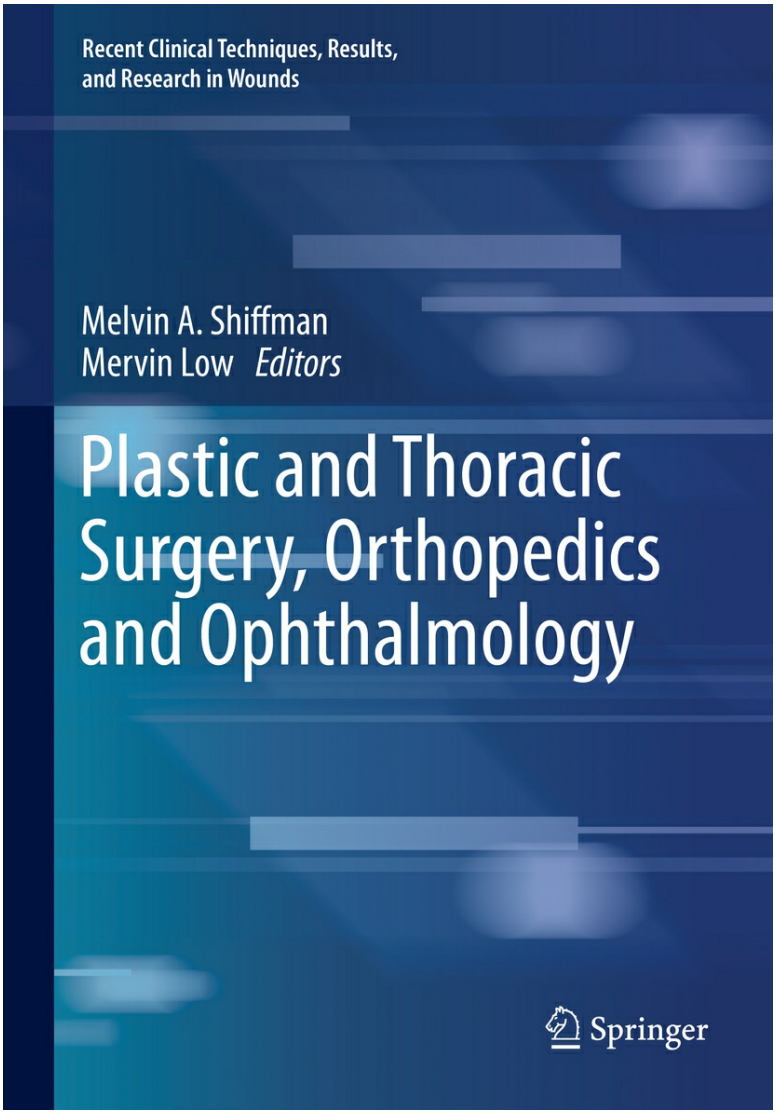
Recent Clinical Techniques, Results,
and Research in Wounds
Melvin A. Shiffman
Mervin Low Editors
Plastic and Thoracic
Surgery, Orthopedics
and Ophthalmology
Springer

Volume 4

Recent Clinical Techniques, Results, and Research in Wounds

Series Editors
Melvin A. Shiffman and Mervin Low

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Plastic and Thoracic Surgery, Orthopedics and Ophthalmology

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Foreword [1]

It is a great honour for me to be invited to provide a foreword for the series of six books edited by Dr. Shiffman and Dr. Low, which cover a broad expanse of subjects relevant to and important in the care of patients with wounds.

Wounds have existed since the beginning of time and, until recent years, have received scant attention unless major conflicts developed which necessitated innovation in the treatment of patients with wounds. However, in recent years there has been an increasing interest in this subject as evidenced by the explosion of journals, meetings, societies and associations and initiatives that have been developed in this field.

The need for an academic underpinning of the subject of wound healing is without question. Research papers published in recent years have undoubtedly enhanced the scientific basis for wound healing. This, coupled with demographic changes in many countries around the world, has led to increasing numbers of patients developing wounds or wound healing problems. It is recognised that in the vast majority of geographies globally the number of patients with wounds is increasing in everything other than major burns where better health and safety initiatives have been an effective preventive strategy.

This series of books not only attempts to deal with subjects that are normally seen in wound healing text but also provides a huge amount of space to the management of wounds seen in surgical practice, both general and specialist surgery. The sections on infection are an attempt to deal with a very common but poorly managed clinical problem and one that requires urgent attention in view of the global challenge of antimicrobial stewardship. The tradition chronic wounds are also included and provide a medical as well as a nursing and paramedical focus on these subjects.

It is particularly pleasing to see books and chapters focused on specialised surgical practice as these are areas that are rarely covered in other educational products in this area. The opportunity for new therapies, measuring the range of effective and appropriate outcomes and the use of new technologies are all included.

For those of us who work in the area of wound healing, these books will unquestionably be an important reference source. For those readers who want to get an insight into this common, expensive and complex problem they will without doubt find the content of these books an important source of informed opinion and refer to the rapidly expanding evidence base that is developing in this subject area.

I would urge you to immerse yourself in these books. Read, reflect and consider how information that you have had access to can and will change your clinical practice.

Keith Harding

Preface

We are delighted to have the book on wounds extended into six volumes. There is so very much medical literature in journals and books that to cover the whole gamut of wounds would be virtually impossible. We tried to include as many of the experienced practitioners in wound care as possible, but many of them are too busy to spend the time committing to submitting a chapter.

The selection of topics in each of the volumes was decided by the number of authors responded to each of the subjects. As usual in editing a book, many authors who agreed to submit manuscripts finally were not available to complete the chapters. We contacted or tried to contact over 1500 authors and most of them did not respond or the responses were not as good as expected.

The volumes include:

1. Biofilm, Pilonidal Cysts and Sinuses
2. Burns, Infections and Wound Management
3. Pressure Injury, Diabetes and Negative Pressure Wound Therapy
4. Plastic and Thoracic Surgery, Orthopedics and Ophthalmology
5. Vascular Surgery, Neurosurgery, Lower Extremity Ulcers, Antimicrobials, Wound Assessment, Care, Measurement and Repair
6. Chronic Wounds, Wound Dressings and Wound Healing

There are many expert international contributors who have worked in various aspects of wound research as well as clinical practice. We have tried to have chapters that involved humans and in vivo results and avoided as much as possible animals and in vitro results. Chapter conclusions are those of the authors and may not be the same as those of the editors. At times the chapter may appear cumbersome, but the authors try to show some proof of their results. Language difficulties are common when translated into English so that grammar, spelling and sometimes words have to be corrected.

Hopefully, the reader will get information that adds to their care and treatment of patients. Researchers may gain knowledge of other researchers' progress and improve on the results or can continue their work in other directions. Controversy is many times a good thing since looking in other directions to prove or disprove a result can improve knowledge. We have a long way to go to be able to treat all wounds properly and successfully in as short a time as possible.

Melvin A. Shiffman

Mervin Low

Tustin, CA, USA, Newport Beach, CA, USA

Contents

Footnotes

1 [1] P. S.

We, Melvin A. Shiffman and Mervin Low, are greatly enthralled by Keith Harding's willingness to write the Foreword for the books on wounds. Keith Harding is the Director of TIME Institute (Translation, Innovation, Methodology and Engagement) and Head of the Wound Healing Research Unit in the School of Medicine at Cardiff University . He is Clinical Lead for Wound Healing in the Cardiff and Vale NHS Trust . In September 2013 Harding was appointed Dean of Clinical Innovation at Cardiff University . From 2002 to 2005 he was Head of the Department of Surgery at Cardiff University . He is Editor-in-Chief of the*International Wound Journal* . Harding is a Past President of the European Tissue Repair Society. He was the first President of the European Pressure Ulcer Advisory Panel and first Recorder of the European Wound Management Association . He was Chair of the International Working Group on Wound Healing in Diabetic Foot Disease in 2003. He was Chair of the Expert Working Group that produced a range of International Consensus Documents from 2004 to 2011. Professor Harding was appointed a Commander of the Order of the British Empire in the 2013 New Year Honours for services to medicine and healthcare.

Part I
Orthopedics

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Management of Complex Distal Lower Extremity Wounds Using a Porcine Urinary Bladder Matrix (UBM-ECM)

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Disclosure: Dr. Kraemer has been a consultant for ACell®, Inc., (Columbia, MD) since 2014 and has received monies for presenting his clinical experience on the use of the UBM-ECM wound device. He began using the UBM-ECM wound devices in 2010.

1 Introduction

Wounds of the distal third of the leg, ankle, and foot often pose challenging reconstructive problems because of the lack of suitable local available tissues as well as the frequent bone and tendon involvement in a wound bed with compromised arterial inflow or venous outflow. With acute wounds, there is often an associated crushing or shearing trauma to the local tissues, while the more chronic wounds have a marked degree of inflammation and bacterial colonization. Additionally, ambulation can lead to dependent edema as well as added stress and strain on the injured parts which may contribute to repeated wound breakdown.

The recognized ultimate goal of lower extremity limb reconstruction is achieving durable, stable, infection-free, pain-free, minimally scarred wound healing that also facilitates primary bone healing, appears as normal as possible, and allows normal ambulation. Trying to achieve this in an ever-aging population with increased medical comorbidities can be most complicated. Beginning in 2012, we began using UBM-ECM (urinary bladder matrix-extracellular matrix) wound devices (initially marketed as MatriStem® and more recently rebranded as Cytal™, ACell®, Inc., Columbia, MD) as the primary wound management modality to treat lower extremity wounds in patients with significant medical comorbidities that would beat higher complication risk for treatment with a standard regional or free flap [1, 2]. While wound bed excisional debridement is the recommended preparation for Integra™ Bilayer Wound Matrix (Integra™ LifeSciences, Plainsboro, NJ) use [3], we were surprised to find that wounds managed with UBM-ECM responded well with a lesser wound bed debridement, thus allowing for more tissue preservation even in the presence of significant bacterial colonization (Figs. 1, 2, 3, 4, 5, 6, and 7). Unlike the report of Valerio et al. [4] who described UBM-ECM as an adjunct to standard treatments, we have advanced the use of UBM-ECM to a primary reconstructive modality. We found that all wounds, regardless of size, responded to the UBM-ECM wound device. In general, the amount of UBM-ECM wound device needed, the number of device placement procedures performed, and the time needed to heal the wound increased as the wound size increased. Healing times also varied with some patients opting for a split- or full-thickness skin graft once adequate vascularized tissue filled the wound and skin grafting became possible. Despite the longer wound healing times when compared to standard flap therapy for similar wounds, there were no infected non-unions, the wounds closed over all of the exposed tendons, and the exposed hardware was retained or easily removed after the fracture healed. More importantly, once the wounds healed, the wounds remained healed. Compared to standard flap therapy [5–21], the distal limbs had a much more normal appearance and did not require subsequent revisions after healing, and the patient suffered no donor site scars other than a full- or split-thickness skin graft donor site.

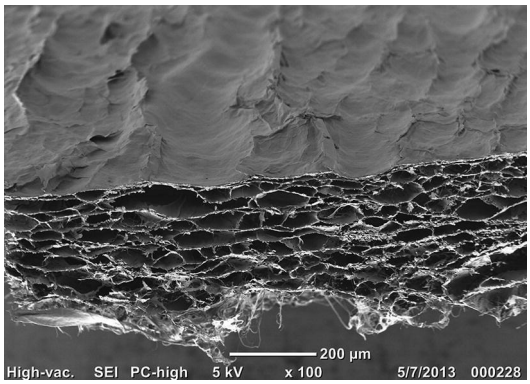


Fig. 1 Scanning electron microscopic image of the UBM-ECM wound device. The intact basement membrane layer is seen as the top layer with the preserved tunica propria ECM lattice structure evident below (Courtesy TW Gilbert, Ph.D., ACell®, Inc., Columbia, MD)

Fig. 2 (**a**) Non-compressed volume of 500 mg of the MicroMatrix powder. After being placed in the wound, the powder does not maintain this volume. (**b**) Appearance of a 10 × 15 cm rehydrated Cytal Burn Matrix (right) and MatriStem Surgical Matrix sheet (left). Note the notch of the Surgical Matrix Sheet in the top right corner indicates the sheet is oriented with the intact basement membrane layer facing up. (**c**) Compressed volume size of a rehydrated Cytal Burn Matrix sheet 7 × 10 cm on the left and 10 × 15 cm sheet on the right

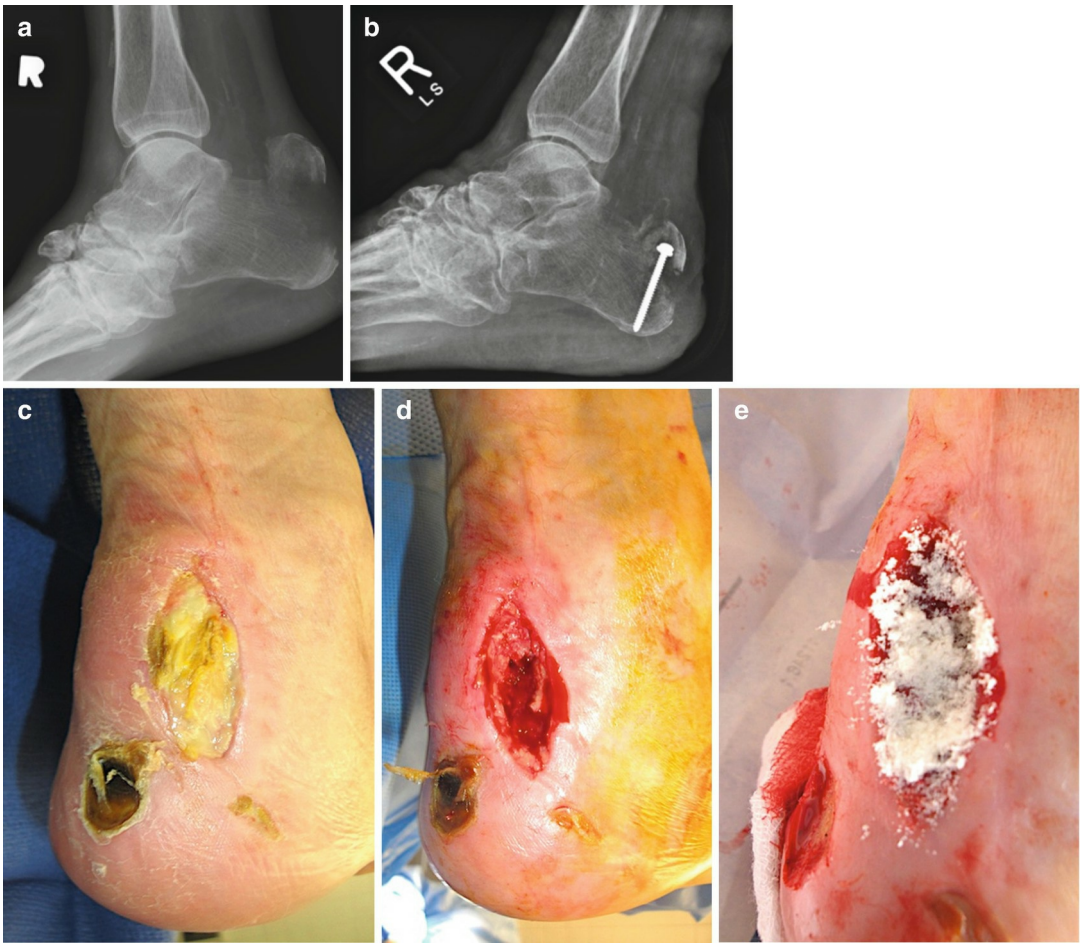
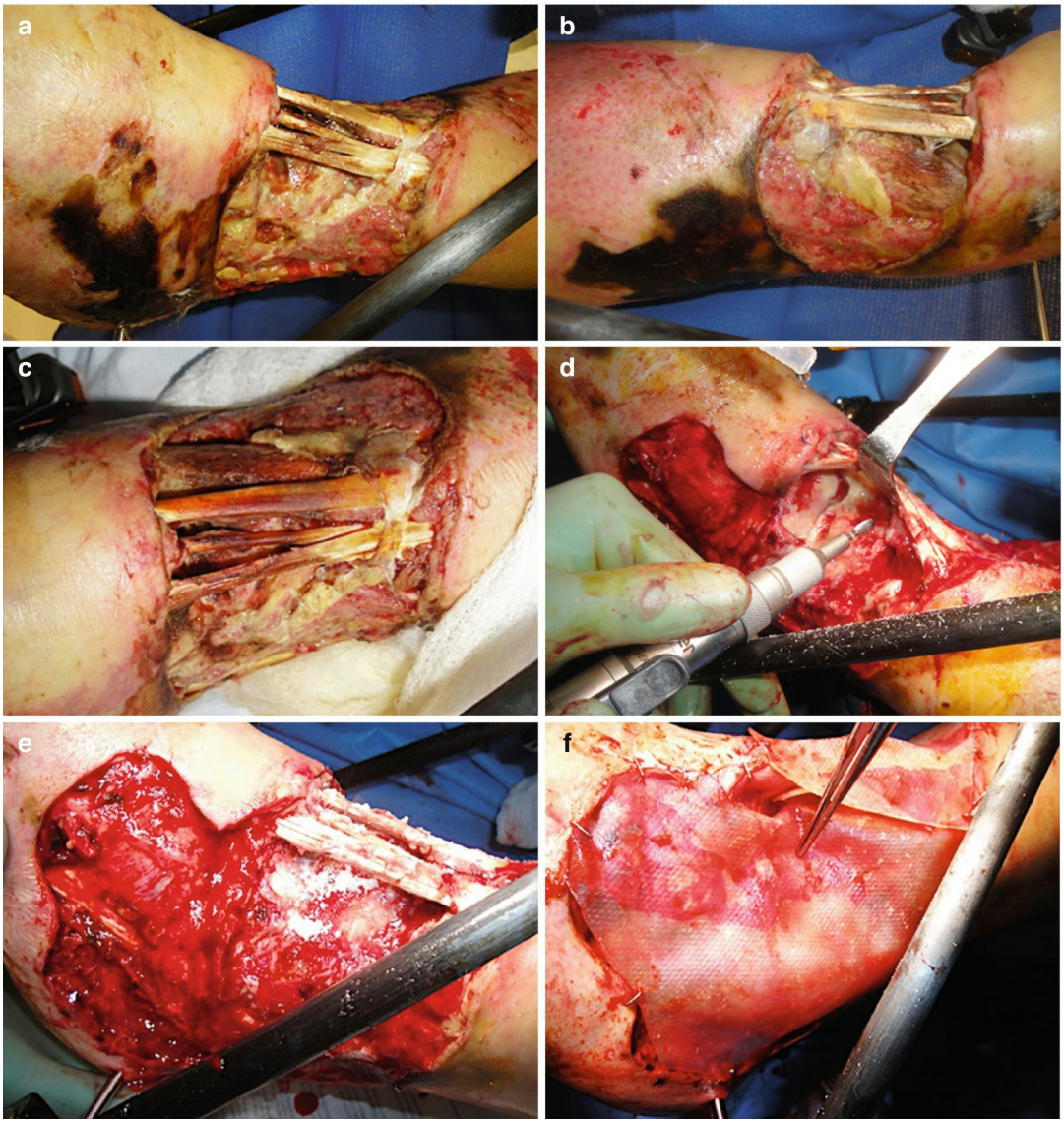


Fig. 3 (**a**, **b**) A 63-year-old legally blind diabetic female S/P pancreas/kidney transplant on immunosuppression sustained a calcaneal tongue-type fracture which failed to hold reduction and (**c**) posterior heel wound which developed. (**d**) Posterior heel wound post-debridement and screw removal due to failure. (**e**) Placement of 100 mg MicroMatrix powder into the wound. (**f**) Placing a cut up 5 × 5 cm Surgical Matrix sheet layered into the wound and covered over with Adaptic and polyurethane sheet dressing. (**g**) Wound appearance 14 days later. (**h**) 3.5 months post-injury she fell and now fractured her ankle mortise. An additional 5 × 5 cm surgical sheet was placed in the remaining cavity. (**i**) An additional 200 mg of MicroMatrix powder was placed into wound by pulling the wound sheet partially out, powdering it, and placing it back into the wound. (**j**) The wound was healed by 9 months post initial injury and follow-up photo shown at 1 year. Reproduced with permission [1]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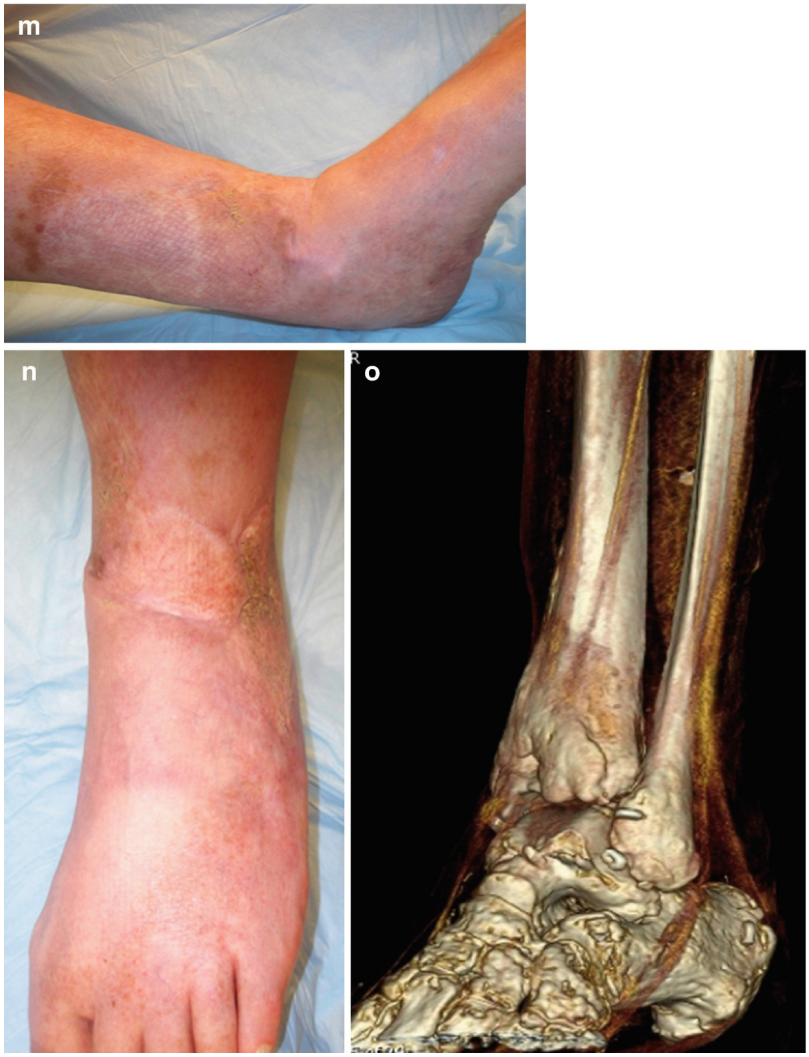

Fig. 4 (**a**–**c**) Lateral, medial, and anterior ankle appearance 2 weeks post-injury of a 57-year-old male whose leg was wrapped around a dump truck axle causing a total talus and ankle dislocation with associated medical problems of facial fractures, a contralateral acetabular fracture, diabetes, and full anticoagulation treating a recent pulmonary embolism. Initial wound management was NPWT, and wounds were culture positive for wound methicillin-sensitive *Staph aureus* and *Pseudomonas*. (**d**) Open ankle joint with distal tibial debridement and exposed talus demonstrated—note rongeurs were used for the final bone debridement. (**e**) Generous coating of MatriStem MicroMatrix powder was applied to the wound bed and tendons. (**f**) Wound bed and tendons were covered with MatriStem Surgical sheet. (**g**) Wound appearance as the UBM-ECM promotes constructive remodeling 2 weeks later. (**h**) Split-thickness skin grafts were applied once sufficient lateral ankle wound healing occurred. (**i**) Further healing of ankle tissues filling up to under the anterior ankle tendons. (**j**) Ankle tissues have grown up around and now envelop the tendons. At this point a full-thickness skin graft is placed over these tendons to complete the closure of the open ankle wound. Wound totally closed at 19 weeks post-injury. (**k**) Early ankle appearance 3 weeks after full-thickness skin graft over anterior ankle tendons. (**l**–**n**) Healing 2 years post-injury. Note the progressive healing and merging of the skin grafts into the normal ankle tissues. (**o**) CT scan demonstrating the damaged talus and the intact anterior ankle tendons of the healed ankle wound. Reproduced with permission [1]