Concepts of Total Contact Cast(**TCC**) & Negative Pressure Wound Therapy(**NPWT**)

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Total Contact Cast

TTC on DM foot ulcer

- **Risk classification**
  - The **International Working Group** on the Diabetic Foot
    - Group 0
      - Patients without neuropathy
    - **Group 1**
      - **Neuropathy but without foot deformity or peripheral vascular disease**

        → **Total contact cast -> often heals within a matter of weeks**
    - Group 2 : Neuropathy and either deformity or peripheral vascular disease
    - Group 3 : History of foot ulceration or lower extremity amputation

The Depth-Ischemia Classification of Ulceration

Grade	Classification	Treatment
0	At-risk foot No ulceration	Patient education Regular examination Appropriate footwear Appropriate insoles
1	Superficial ulceration, not infected	External pressure relief Total contact cast Walking brace Special footwear
2	Deep ulceration exposing a tendon or joint	Surgical debridement Wound care Pressure relief if the lesion closes and converts to grade 1 (prn antibiotics)
3	Extensive ulceration with exposed bone and/or deep infection (osteomyelitis) or abscess	Surgical debridement Ray or partial foot amputation Antibiotics Pressure relief if wound converts to grade 1

Wagner Classification of DM foot

0	Intact skin (may have bony deformities).
1	Localized superficial ulcer.
2	Deep ulcer to tendon, bone, ligament or joint.
3	Deep abscess or osteomyelitis.
4	Gangrene of toes or forefoot.
5	Gangrene of whole foot.

Total contact cast

- **Treatment of plantar ulcer**
  - Diabetic neuropathy
    - **Forefoot or midfoot ulcer of Wagner stage I, II**
  - Charcot joint
    - Fracture & dislocation of Eichenholtz stage I, II
  - Neurosyphilis
  - All types of ulcer causing sensory deficit of the foot

- **Contraindication**
  - **Severe arterial insufficiency**
  - Severe inflammation
  - Poor skin status
  - Low compliance

Peak plantar pressures (kPa) during cast and normal walking

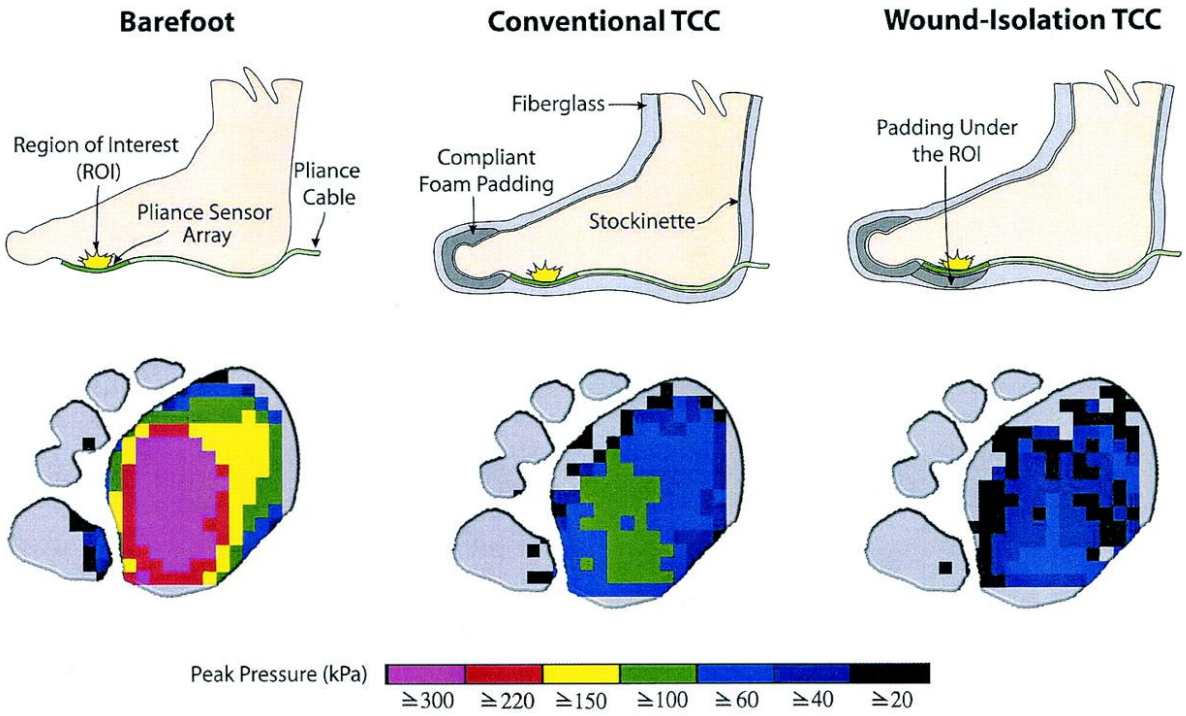
- kPa = kilopascals (103 N/m2).
- **Normal walking is at casted cadence**

Jacqueline JW et al. Journal of Rehabilitation Research and Development, 1995

Sensor locations	Normal walking	Cast walking
Heel	1020 (±761)	905 (±673)
Lateral midfoot	262 (± 186)	224 (± 95)
Medial midfoot	115 (± 180)	101 (± 54)
5th metatarsal	273 (± 56)	179 (± 24)
4th metatarsal	440 (± 185)	160 (± 69)
1st metatarsal	602 (± 280)	286 (± 281)
Hallux	1082 (± 566)	333 (± 294)

Concepts of TCC

- Decrease of pressure around the lesion by total contact
  - **Forefoot pressure distribute of approximately 30% to other region**
  - Heel pressure increased ??? → less reliable resolution of heel ulcer
- Distributing the weight bearing to the foot plantar surface and distal lower leg



Effects of TCC

- **Padding** of the lesion itself -> decrease the pressure
- Stopping the inflammation progression of the lesion by fixation of the lower extremity
- Minimize the compression between the skin and granulation tissue
- Preservation of the foot
- Facilitation of the microcirculation
- **Possible to perform at outpatient basis and to go back to work**

Management before TCC procedure

- **Removal of necrotic tissue**
- **Management of severe swelling** before performing TCC
- Thick skin around the ulcer **should be debrided as the same thickness around the skin**
  - Removed pathogenic bacteria & facilitate skin growth
- After dressing with betadine, only allow one 2-inch size gauze
  - Not to compress the wound

Protective padding

- Padding with cotton between toes
- Seamless stocking is used to cover from toes to tibial tuberosity.
- **Should be cut to avoid folding around the ankle**

Protective padding

- Padding the 1st and 5th metatarsal head, medial and lateral malleolus with cotton
- Cast applied right above the stockinette or after covering it once with very thin size cotton
- The floor made as a rocker bottom shape
  - **To save the cast when weight bearing and make walking more easier**

Cautions of TCC

- **Must not be overpadded**
  - Shifting of limb within cast -> new pressure lesions
- **Must limit toe motion**
  - **Inhibit hyperextension of MTP joint -> persistence of ulcer**
- **Bony prominence & high pressure area should be padded**
  - Diminish concentration of pressure
  - Ant. subcutaneous crest of tibia, malleoli, dorsum of toes, protuberance of Charcot joint
- Stiffening plantar walking surface of the cast
  - incorporating a **wooden platform** into outer layers

Management after TCC procedure

- **Non-weight bearing for the first 24 hours** after TCC appliance
- If much discharge, TCC should be changed often
- Decrease of swelling 1-2 days after TCC appliance
  - **If loose, do not allow weight bearing and reapply TCC immediately**
- **Change 5-7 days after the first appliance**
  - Cast getting loose due to rapid decrease in swelling
- If ulcer more stable and discharge decrease
  - **Changed every 2 weeks**

Complication

- Superficial abrasion, blister, new dorsal ulceration
  - Most common
  - Dorsum of toes & ant. border of tibia
- Joint contracture and muscle atrophy due to long-term fixation
- Occurrence of new ulcer or wound due to malpractice
- Wound caused by saw used when removing cast
  - Due to less padding

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Total Contact Casting for Neuropathic Ulcers: A Lost Art?

Authors: Robert M. Greenhagen, DPM[1], Dane K. Wukich, MD[2]

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<Literature review on the reported total contact casting complication rate>

	Patients	Casts	Healing rate(%)	Complication rate per patient(%)	Complication rate per cast(%)
Baker	13	*	85	15	*
Boulton, et al.	7	*	100	43	*
Guyton	70	398	*	30	5.5
Helm, et al.	22	*	73	14	*
Katz, et al.	20	*	74	65	*
Laing, et al.	46	*	77	11	*
Mueller, et al.	21	*	90	14	*
Myerson, et al.	67	*	90	12	*
Sinacore, et al.	30	*	82	27	*
Wukich and Motko	13	82	83	*	17

*= not reported

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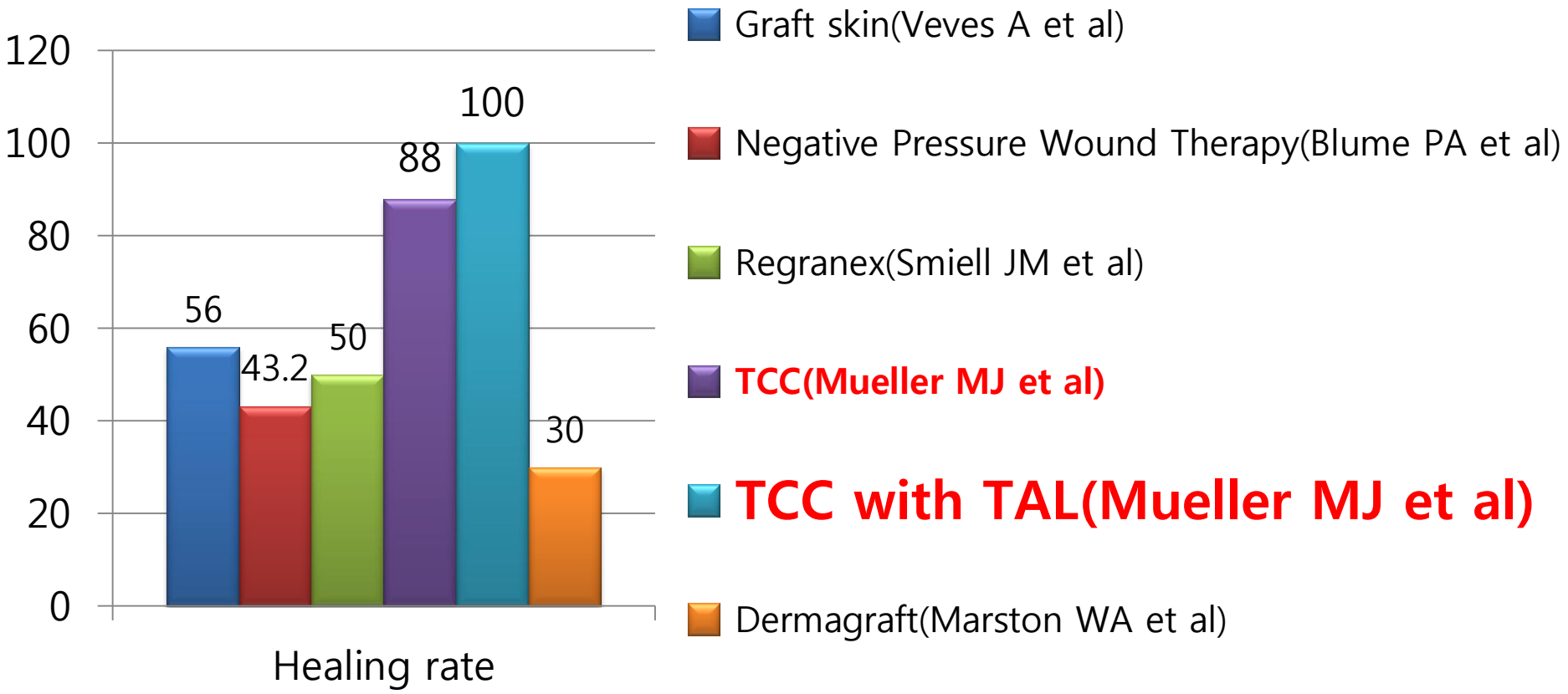
<Compare with other treatment>



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- 절대로 집에서 기브스를 풀지 마십시오.
- 다음과 같은 일이 발생하면 바로 병원에 가야 합니다.
  - 과도하게 발이나 종아리가 부어 기브스가 조이는 경우
  - 너무 느슨해져서 하지가 약 1cm 이상 움직이는 경우
  - 기브스가 손상된 경우
  - 기브스 밖으로 어떤 농이나 피가 나오는 경우
  - 기브스에서 심하게 냄새가 나는 경우
  - 감자기 몸에서 열이 나거나, 발이 많이 아픈 경우, 서혜부에 림프가 잡히는 경우

  -> 이런 경우는 절대 걷지 말고, 다리를 올리고 있어야 하며, 목발 등을 이용하여 병원으로 오시기 바랍니다.

Negative Pressure Wound Therapy

World wound patient review

Wound Type	Incidence (Million)	Healing Time (day)	compound annual growth rate(2005~2014)
Surgical Wounds	96.7	14	3.1
Traumatic wounds	1.5	28	1.4
Lacerations	19.5	14	1.0
Burn wounds (out-patient)	3.2	21	1.0
Burn wounds(medically reated)	6.2	21	1.0
Burn wounds (hospitalized)	0.2	50	1.1
Pressure ulcers	6.6	-	6.2
Venous ulcers	9.7	-	6.4
Diabetic ulcers	10.0	-	9.4

Fundamental management principles for optimal healing outcomes

- Optimize the patient's health status
  - Nutritional support, Adequate hydration, & Glycemic control
  - Optimal control of cormorbid diseases such as pyoderma gangrenosum & anemia
  - **Smoking cessation & Moderate alcohol intake**
- Treat the underlying cause of the wound
  - **Improve blood flow and tissue perfusion**
  - Use offloading devices and other techniques to optimize the management of diabetic foot ulcers and pressure ulcers
- **Optimize the wound bed and local wound environment**
  - **Debride the wound, treat deep infection, maintain moisture balance**
- Address patient and family concerns
  - Provide wound care education & good follow-up care

Common goals of NPWT

- Promote **rapid reduction in wound volume**
- Promote **growth of granulation tissue and contraction of wound edges**
- **Manage exudate**
- **Prepare the wound bed** for transition to another treatment modality
  - MWH, surgical closure, or a flap or graft
- Reduce bioburden
- Decrease hospital stay length
- Decrease morbidity and mortality
- **Decrease frequency of dressing change**
- **Prevent deterioration of the wound**
- **Minimize contamination and wound odor by providing a temporary barrier**
- Improve quality of life

Mechanism of NPWT

NPWT therapy

*** Removal of excess interstitial fluid**

* Mechanical stress

*Provision of a **moist wound environment**

* Acceleration of cell proliferation by reducing the cytokine

* Restoration of flow in small blood flow

* Granulation tissue formation

- Angiogenesis
- Stimulating cell growth

* Stimulation of angiogenesis & local blood flow

* Reduction in bacterial count

* Mitogenesis of cell involved in the wound repair process

Wound healing

Mechanism of NPWT

- Secondary effects
  - Speeds wound healing
  - Increases in blood flow around wounds
  - Changes in bacterial burden
  - Changes in wound biochemistry and systemic response
  - Improves wound bed preparation

Prerequisites of NPWT

- **Two important prerequisites**
  - Wound should be clean
    - Free of necrotic tissue
  - Wound should be well vascularized
    - If not -> further necrosis may occur

      Ex) DM ischemic toes

Indications of NPWT

- currently used on a number of wounds in all fields of surgery
  - introduced by Argenta & Morykwas in 1997

Table 1: Wounds for which VAC therapy is suitable

Wound type/process	Example
Acute	Trauma (upper/lower limb)
	Burns
Chronic	Pressure sores
	Leg ulcers
	Diabetic ulcers
Salvage	Wound dehiscence
	Wound infection
	Postoperative sternum infections
Surgical	Skin grafts
	Flap surgery
	Wound bed preparation

Adapted from: Jones SM et al (2005) [14]

Excellent treatment

Recommendations for diabetic foot ulcers

- **Strongly consider**
  - **Debrided Wagner grade 4**
- Case by case
  - Debrided Wagner grade 2, 3 wounds with treated infection
- **Not recommended**
  - **Wagner grade 1**
  - **Wagner grade 5**

Recommendation for skin grafts or skin substitutes

- **Strongly consider**
  - **For skin grafts and skin substitutes on complex areas**
    - **Areas of flexion/extension**
    - **More complex anatomical sites:**
      - **Groin, Axilla, Joints**

- Case by case
  - Need early mobilization
  - Need rapid hospital discharge

- **Not recommended**
  - **Simple grafts for which cost and length of hospital stay do not warrant its use**

NPWT Therapy Contraindications

- Malignancy in wound
- Necrotic tissue with eschar
- Untreated osteomyelitis
- Fistulas to organs or body cavities
- Over exposed arteries or veins

When to discontinue NPWT

- **Achievement of desired goals**
  - Exudate volumes have reduced sufficiently to allow patient to be transitioned to another treatment modality
  - The wound bed is sufficiently prepared with granulation tissue
  - The wound is prepared for a flap or graft
  - Wound is optimized for surgical closure
  - Wound becomes superficial

- **Failure to improve**
  - **Deterioration of wound**
  - **Worsening infection**
  - **Significant periwound maceration**

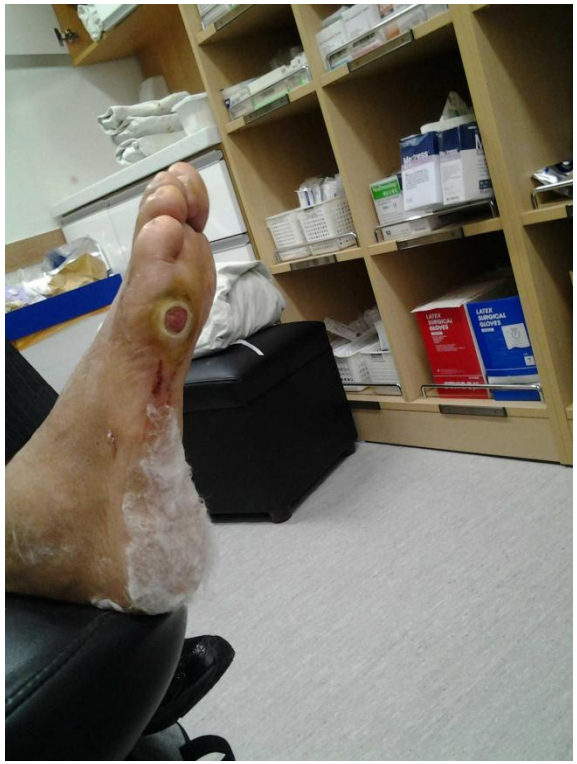
When to discontinue NPWP

- Complications develop
  - Excessive bleeding
  - Inability to obtain an adequate seal
- Poor patient compliance
- Patient cannot tolerate therapy
  - due to pain, allergy

Case 1

- 염OO (67/M)
- CC : 5th MTPT, right
  - Chronic ulceration
  - Over 6m.
- 2012-7-4 (initial)
  - 1st TCC apply

- 2012-7-16 (2nd visit)
  - 2nd TCC apply



- 2012-7-25 (3rd visit)
  - 3rd TCC apply : wound healing process

- 2012-8-8 (4th visit) : pin point ulcer 크기

- 2012-8-20 (5th visit)
  - Total contact cast # 6wks.
  - Complete healing state
    → Insole application

Case 2

- **C.C :** Rt. Foot pain

  onset) 내원 3일 전

- **P.I (63/F)**

  15년전 부터 DM Hx 있는 분으로 3일 전부터 fever 동반한 상기 증상으로 ER 경유 내원.

- **PMHx :** DM / HTN (+/-)

Initial gross photo (2010.8.11)

I & D under FSNB (2010.8.12)

Open ray amputation under SNB (2010.8.19)

Wound revision under SNB (2010.9.13)

CuraVAC apply (2010.9.13~)

2010.10.14

Operation (2010.10.21)

- Full thickness skin graft

- Anesthes ck

Case 3

- **C.C :** Lt. Foot ulceration

  onset) 내원 2개월 전

- **P.I (61/M)**

-2011 초 DM 진단받은 분으로 2개월 전 마사지기로 발 안마하다 병변 발생 후 악화되어 내원.

- **PMHx :** DM / HTN (+/-)
- **Imp.**
  - **Necrotizing fascitis, lower leg, Lt.**
  - **DM foot ulcer with infection, Lt.**
  - **r/o Gas gangrene, lower leg, Lt.**

Initial gross photo (2010.6.21)

Fasciotomy & I & D under general anesthesia (2011.6.21)

Wound revision under FSNB x 2 times (2011.7.21. and 8.2)

CuraVAC apply(2011.8.2~)

Operation (2011.8.18)

- Full thickness skin graft
- Anesthesia : FSNB and local inguinal block

Last gross (2011.11.14)

Case 4

- **C.C :** Lt. Foot pain

  onset) 2006. 10월

- **P.I (63/M)**

  2006.10 경 유리에 발바닥 찔린 후 지속적으로 타과 외래 진료 받다가 호전 없어 OS refer 후 내원

- **PMHx :** DM(+)

Initial gross photo (2011.9.7)

Daily soaking dressing & CuraVAC apply (2011.9.15~)

2011.9.18

Wound revision under FSNB (2011.9.23)

2011.9.23

Daily soaking dressing & CuraVAC apply (2011.9.23~)

Operation (2011.10.21)

- Full thickness skin graft
- Anesthesia : FSNB and

Last F/U gross(2011.12.21)

Case 5

- **C.C :** Lt. foot painful swelling

  onset) 5일 전

- **P.I (56/M)**

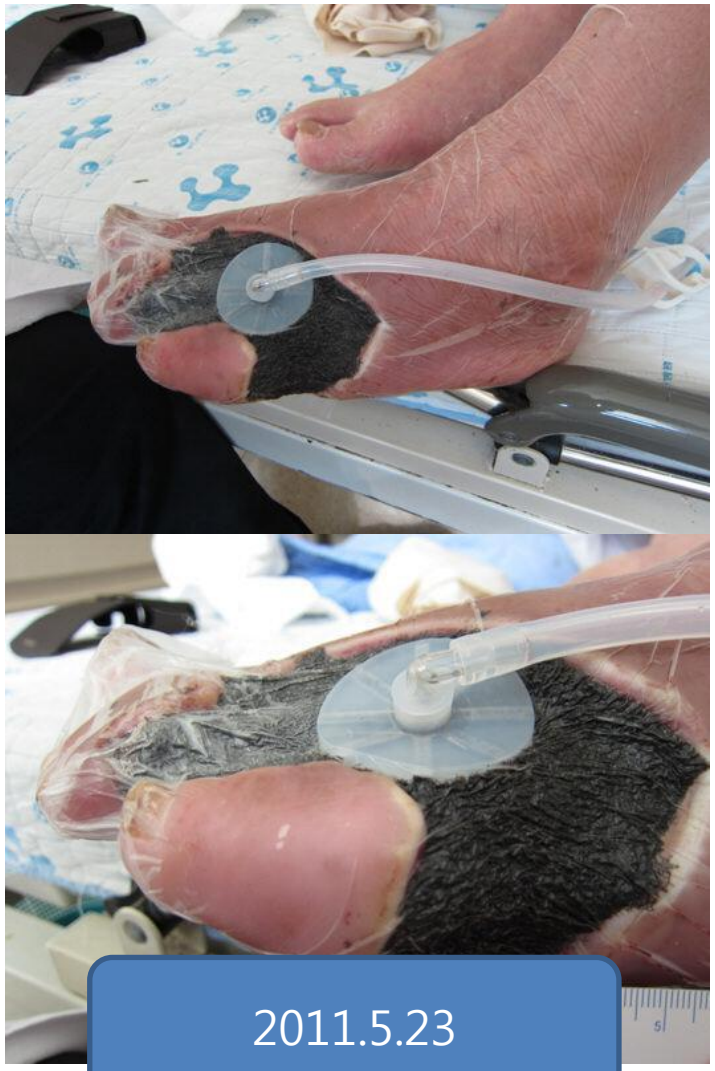
  DM 진단받고 치료 중인 분으로 5일 전 부터 상기 증상 있어 올리브 오일과 숯가루 바르면서 악화되어 내원

- **PMHx :** DM / HTN (+/-)

Initial gross photo (2011.4.22)

I & D under SNB (2011.5.16)

Daily soaking dressing
&
CuraVAC apply



Daily soaking dressing
&
CuraVAC apply

Operation (2011.7.15)

- Full thickness skin graft

- Anesthesia : SNB and

Last F/U (2011.8.4)

Case 6

- 50세/ 남
- 우측 족부 괴사 및 하퇴부 통증
- 오래됐어요…
- DM(+)

Initial gross (2010.11.16)

Open amputation under FSNB (2011.11.16) Daily soaking dressing

CuraVAC
11days(10.12.20)

Debridement and repair under SNB (10.12.23)

1st MTPJ osteomyelitis(11.01.06)

2nd amputation under SBN and repair(11.01.10)

CuraVAC management(11.02.07)

OPD f/u

Case 7

- C.C : Lt. 1st toe painful pus discharge

  onset) 내원 3일 전

- P. I : (63/F)
  - DM (+), 10년 전 당뇨 진단 및 치료
  - 5년 전부터 Lt. 1st toe에 상처 있어서 local에서 소독
  - **3일전부터 pain, swelling, redness**

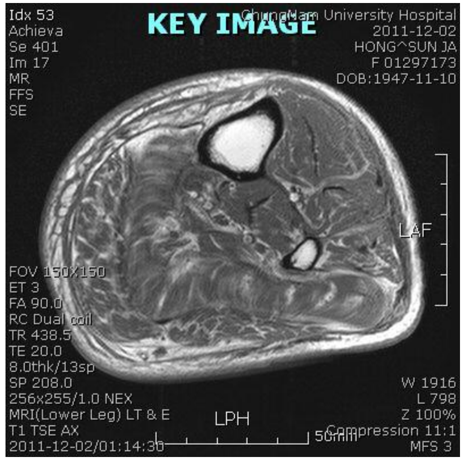
- Past Medical Hx. :
  - Known DM (Insulin : humalog 아침 50U, 저녁 10U)
  - COPD

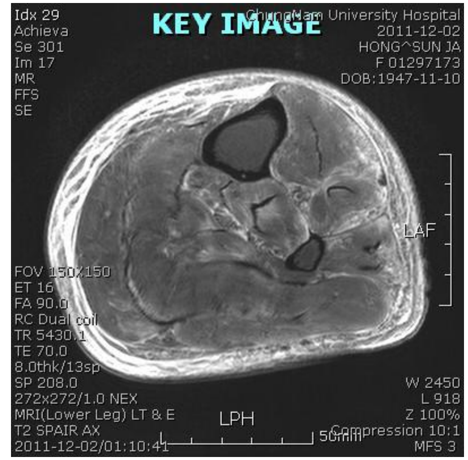
Case Presentation

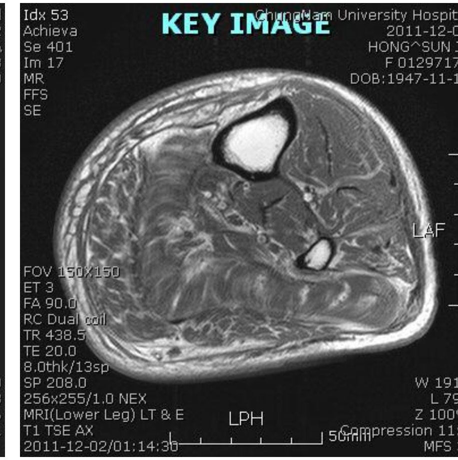
- Post admission # 2 days

Case Presentation

- MRI





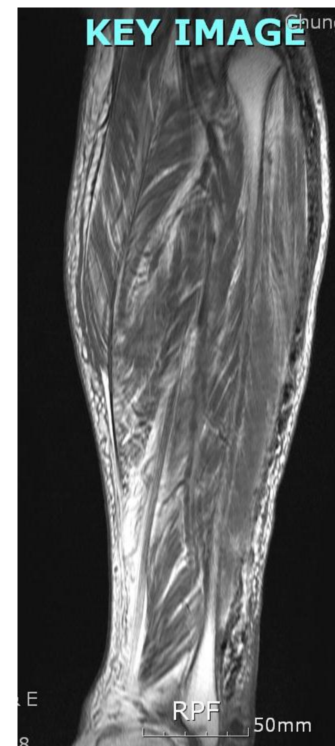


CONCLUSION Lt. leg

Diffuse cellulitis and fasciitis along the Lt. leg
- diffuse subcutaneosu edema

Diffuse myositis
- esp. ant. & lat. compartments

Necrotizing fasciitis
- air trapping along the crural fascial plane, anterior & lateral aspect



Emergency I & D

Gross finding after infection control

CuraVac application for 3 weeks

Preop. gross finding

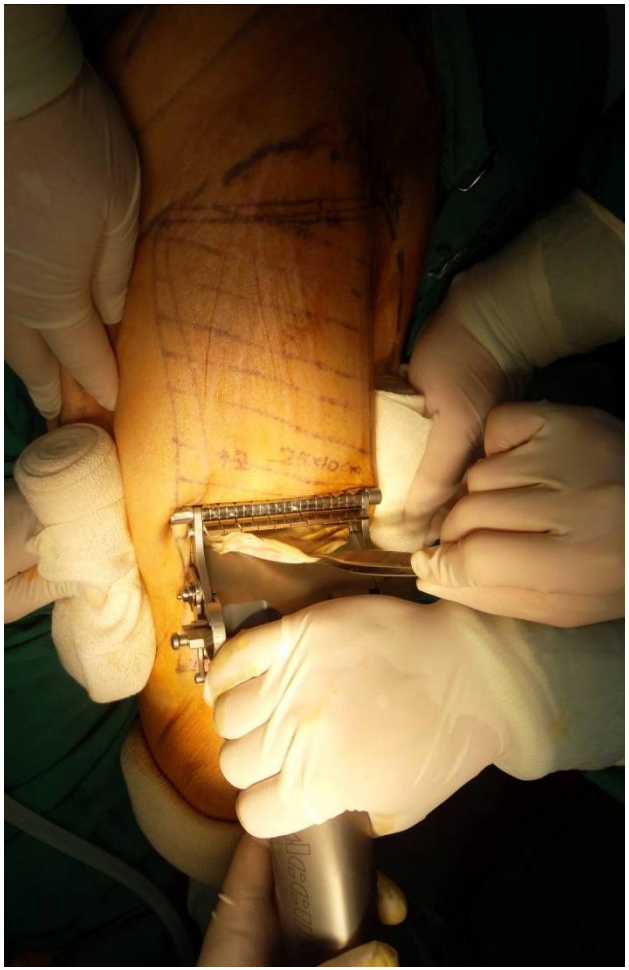
- Sizing of recipient site
  - Lt. lower leg : 20 X 10cm
  -  : 5 X 5cm

Marking of donor site

- 10x25cm for STSG

Harvesting of donor site

– Using dermatome blade



Procedure

– Under rubber tourniquet

Postop. 2 weeks

2nd FTSG under SNB & inguinal block

Last follow-up

Thanks
for your attention!