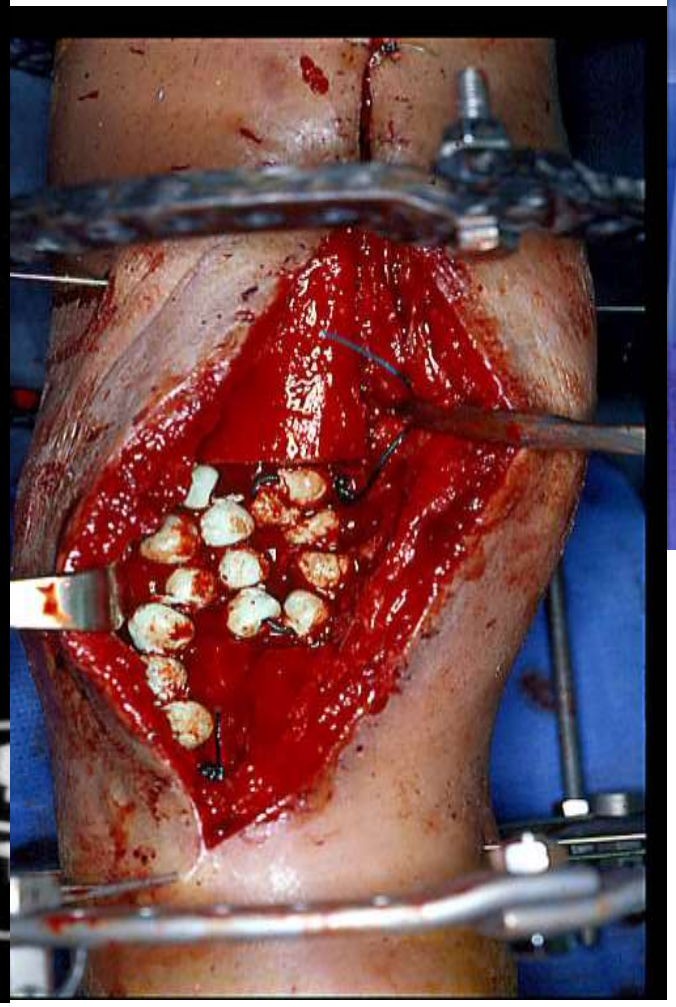
TIMELY ADMISSION TO THE DEFINITVE TRAUMA CENTER

Antibiotics in Open Fractures

- Antibiotic Bead Pouches:
  - Grade 2 fractures:
    - Reduce infection rate from 15-20% to 3-4%
  - Grade 3 fractures:
    - Reduce infection rate from 20-44% to 4%

(Henry et al J Trauma 30(10), 1990 and CORR 295, 1993)
(Keating et al J Ortho Trauma 10(5), 1996)

DEAD SPACE MANAGEMENT



DEAD SPACE MANAGEMENT

DEAD SPACE MANAGEMENT

- Basic Science
  - ❑Edema fluid and its contents inhibit proliferation of kertinocytes, fibroblasts, and vascular endothelial cells

DEAD SPACE MANAGEMENT

- Basic Science
  - ❑Cells responed to controled distraction with increased rate of mitiosis, new vessel formation, and recruitment of adjacent tissue via viscoelastic flow

Vacuum-Assisted Closure (V.A.C.)

- Changes in Wound Environment
  - ❑ Blood Flow
    - Peak flow four time baseline
    - 125 mmHg subatmospheric pressure
    - 5-minutes-on/2-minutes-off cycle

Vacuum-Assisted Closure (V.A.C.)

- Changes in Wound Environment
  - ❑ Granulation Tissue Formation
    - 63% increase with continuous subatmospheric pressure
    - 103% increase with intermittent subatmospheric pressure

Vacuum-Assisted Closure (V.A.C.)

- Changes in Wound Environment
  - ❑ Bacterial Clearance
    - Wounds with 10^8 organisms/gram of tissue
    - Infection>10^5 organisms/gram of tissue
    - V.A.C. wounds < 10^5 organisms/gram of tissue at 5 days of treatment, control group at 11 days


2005 1 5


2005

J Orthop Trauma. 2008 Nov-Dec;22(10 Suppl):S135-7.

Current thought regarding the mechanism of action of negative pressure wound therapy with reticulated open cell foam.

Webb LX, Pape HC.

- The enhancement of the dynamics of microcirculation by active evacuation of excess interstitial (edema.)
- Physiologically, lowering of the heightened capillary afterload and a qualitative dilution of contained microcontaminants, bacteria, and proinflammatory cytokines.
- Based on these effects, the use of NPWT/ROCF has found a place in the management of high-energy traumatic wounds and certain high-risk elective surgical wounds.

J Orthop Trauma. 2009 Sep;23(8):552-7.

Negative pressure wound therapy after severe open fractures: a prospective randomized study.

Stannard JP, Volgas DA, Stewart R, McGwin G Jr, Alonso JE.

- 23 pts / 25 fractures underwent I and D with standard fine mesh gauze dressing, repeat I and D every 48-72 hours until wound closure.
- 35 patients NPWT group with VAC applied at every I and D, similar protocol until closed
- Control patients….2 acute infections (8%) and 5 delayed infections (20%), (28% total)
- NPWT patients …. 0 acute infections, 2 delayed infections (5.4%), (5.4% total).

- There is a significant difference between the groups for total infections (P = 0.024).
- Patients treated with NPWT were only one-fifth as likely to have an infection compared with patients randomized to the control group.

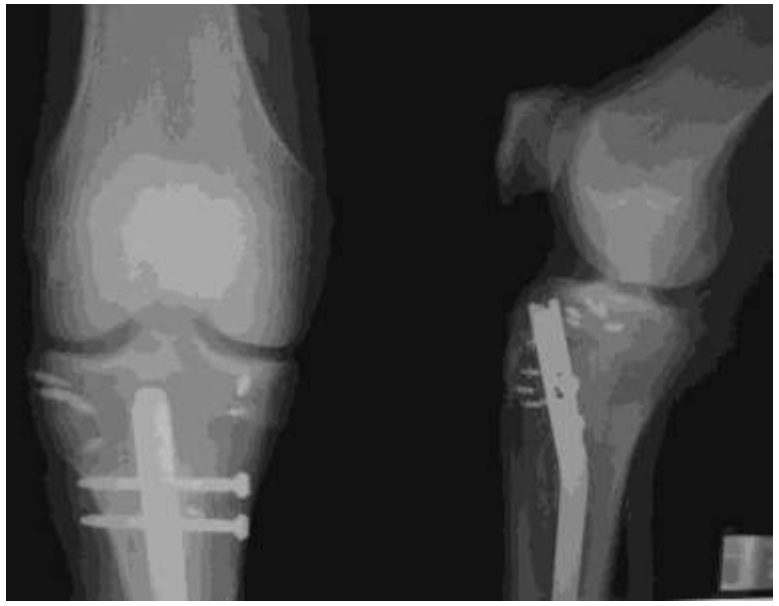
J Orthop Trauma. 2012 Sep;26(9):512-8.

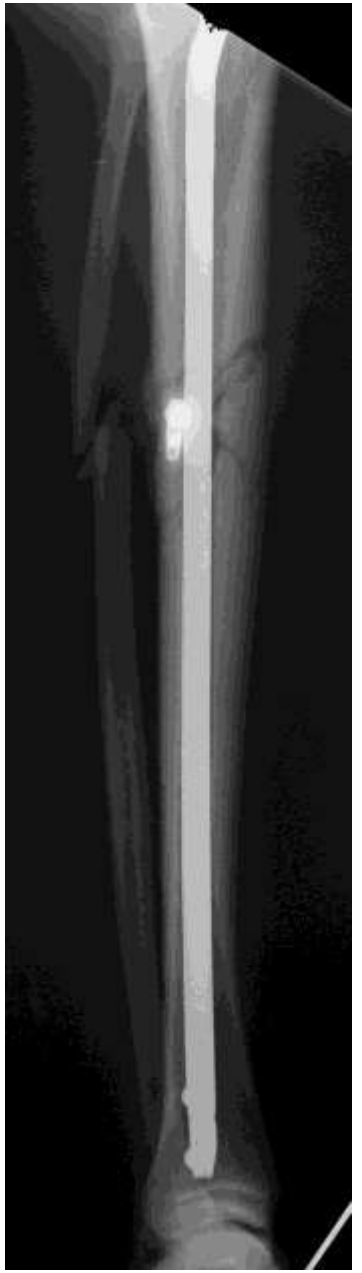
Negative Pressure Wound Therapy Reduces The Effectiveness Of Traditional Local Antibiotic Depot In A Large Complex Musculoskeletal Wound Animal Model.

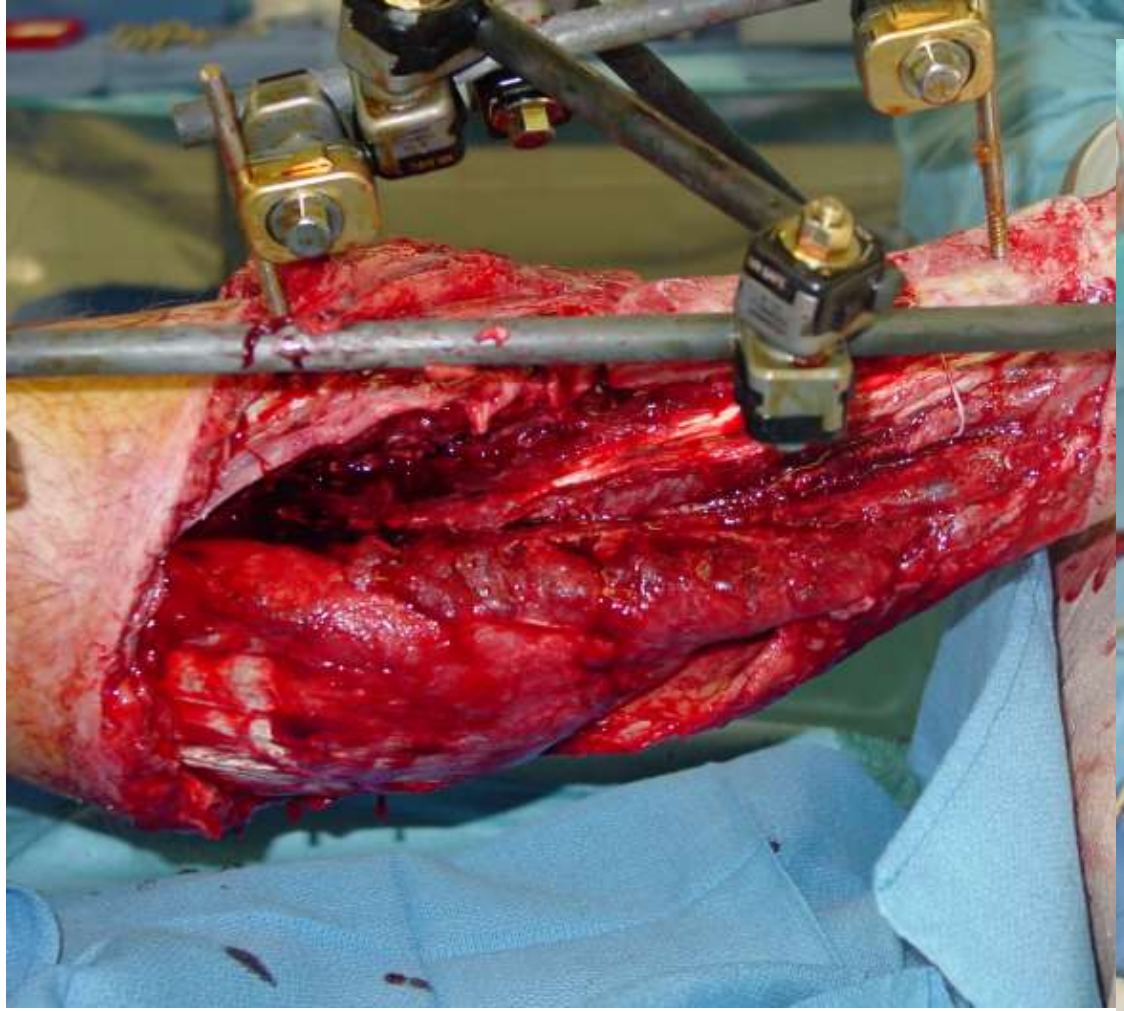
Stinner DJ, Hsu JR, Wenke JC.

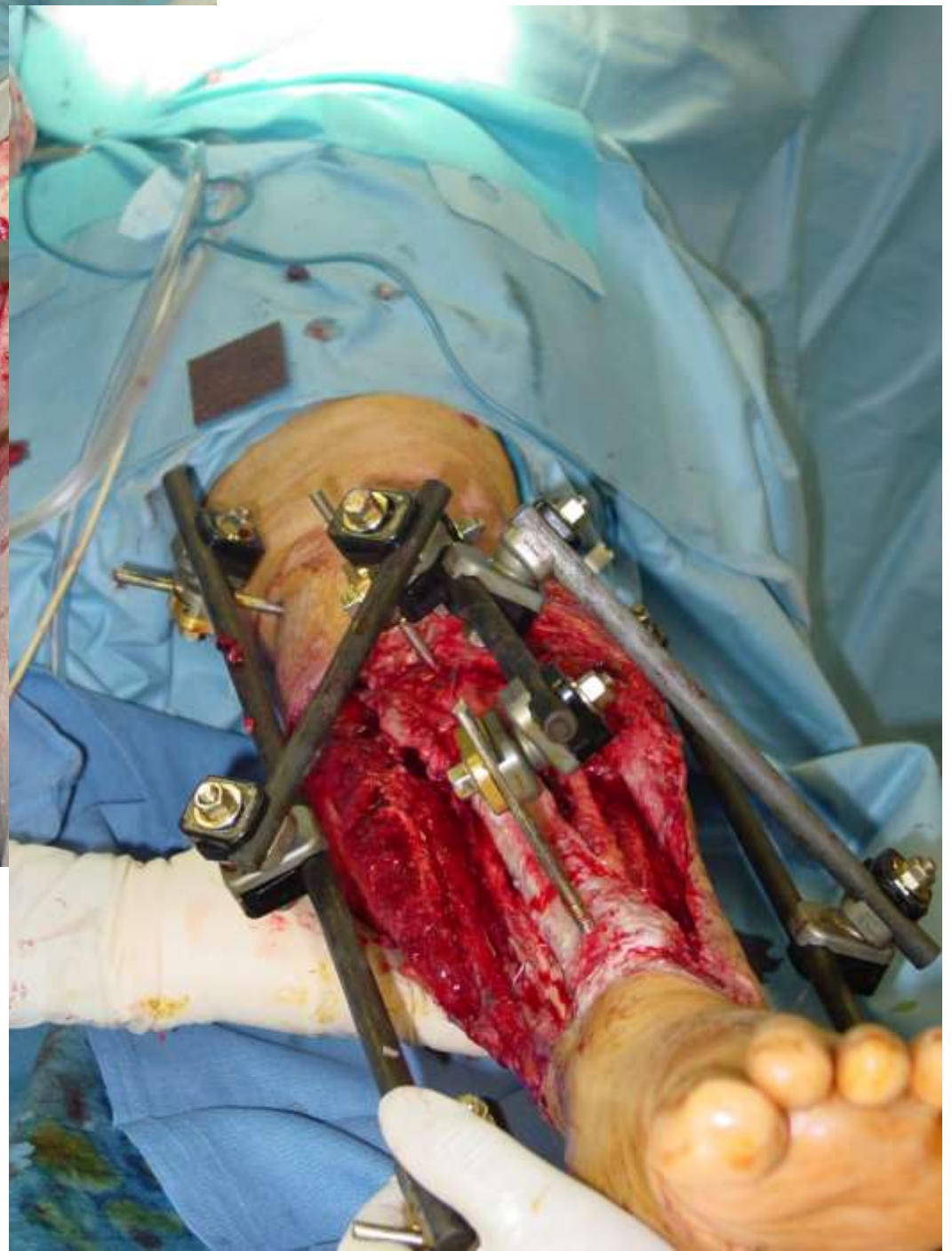
- The effectiveness of a bead pouch was compared with antibiotic beads with NPWT.
- Antibiotic bead pouch group had 6-fold less bacteria vs augmented NPWT group,
  - 11 ± 2% versus 67 ± 11% of baseline values, (P = 0.01).
- High levels of the antibiotic were consistently recovered from the augmented NPWT effluent
- *NPWT reduces the effectiveness of local antibiotic depot.*

62M, MCA, IIIB Tibia









TIMING OF WOUND CLOSURE

- WHEN TO CLOSE THE WOUND???
- WHAT OBJECTIVE MEASURES PRESENT TO GAUGE WOUND HEALTH?

TIMING OF WOUND CLOSURE

- WHEN TO CLOSE THE WOUND???
- WHAT OBJECTIVE MEASURES PRESENT TO GAUGE WOUND HEALTH?

AGGRESSIVE TREATMENT OF 119 OPEN FRACTURE WOUNDS

De Long WG , Born CT et al ; J Trauma, June 1999

CONCLUSIONS

- Immediate Closure of Wounds After Thorough Debridement By an Experienced Fracture Surgeon Appears to Cause No Significant Increase in Infection or Need for Secondary Procedures
- PRIMARILY LOW GRADE FRACTUES

CONCLUSIONS

- Early Closure May Decrease the Need for Subsequent Debridements and Soft Tissue Procedures Thereby Decreasing Surgical Morbidity
- This Treatment Seemed Safe to Study In a Prospective Randomized Fashion

WOUND CULTURES

- PRE-OP CULTURES GENERALLY UNRELIABLE (no value)
  - of infected cases pre debridement cultures grew infecting organism 22% of time
- POST IRRIGATION AND DEBRIDEMENT CULTURES AS TREATMENT GUIDELINE
  - of infected cases post debridement cultures grew infecting organism 42% of time

EFFICACY OF CULTURES IN THE MANAGEMENT OF OPEN Fxs

LEE, J. CLIN ORTHO 339:71-75, 1997

WOUND CULTURES

- NEW PARADIGM
- CULTURES AS AN INDEX TO OVERALL BIOLOGIC HEALTH OF WOUND
- OBJECTIVE INDICATOR FOR WOUND CLOSURE
- NOT USED AS A MARKER FOR “INFECTION” Rx

THE JOURNAL OF BONE & JOINT SURGERY
JB&JS

Timing of Wound Closure in Open Fractures Based on Cultures Obtained After Debridement

Christopher J. Lenarz, J. Tracy Watson, Berton R. Moed, Heidi Israel, J. Daniel Mullen and James B. MacDonald

J Bone Joint Surg Am. 2010;92:1921-1926. published Jul 21, 2010; doi:10.2106/JBJS.I.00547

- >600 OPEN FRACTURES
- POST I AND D CULTURES
  - If culture + ...repeat I & D until culture –
- WOUNDS CLOSED WHEN CULTURE –

Gd IIIB / C

Gustilo Type	No.	Culture Positive	Deep Infections	Deep Infection Rate	No. of Irrigation and Debridements*	Standard Deviation	Days to Closure*	Standard Deviation
IIIB	24	7	1	4.2%	5.00 (4.25-5.75)	1.56	14.47 (9.16-19.79)	11.03
IIIC	14	3	3	21.4%	6.00 (4.56-7.44)	2.38	18.5 (10.81-26.27)	12.79

- INCREASED TIME TO CLOSURE FOR HIGHER ENERGY Fxs
- AVERAGE 3 DEBRIDEMENTS……FULLY *DETERMINE ZONE OF INJURY*…
- LOW Rts OF INFECTION…….

TABLE II Lower Extremity Fractures Grouped by Gustilo Type with Deep Infection Rates, Mean Number of Irrigation and Debridement Procedures, and Mean Number of Days to Closure

Gustilo Type	No.	Culture Positive	Deep Infections	Deep Infection Rate	No. of Irrigation and Debridements*	Standard Deviation	Days to Closure*	Standard Deviation
I	22	0	0	0%	1.28 (1.07-1.49)	0.46	0.76 (0.23-1.29)	1.18
II	95	3	3	3.2%	1.90 (1.75-2.05)	0.66	2.58 (2.05-3.10)	2.38
IIIA	93	6	2	2.2%	2.41 (2.19-2.65)	1.02	4.37 (3.52-5.22)	3.86
IIIB	24	7	1	4.2%	5.00 (4.25-5.75)	1.56	14.47 (9.16-19.79)	11.03
IIIC	14	3	3	21.4%	6.00 (4.56-7.44)	2.38	18.5 (10.81-26.27)	12.79
Total	248	19	9	3.6%	2.58	1.68	6.15	7.37

- OVERALL Rt OF INFECTION FOR UPPER AND LOWER EXTREMITIES…4.3%....

Delayed Wound Closure Increases Deep-Infection Rate Associated with Lower-Grade Open Fractures

A Propensity-Matched Cohort Study

Richard J. Jenkinson, MD, MSc, FRCS(C), Alexander Kiss, PhD, Samuel Johnson, MD, David J.G. Stephen, MD, FRCS(C), and Hans J. Kreder, MD, MPH, FRCS(C)

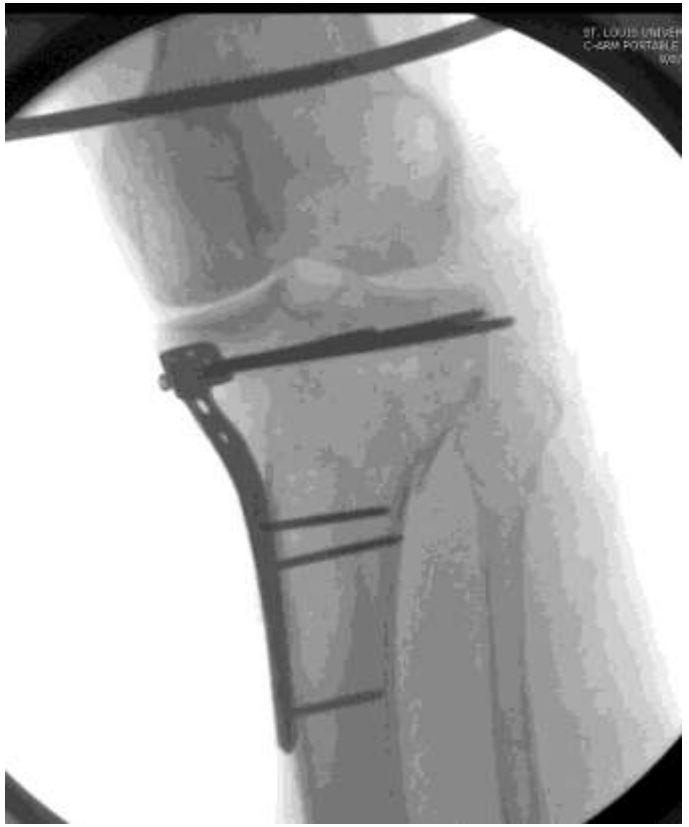
- Deep infection with immediate closure 4.1%
- Delayed primary closure infection rate 17.8%
- Immediate closure of select wounds by experienced surgeons ..grade-I, II, and IIIA fractures is safe and associated with lower infection rates compared with DPC….

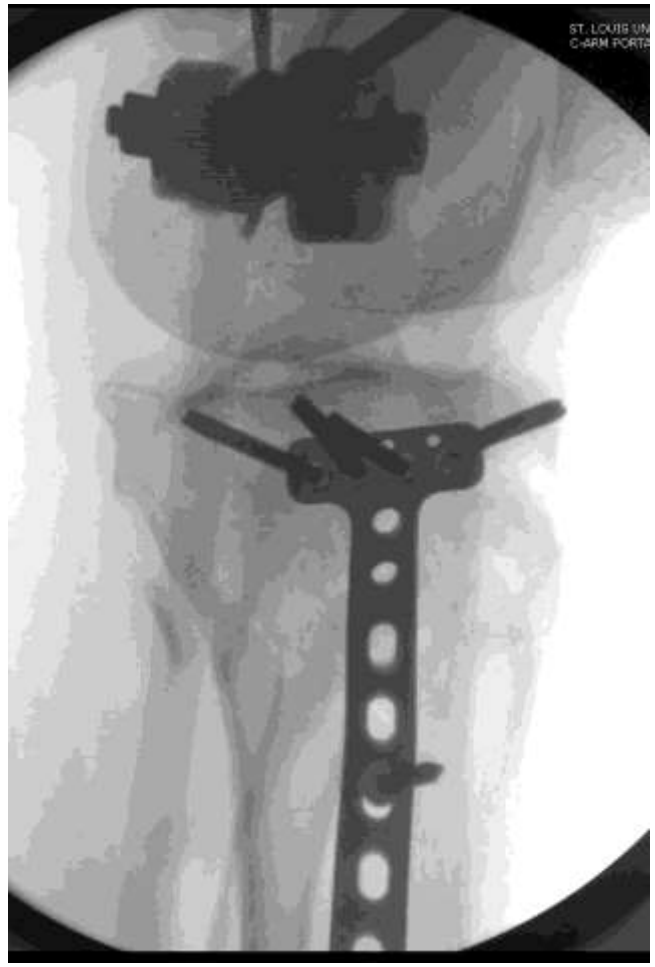
DEFINITIVE FIXATION TIMING?

- USUALLY SAFE IF EXCELLENT DEBRIDEMENT HAS BEEN DONE
- IF IN DOUBT, TEMPORIZE WITH EXTERNAL FIXATION, RE-DEBRIDE, THEN DEFINITIVELY FIX

28 y/o MVA Gd IIIb


MOJAVE

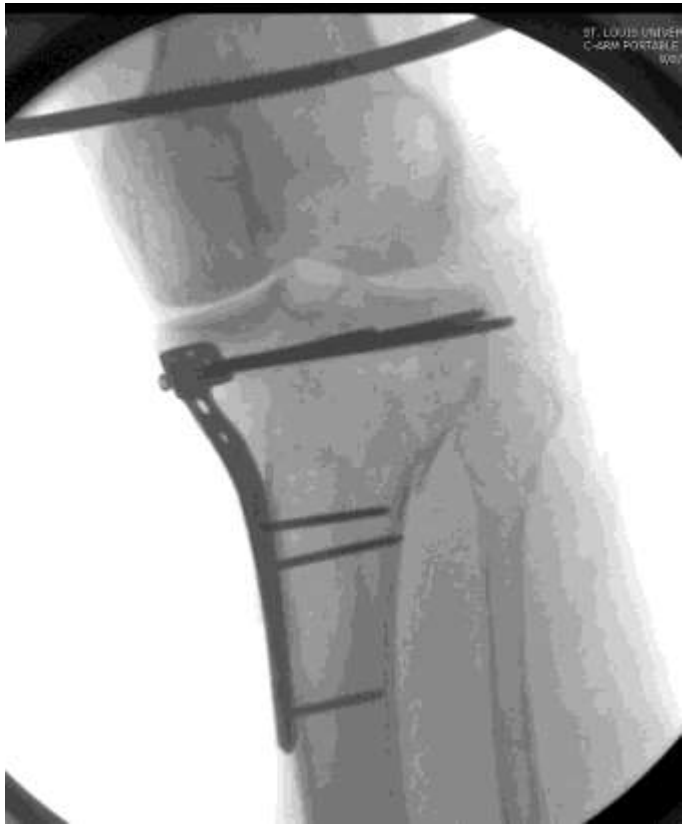


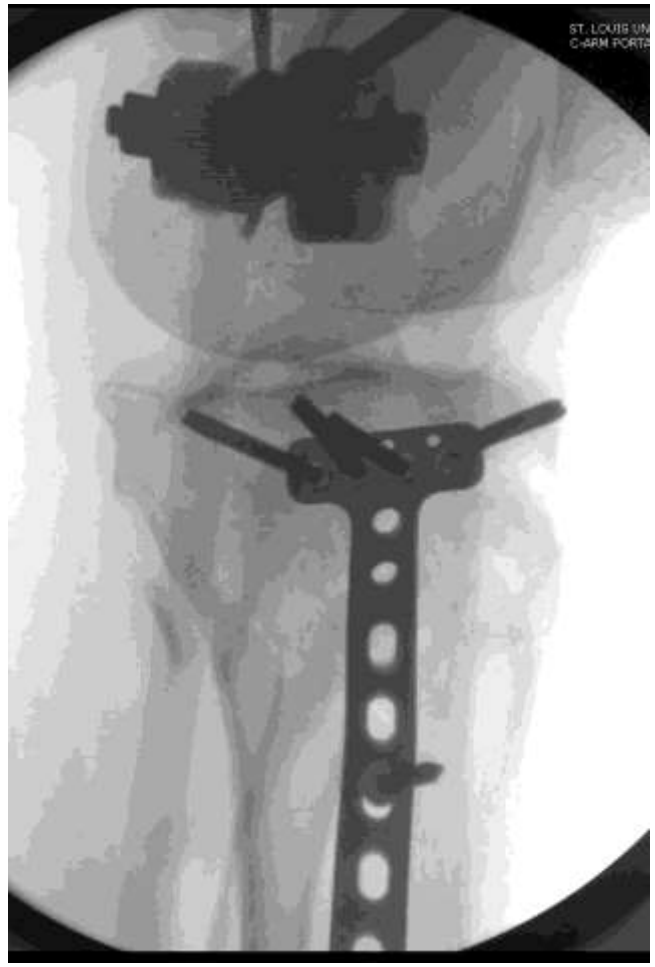


2ND DEBRIDEMENT

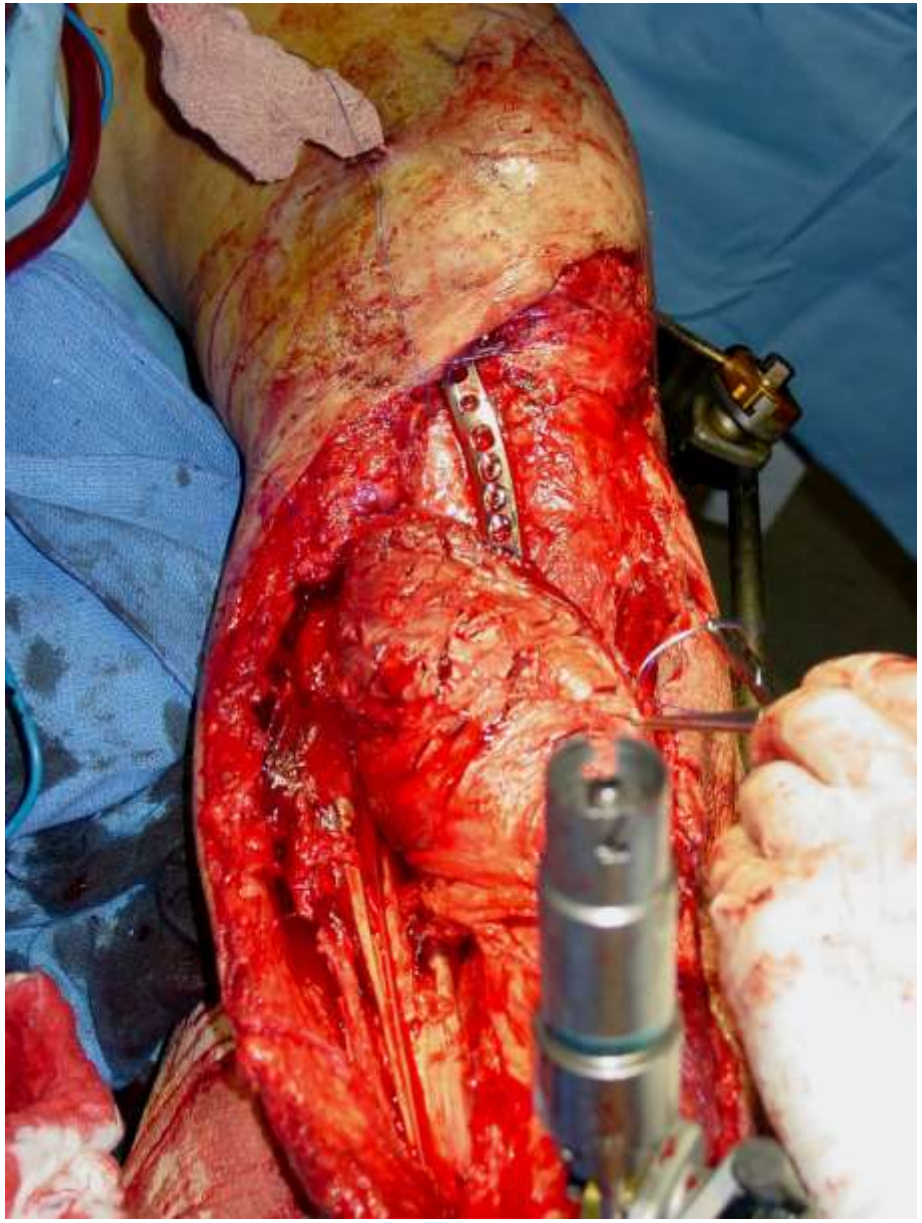
INITIAL SPANNING FRAME

- EXTENSIVE ZONE OF INJURY
- KEEP PINS OUT OF THIS AREA UNTIL FULLY DECLARED





2ND DEBRIDEMENT

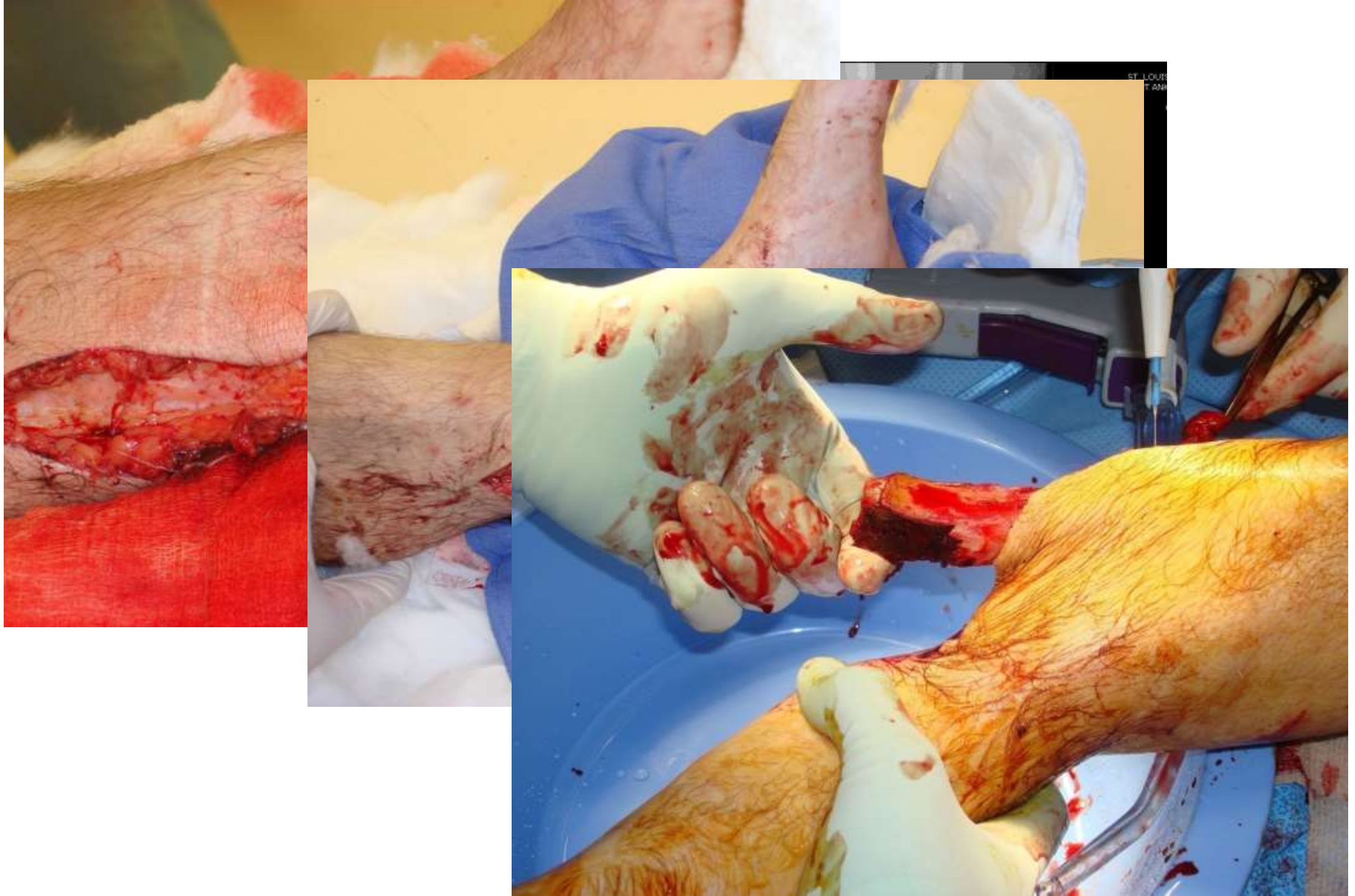


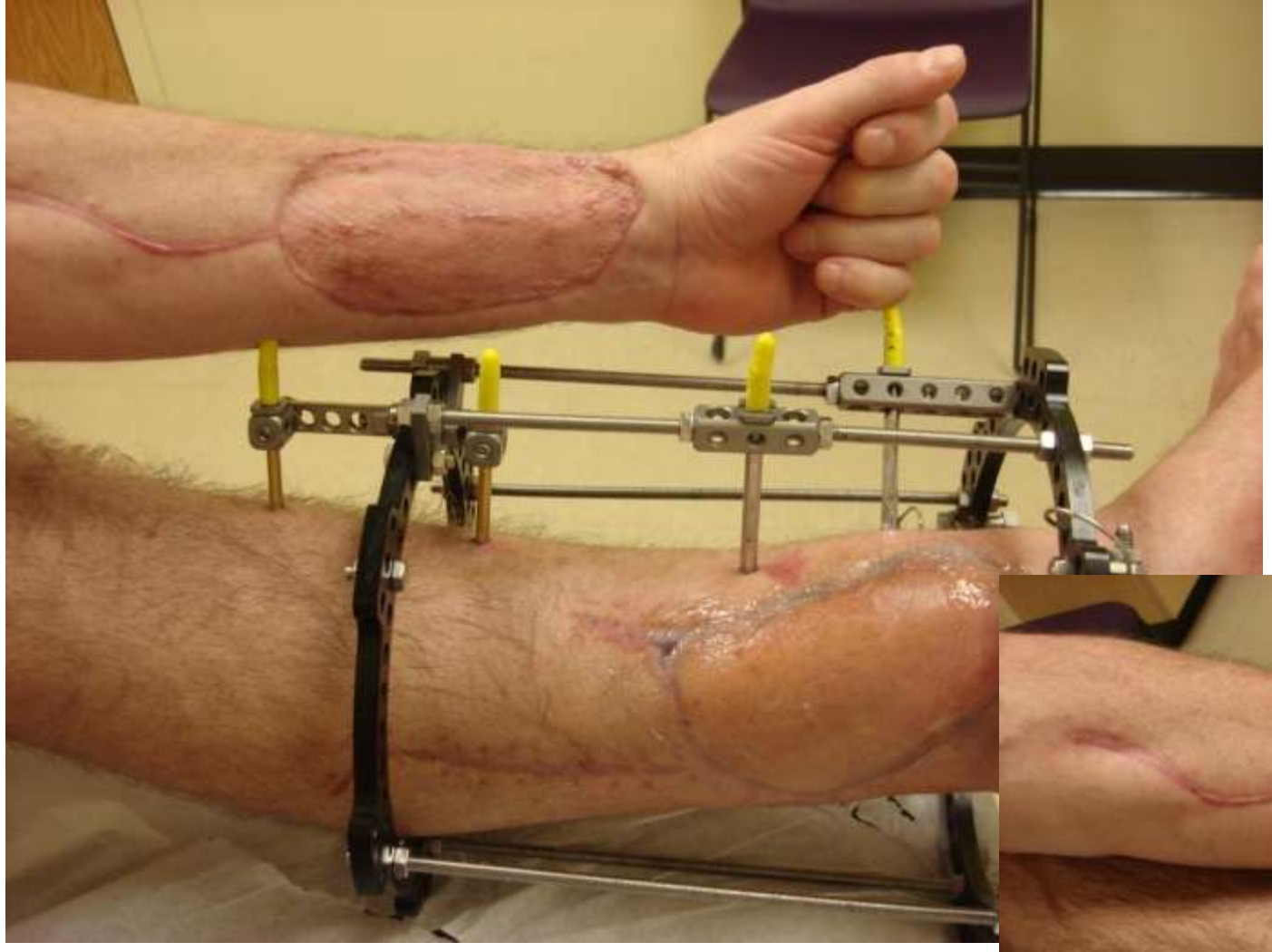
STABILIZATION ADVANTAGES

- ABILITY TO PROVIDE EARLY MECHANICAL LOADING
  - ONE OF THE MOST IMPORTANT CONDITIONS TO POSITIVELY INFLUENCE BONE HEALING

COVERAGE OPTIONS

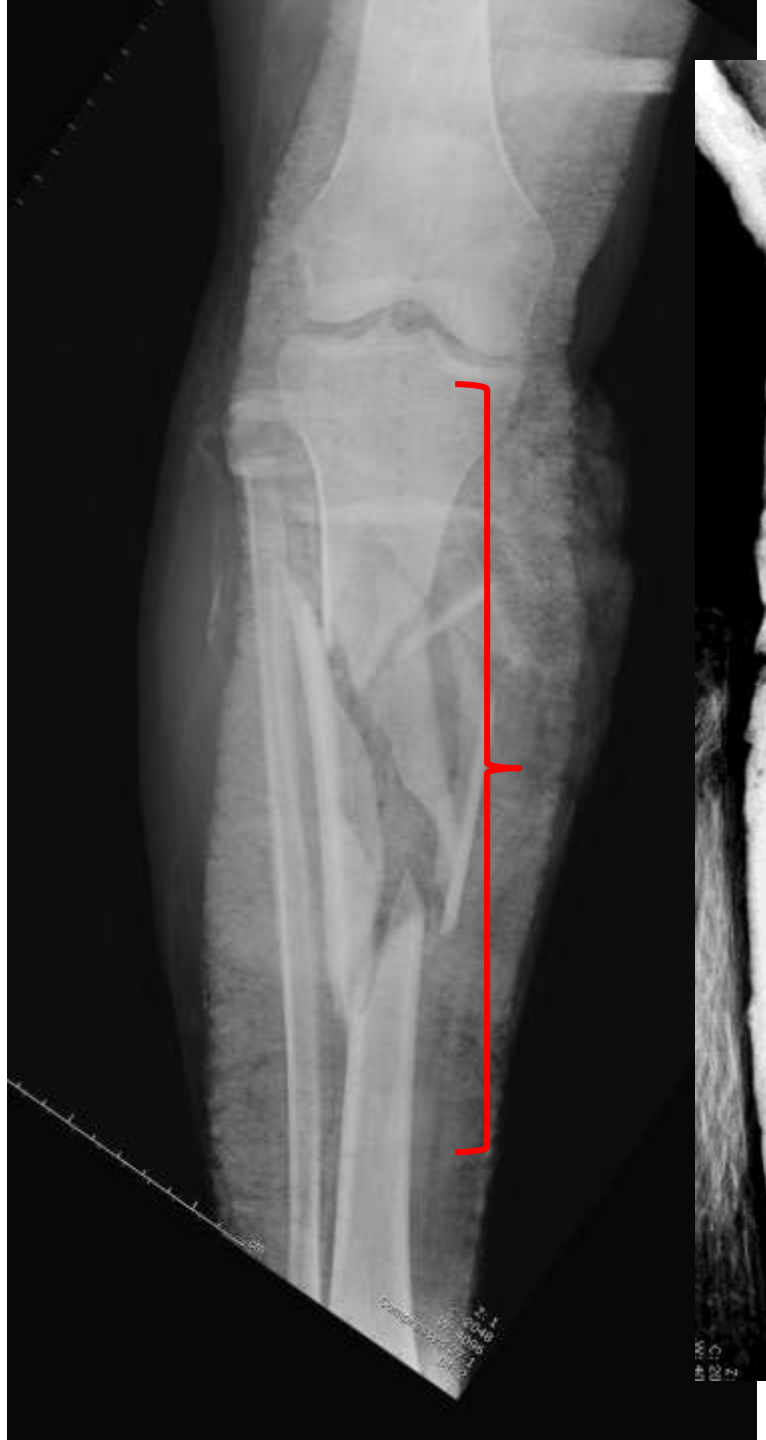
- FREE FLAP COVERAGE
  - ❑RECTUS / LATISSIMUS / FREE FASCIAL ISLAND FLAPS / GRACILIS
  - ❑MYOCUTANEOUS RADIAL FOREARM

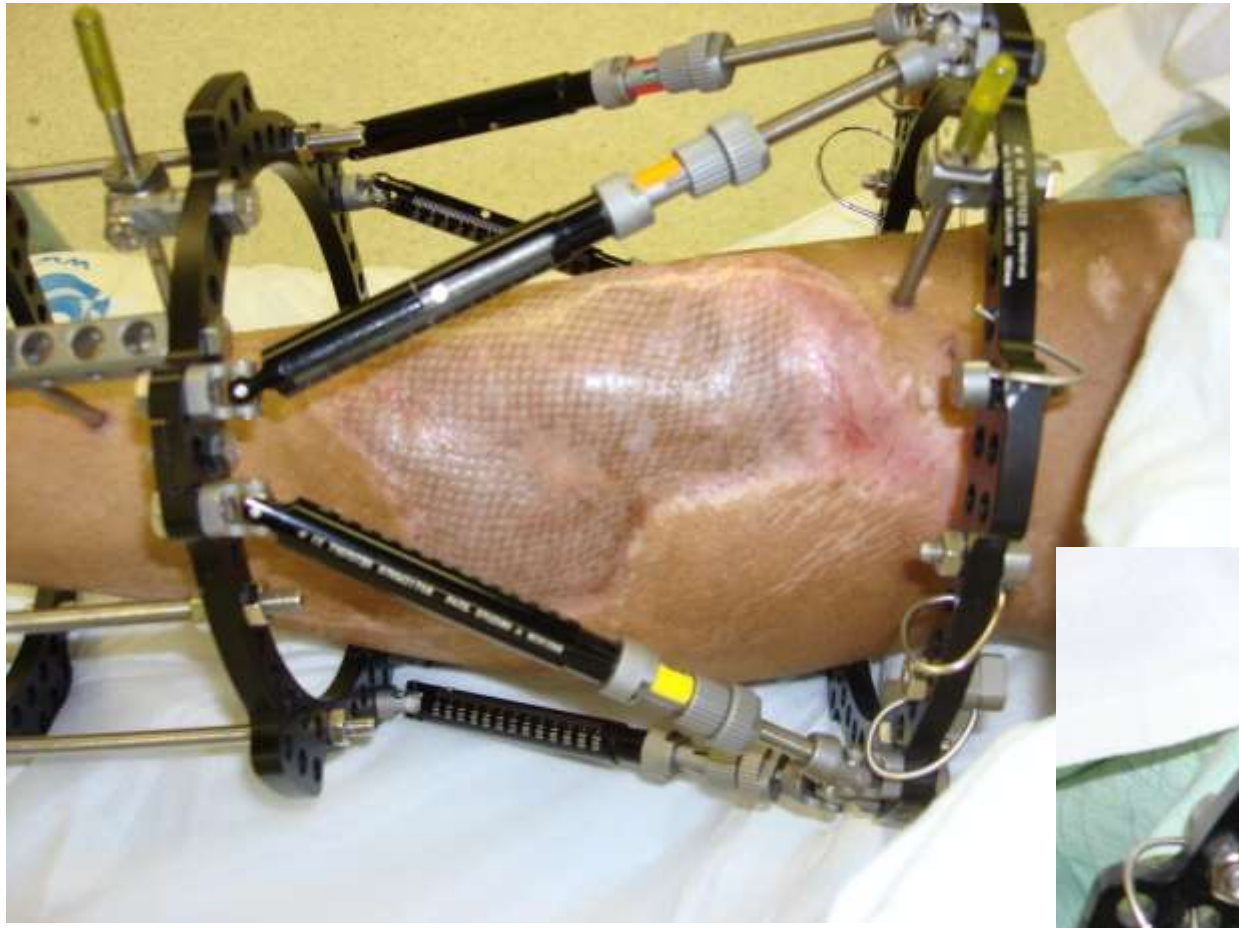


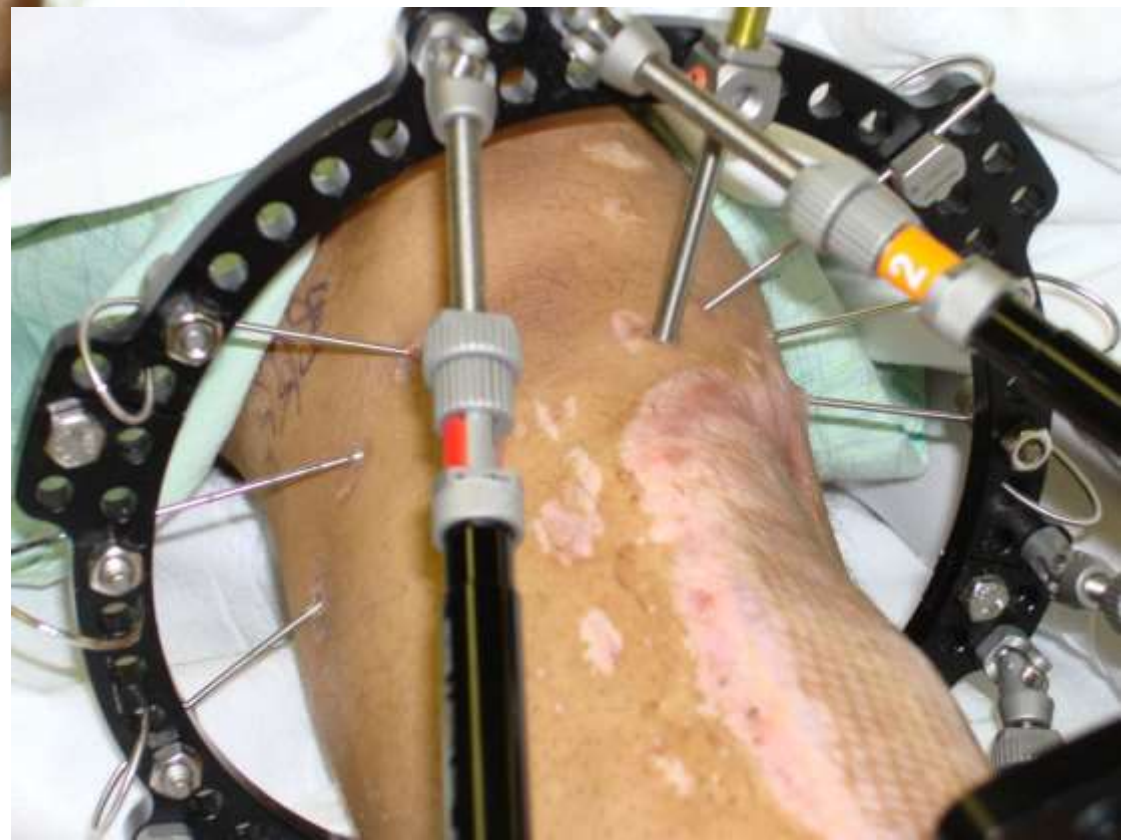


COVERAGE OPTIONS

- LOCAL ROTATIONAL FLAP
  - ❑ GASTROC / SOLEUS / SURAL ISLAND
  - ❑ DEFATTED FASCIAL ROTATION FLAP





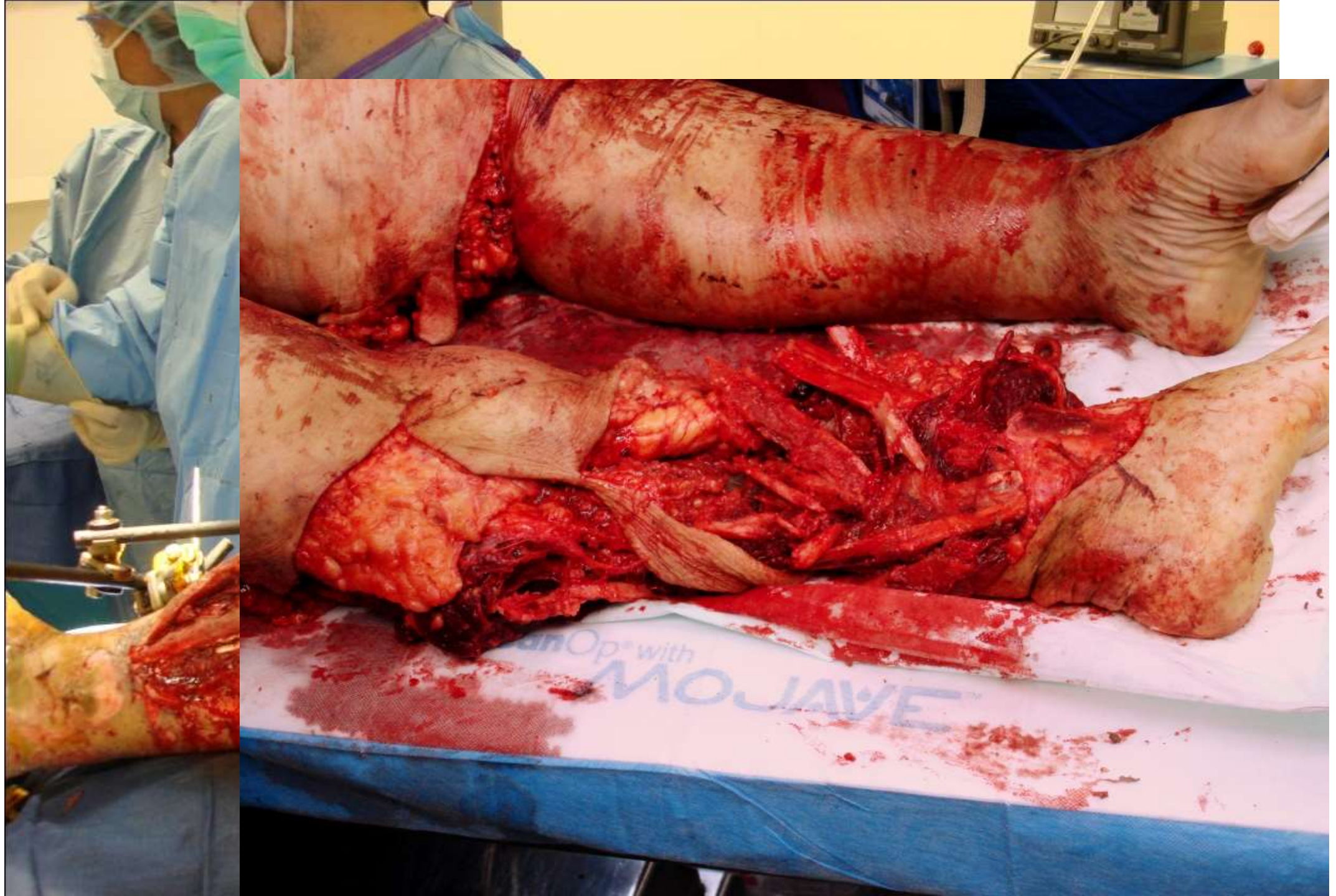


LEAP STUDY

- Webb et.al. JBJS 2007 IIIB open tibial shaft Fx
- IM nail /ex fix with rotational flap similar functional outcomes

LEAP STUDY

- timing of wound **débridement** (within six hours after the injury vs six to twenty-four hours after the injury),
- the timing of soft-tissue **coverage** (three days or less after the injury as compared with more than three days after the injury),
- timing of bone **grafting** procedures (less than three months after the injury as compared with three months or more after the injury)
- *DID NOT IMPACT THE INFECTION OR UNION RATES AND HAD NO EFFECT ON FUNCTIONAL OUTCOME."*


with
MOJAVE

COVERAGE OPTIONS

- FREE FLAP COVERAGE
  - ❑LEAP STUDY >>>>> EARLY COVERAGE
    - **ROTATIONAL FLAPS 4.3 TIMES RATES OF WOUND COMPLICATIONS COMPARED TO FREE FLAP….**
    - EX-FIX WITH FREE FLAPS
- LOCAL ROTATIONAL FLAP
  - ❑INCREASED TIME TO FLAP COVERAGE AN ADVANTAGE……TO DELINEATE ZONE OF INJURY

Does the Zone of Injury in Combat-Related Type III Open Tibia Fractures Preclude the Use of Local Soft Tissue Coverage?

Travis C. Burns, MD, Daniel J. Stinner, MD,* Daniel R. Possley, DO,* Andrew W. Mack, MD,† Tobin T. Eckel, MD,† Benjamin K. Potter, MD,† Joseph C. Wenke, PhD,‡ and Joseph R. Hsu, MD,‡ the Skeletal Trauma Research Consortium (STReC)*

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DELINEATE THE ZONE OF INJURY AND COVER A HEALTHY BIOLOGICALLY SOUND WOUND…….

REGARDLESS OF THE TIMING TO *DEFINITIVE* COVERAGE

Type IIIB Open Segmental Tibia

Reamed IMN

SUMMARY

- TIMING OF INTRAVENOUS ANTIBIOTICS MATTERS (early > later)
- TIMING OF DEBRIDEMENT *MATTERS LESS*
- LIBERAL USE OF ANTIBIOTIC BEAD POUCHES , VAC DRESSINGS, COMPOSITE BIOLAYERS
- IMMEDIATE WOUND CLOSURE APPPEARS TO BE REASONABLE IF A THOROUGH DEBRIDEMENT WAS PERFORMED…..CULTURE - WOUNDS
- DURATION OF I.V. ANTIBIOTICS SHOULD PROBABLY CONTINUE TO BE AT LEAST 72 HOURS
- THE QUALITY OF THE DEBRIDEMENT PROBABLY MATTERS….*MOST*
- THIS IS MORE IMPORTANT THAN THE METHOD OF *STABILIZATION!!*