AUTOLOGOUS BONE GRAFT

IS THERE ANY LIFE LEFT IN IT?

DEDICATED TO MY MENTOR

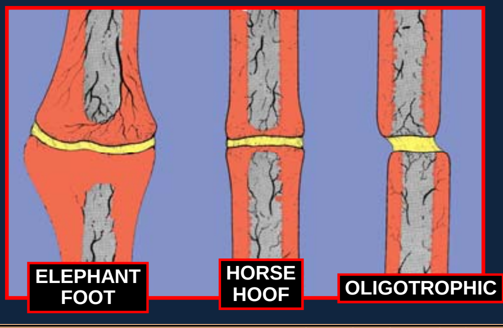
HOWARD ROSEN, M.D.

(1925-2000)

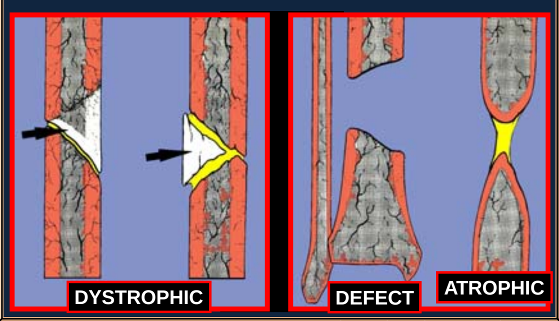
WHY DO WE EVEN USE A BONE GRAFT?

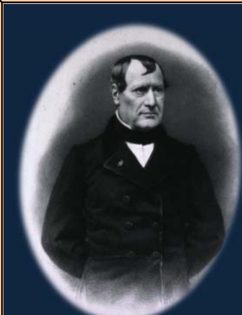
- NONUNIONS
- BONE DEFECTS
- ARTHRODESES

Need mechanical stability



NEEDS VASCULARITY & VOID FILLER





Flourens (1842)

Flourens conclusively showed that periosteum was osteogenic and was the chief agent in the healing of bone defects

FIRST BONE GRAFT - 1858

De la production artificielle des os au moyen de la transplantation de perioste et des greffes osseux.

Ollier, L.X.
Comp Rend Soc de Biol 5: 145. 1858

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OSTEOPERIOSTEAL GRAFTS

(Delageniere = 1921)

AKA "Judet Decortication"

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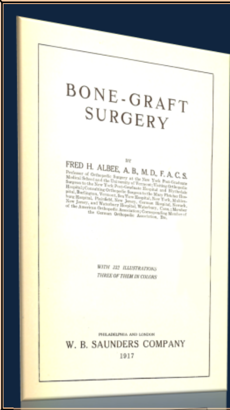
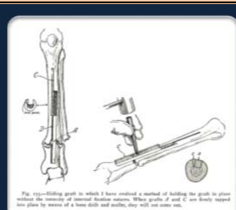
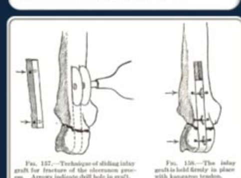


BONE-GRAFT SURGERY

FRED H. ALBEE, A.B., M.D., F.A.C.S.

W. B. SAUNDERS COMPANY
1917





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INLAY GRAFTS

- NO PLATES AVAILABLE
- KANGAROO TENDON

Fig. 12. — Albee osteotome for splitting spinous processes. By courtesy of Kny - Scheerer Company.

Fig. 13.—Albee's fracture tenaculum especially designed for reduction of fracture of the patella, grasping head of femur in reconstruction operation, and approximating other fracture fragments in general. See Fig. 152. By courtesy of Kny-Scheerer Company.

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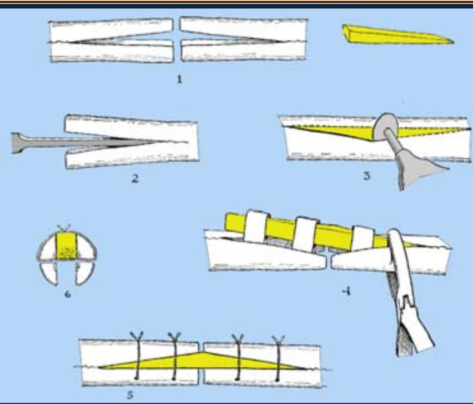

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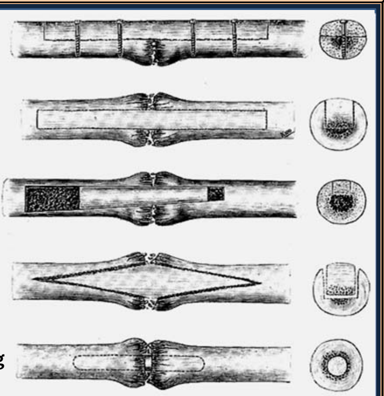

Ony with screws

Simple Inlay

Sliding Inlay

Diamond Inlay

Intramedullary Peg

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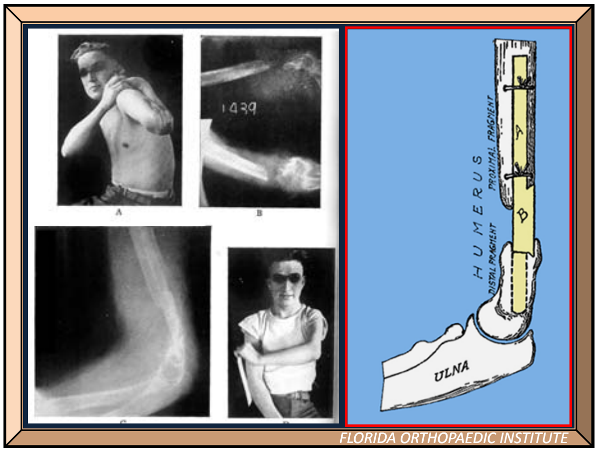
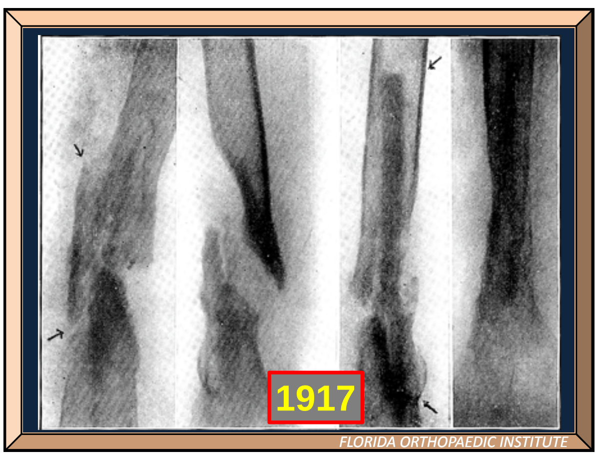
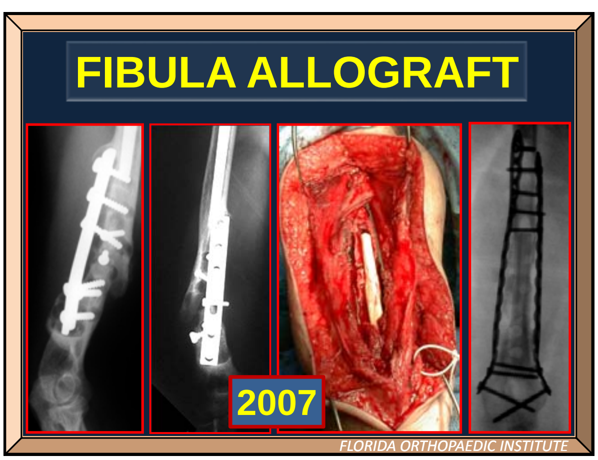

HUMERUS
PROXIMAL FRAGMENT
DISTAL FRAGMENT
A
B
ULNA
FLORIDA ORTHOPAEDIC INSTITUTE


1917
FLORIDA ORTHOPAEDIC INSTITUTE


FIBULA ALLOGRAFT
2007
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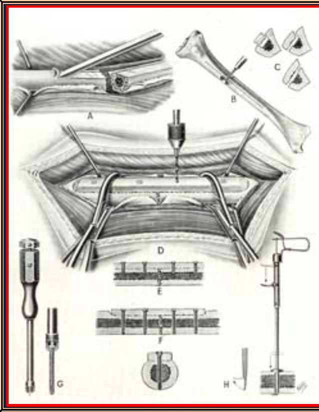

TIBIAL CORTEX ONLAY BONE GRAFT

1946

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Fixation of bone graft with vitallium screws. As a rule, four screws are sufficient, two in each fragment. In this particular case a double fracture necessitated an 8-in. graft, and six screws were used.

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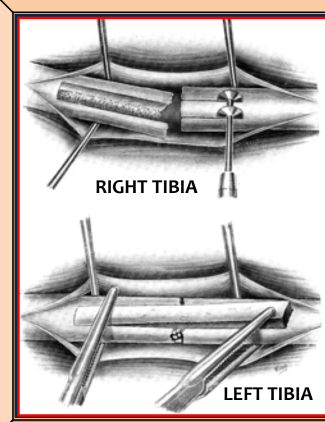

"ROBBING PETER TO PAY PAUL"

1950's

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CORTICAL GRAFTS

- TOOK FOREVER TO HEAL
- OFTEN FRACTURED
- DONOR SITE PROBLEMS

CANCELLOUS GRAFTS

- LACK STRENGTH SO USED WITH PLATES
- VASCULAR INVASION BY HOST IN 2 DAYS

ILIAC CREST GRAFT

THE USE OF CANCELLOUS CHIPS IN BONE-GRAFTING

TABLE I

Bones	Average Time of Union: Cortical Grafts Only	Average Time of Union: Cortical Grafts Plus Cancellous Chips
Humerus	16 weeks	8 weeks
Radius and ulna	17½ weeks	8 weeks
Tibia and fibula	17 weeks	8 weeks
Femur	22 weeks	14½ weeks

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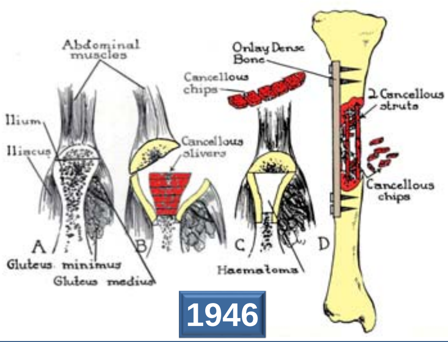
HARVESTING ILIAC CREST



1946

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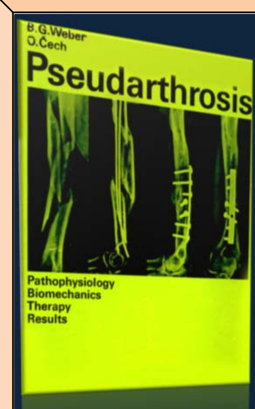

ORIGINALLY USED FOR ITS FASTER HEALING PROPERTIES

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Moreover, it can be argued, from the results obtained using the other types of graft, that there are two main sources of new bone formed by a fresh iliac autograft, namely: 1) osteoblasts on the surfaces of the grafted bone, and 2) cells contained within the marrow of the graft.

in the 1960's the osteogenic potential of red bone marrow became known.

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Technique for Human Marrow Grafting

By E. Donnall Thomas and Rainer Storb

A technique is described for marrow aspiration from living human donors and for processing the marrow for intravenous infusion to marrow graft recipients.

Blood, Vol. 36, No. 4 (October), 1970

Table 1.—Results of Human Marrow Aspirations

Donor	Age	Sex	Weight Kg.	Aspiration Site	Total Volume	Volume of Blood	Nucleated Cells × 10⁹	Peripheral Blood Cells × 10⁹	Marrow Cells × 10⁹
1	30	M	81.0	Sternum	50	25	1.68	0.18	1.50
				Anterior crests	*212*	*137*	*4.76*	*0.95*	*3.81*
				Posterior crests	634	534	16.67	3.74	12.93
				All	896	696	23.11	4.87	18.24
2	28	M	64.0	Sternum	142	112	3.23	0.67	2.56
				Anterior crests	*243*	*188*	*7.05*	*1.12*	*5.93*
				Posterior crests	610	465	17.81	2.79	15.02
				All	995	765	28.09	4.58	23.51
3	35	F	54.5	Sternum	64	24	3.36	0.14	3.22
				Anterior crests	*101*	*61*	*4.24*	*0.35*	*3.89*
				Posterior crests	211	151	11.37	0.88	10.49
				All	376	236	18.97	1.37	17.60

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DEFINITION

A ***BONE GRAFT*** MATERIAL IS ANY IMPLANTED MATERIAL THAT ALONE OR IN COMBINATION WITH OTHER MATERIALS PROMOTES A HEALING RESPONSE BY PROVIDING ***OSTEOGENIC***, ***OSTEOCONDUCTIVE***, OR ***OSTEOINDUCTIVE*** ACTIVITY TO A LOCAL SITE

MUSCHLER & LANE 1992

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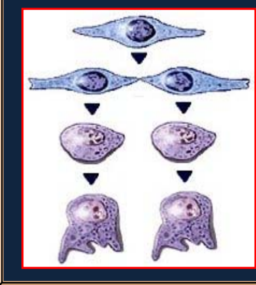
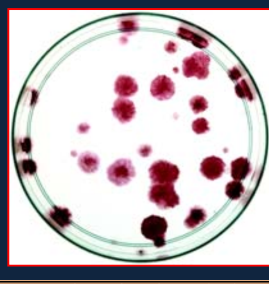
OSTEOGENIC = contains living cells that can differentiate into bone

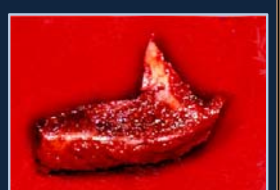




OSTEOGENIC

ASPIRATE

TRICORTICAL GRAFT



(BOTH CONTAIN OSTEOPROGENITOR CELLS)

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OSTEOCONDUCTIVE = promotes bone apposition to act as a scaffolding to allow bone formation

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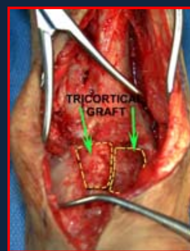
OSTEOCONDUCTIVE

ALLOGRAFT

TRICORTICAL GRAFT



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OSTEOINDUCTIVE = induces cells to turn into osteoblasts

(TGF superfamily)

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ILIAC CREST BONE GRAFT

REMEMBER:

- NO DISEASE TRANSMISSION
- NO IMMUNE RESPONSE
- AMPLE SUPPLY

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CANCELLOUS BONE GRAFT

- STANDARD ILIAC CREST
- CALC, PLATEAU, RADIUS
- FEMORAL & TIBIAL SHAFTS

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Journal of Orthopaedic Trauma
Vol. 3, No. 4, pp. 287–289

1989

A Technique for Obtaining Bone Graft

Roy Sanders and Thomas DiPasquale

Department of Orthopaedic Surgery, University of South Florida, Tampa, Florida, U.S.A.

Summary: A technique is described for obtaining large amounts of morselized cancellous graft to fill significant bony defects. This method uses an acetabular reamer placed against the outer wall of the posterior pelvis. Advantages of this technique include the procurement of copious amounts of homogeneous cancellous bone graft, ease of performance, little postoperative pain, and minimal bleeding. This technique should not be performed in elderly or osteopenic patients. **Key Words:** Bone graft—Defect pseudarthroses—Open fracture.

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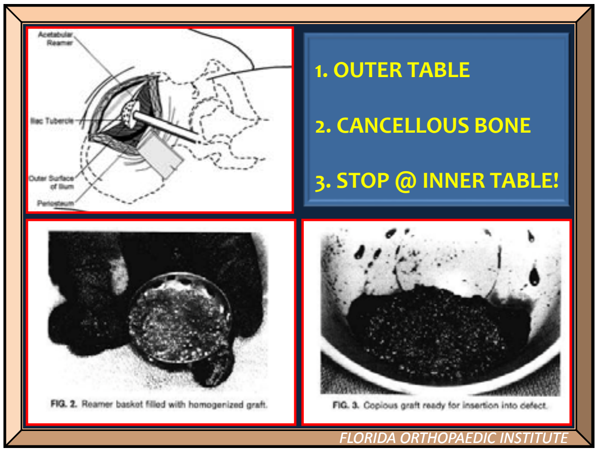

Acetabular Reamer
Iliac Tubercle
Outer Surface of Ilium
Periosteum
1. OUTER TABLE
2. CANCELLOUS BONE
3. STOP @ INNER TABLE!
FIG. 2. Reamer basket filled with homogenized graft.
FIG. 3. Copious graft ready for insertion into defect.
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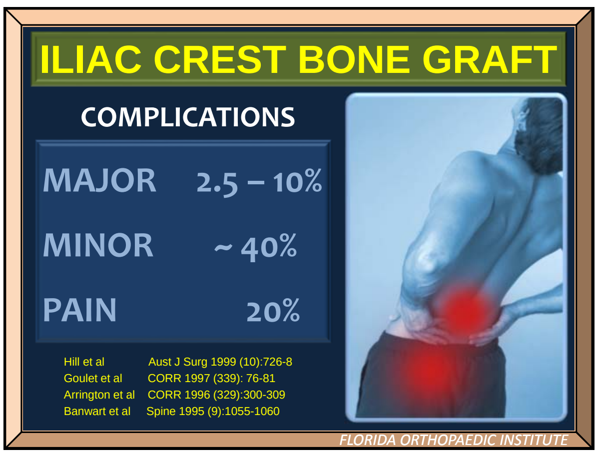

ILIAC CREST BONE GRAFT
COMPLICATIONS
MAJOR 2.5 – 10%
MINOR ~ 40%
PAIN 20%
Hill et al Aust J Surg 1999 (10):726-8
Goulet et al CORR 1997 (339): 76-81
Arrington et al CORR 1996 (329):300-309
Banwart et al Spine 1995 (9):1055-1060
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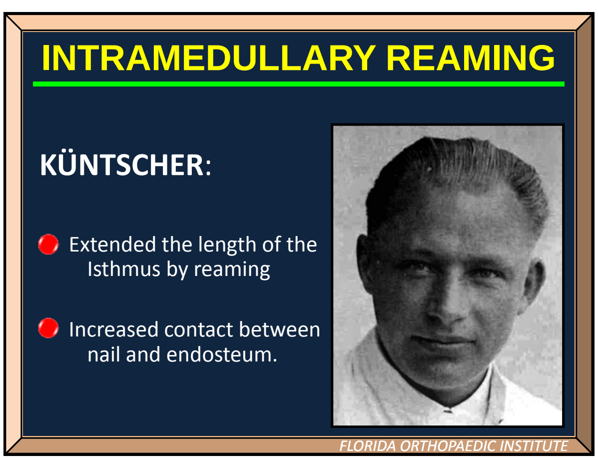

INTRAMEDULLARY REAMING
KÜNTSCHER:
Extended the length of the Isthmus by reaming
Increased contact between nail and endosteum.
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POTENTIAL BENEFITS OF REAMING

- INCREASED STABILITY
- INCREASED PERIOSTEAL FLOW.
- IMPROVED HEALING.
- DECREASED MAL & NON-UNIONS

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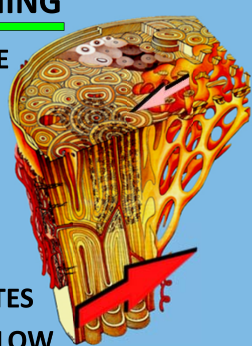
EFFECTS OF REAMING

EVEN THOUGH THERE IS A LOSS OF ENDOSTEAL BLOOD FLOW



REAMING STIMULATES PERIOSTEAL BLOOD FLOW

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REAMING + NAIL

BIO + MECHANICS

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POTENTIAL DISADVANTAGES OF REAMING

- THERMAL NECROSIS
- MEDULLARY PRESSURIZATION
- (WEAKENS THE BONE).

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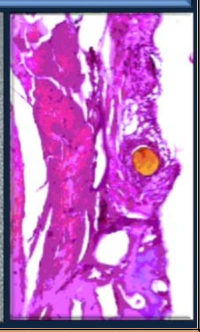
ENDOSTEAL THERMAL NECROSIS



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Measurement of intramedullary pressure in an animal experiment and propositions to reduce the pressure increase

K.M. Stürmer

Universitätsklinikum
Abteilung für Unfallchirurgie
45122 Essen, Germany

INJURY, 1993. VOLUME 24

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PRESSURE IN THE CANAL IS A HYDRAULIC SYSTEM *(PISTON)*

MAIN DETERMINANTS ARE:

- MEDULLARY *VISCOSITY*
- REAMER – CORTEX SPACE

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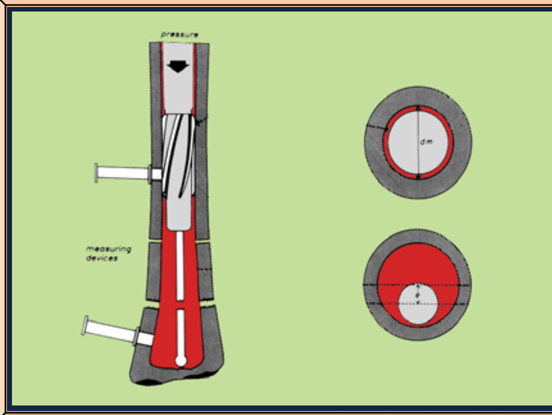

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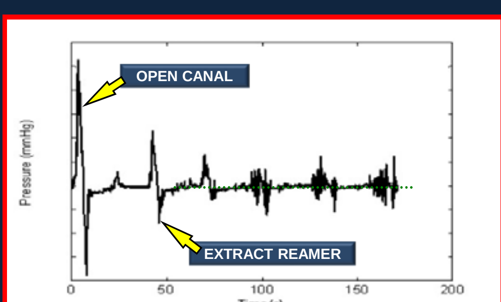
MEDULLARY PRESSURIZATION WITH REAMING



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PRESSURE INCREASES WITH:

- AWL OPENING OF CANAL
- PASSAGE OF GUIDE WIRE
- FIRST PASS REAMERS

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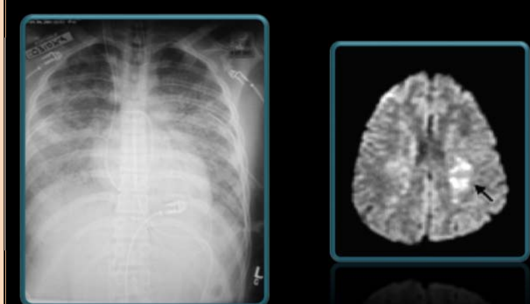
PRESSURIZATION 2^0 REAMING



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REAMER IRRIGATOR ASPIRATOR SYSTEM *(RIA)*

- REDUCES MEDULLARY PRESSURE
- ALLOWS SINGLE-PASS REAMING
- BONE HARVESTING APPLICATION

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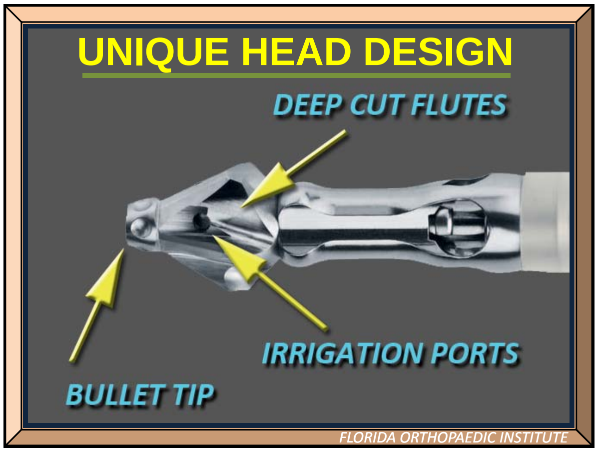
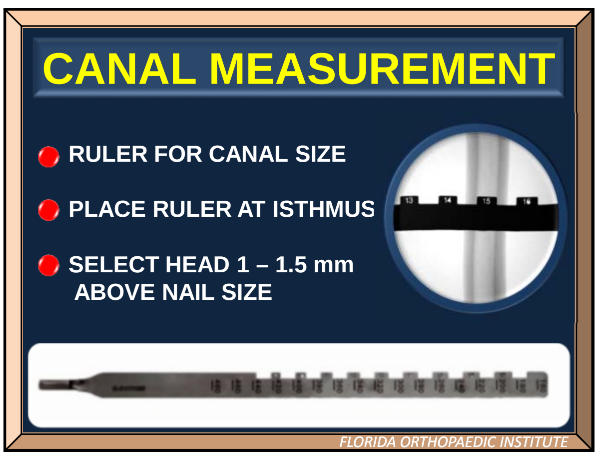

UNIQUE HEAD DESIGN
DEEP CUT FLUTES
IRRIGATION PORTS
BULLET TIP
FLORIDA ORTHOPAEDIC INSTITUTE


CANAL MEASUREMENT
RULER FOR CANAL SIZE
PLACE RULER AT ISTHMUS
SELECT HEAD 1 – 1.5 mm ABOVE NAIL SIZE
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ONE PASS REAMING
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RIA REAMING

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RIA REAMING

- IRRIGATION OBVIATES THERMAL PROBLEMS
- DOES ASPIRATION PROTECT AGAINST MARROW EMBOLI ?

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Reamed Femoral Nailing in Sheep: Does Irrigation and Aspiration of Intramedullary Contents Alter the Systemic Response?

By Hans-Christoph Pape, MD, Boris A. Zelle, MD, Frank Hildebrand, MD, Peter V. Giannoudis, FRCS, Christian Krettek, FRACS, and Martijn van Griensven, MD, PhD

Investigation performed at the Department of Trauma Surgery, Hannover Medical School, Hannover, Germany

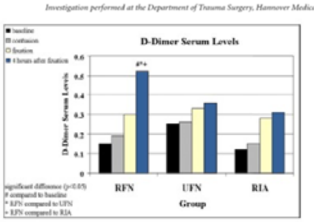

Fig. 1
D-dimer levels (ng/dL) measured in the blood serum samples obtained from the groups treated with reamed femoral nailing (RFN), unreamed femoral nailing (UFN), and reaming, irrigation, and aspiration (RIA).

JBJS Vol 87 A # 11, Nov 2005

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RIA REAMING

- IRRIGATION ASPIRATION PROTECTS AGAINST EMBOLIC PROBLEMS
- DOES IT PREVENT HEALING BY REMOVING ALL THE MARROW REAMINGS ?

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DOES "*ASPIRATION*" OF MARROW NEGATIVELY AFFFECT HEALING?

- Frolke , *Acta Ortho Bel 2000*
  Reaming debris accumulate at fracture site
- Trinkaus, *Unfallchirurg 2005*
  Reaming debris a source of viable stem cells

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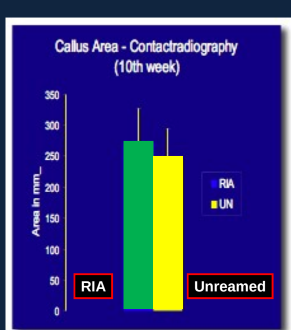
NO EFFECT IN ANIMALS…



C Klein ARI, Vienna

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RIA AS GRAFT

- CAN THE REAMINGS BE SAVED FOR GRAFT?
- ARE RIA REAMINGS EQUAL TO ICBG ?

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RIA AS GRAFT

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RIA vs ICBG: CONSISTENCY

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Qualitative and Quantitative Differences Between Bone Graft Obtained from the Medullary Canal (with a Reamer/Irrigator/Aspirator) and the Iliac Crest of the Same Patient

H. Claude Sagi, MD, Megan L. Young, MD, Louis Gerstenfeld, PhD, Thomas A. Einhorn, MD, and Paul Tornetta, MD

Investigation performed at Tampa General Hospital, Tampa, Florida, and Boston University, Boston, Massachusetts

JBJS, *December 2012*

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PEPTIDES IN REAMINGS > ICBG

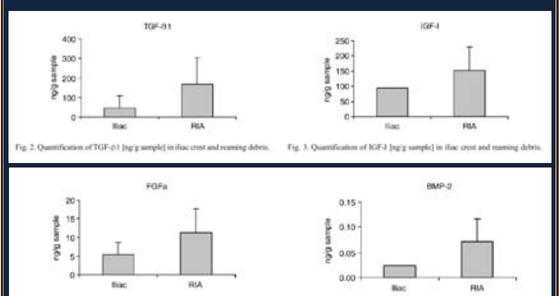

Fig. 2. Quantification of TGF-β1 [ng/g sample] in iliac crest and reaming debris.

Fig. 3. Quantification of IGF-I [ng/g sample] in iliac crest and reaming debris.

Fig. 4. Quantification of FGFa [ng/g sample] in iliac crest and reaming debris.

Fig. 6. Quantification of BMP-2 [ng/g sample] in iliac crest and reaming debris.

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RIA AS GRAFT

- REAMINGS SIMILAR TO ICBG IN VOLUME & CONSISTENCY
- RIA REAMINGS ARE EQUAL TO ICBG BIOLOGICALLY

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CASE REPORT

Complications Associated With Negative Pressure Reaming for Harvesting Autologous Bone Graft: A Case Series

Jason A. Lowe, MD,* Gregory J. Della Rocca, MD, PhD,* Yvonne Murtha, MD,* Frank A. Liporace, MD,† Michael D. Stover, MD,‡ Sean E. Nork, MD,§ and Brett D. Crist, MD*

MUST BE VIGILANT WITH SIZE OF REAMER & TECHNIQUE

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SO HOW DO WE

USE RIA

BONE GRAFT TODAY

?

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2004

ELSEVIER

Journal of Orthopaedic Research 22 (2004) 73–79

Journal of Orthopaedic Research

www.elsevier.com/locate/orthres

Induced membranes secrete growth factors including vascular and osteoinductive factors and could stimulate bone regeneration

Ph. Pelissier [a,*], A.C. Masquelet [b], R. Bareille [c], S. Mathoulin Pelissier [d], J. Amedee [c]

Abstract

Based on a new concept, a procedure combining induced membranes and cancellous autografts allows the reconstruction of wide diaphyseal defects. In the first stage of this procedure, a cement spacer is inserted into the defect; the spacer is responsible for the formation of a pseudo-synovial membrane. In the second stage, the defect is reconstructed two months later by an autologous cancellous bone graft. The aim of this study was to evaluate the histological and biochemical characteristics of these membranes induced in rabbits. Histological studies carried out two, four, six, and eight weeks following implantation revealed a rich vascularization. Qualitative and quantitative immunochemistry showed production of growth factors (VEGF, TGFβ1) and osteoinductive factors (BMP-2). Maximum BMP-2 production was obtained four weeks after the implantation, and, at this time, induced membranes favored human bone marrow stromal cell differentiation to the osteoblastic lineage. Should these results be confirmed in humans, bone reconstruction could be carried out earlier than previously thought and in better conditions than expected, the membrane playing the role of an in situ delivery system for growth and osteoinductive factors.

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INDUCED MEMBRANE – EXPRESSION OF VEGF, TGF-B1 AND BMP-2 AT 2, 4, 6 & 8 WEEKS

The technique for bone reconstruction described by Masquelet combines the induction of a membrane by the means of a cement spacer with a later cancellous autograft [10,12,17]. The first role of the spacer is mechanical as it obviates fibrous tissue invasion of the recipient site. The second role is biological, by the induction of the surrounding membrane.

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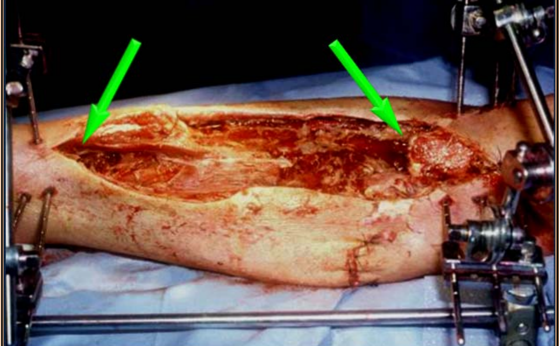
EDGES OF DEFECT



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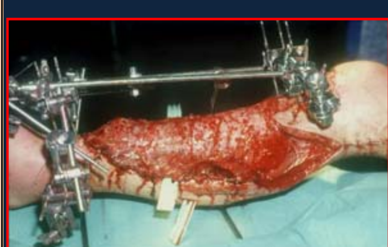
Free flap and cement spacer



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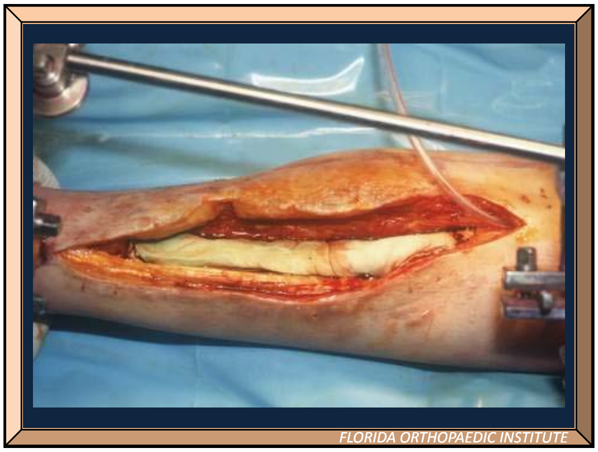
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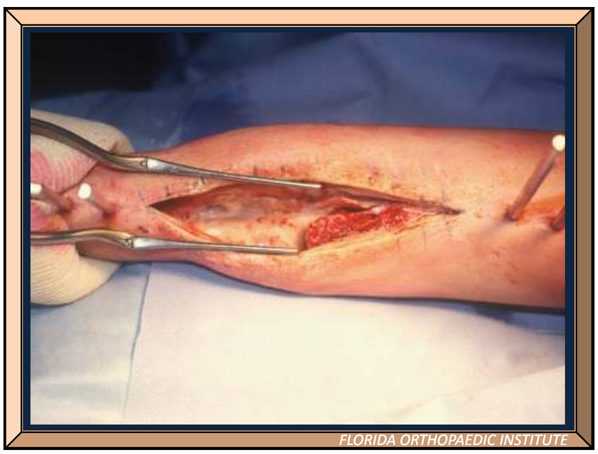
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Result at two years
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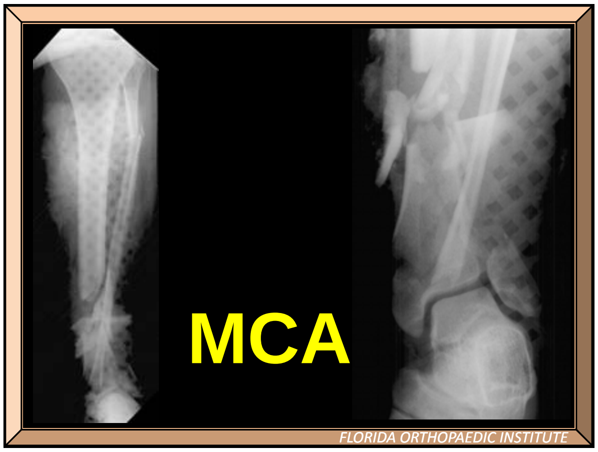

SEVERE TYPE IIIB

- IRRIGATE
- DEBRIDE
- STABILIZE

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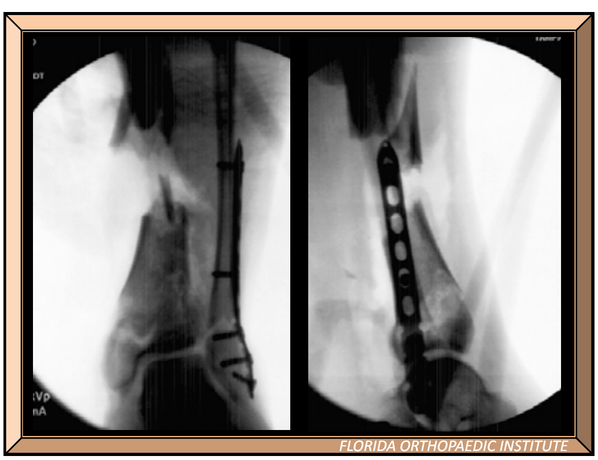
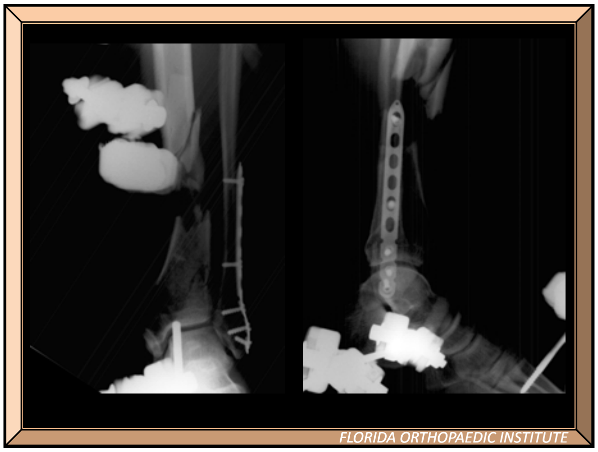
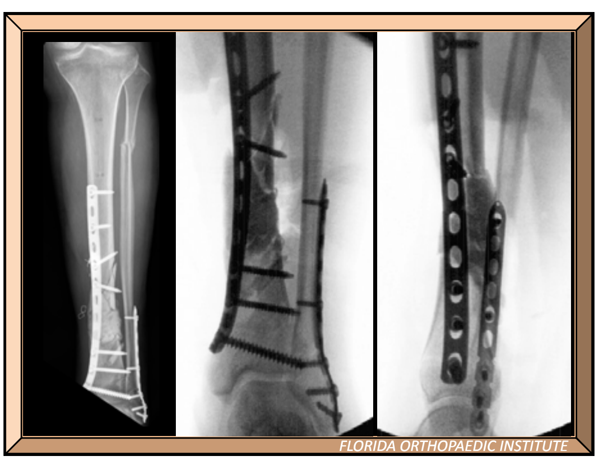




7 DAYS LATER,

- ANTIBIOTIC SPACER
- ANATOMIC PLATING
- FREE LAT FLAP



6 WEEKS LATER,

- SPACER REMOVED
- FLAP LIFTED
- ICBG PLACED

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6 MONTHS LATER,

- BACK FROM MIAMI
- SLIGHT PROBLEM…..

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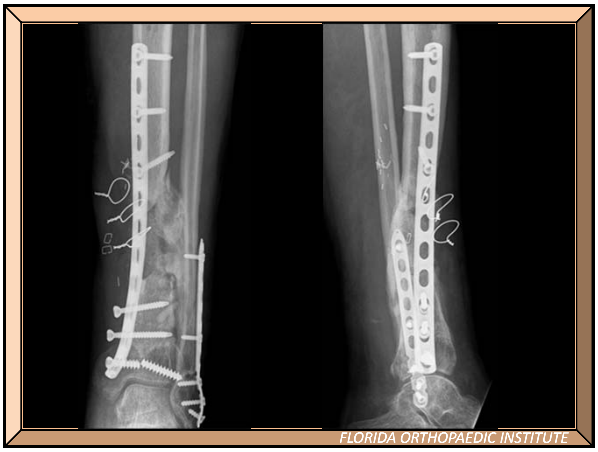
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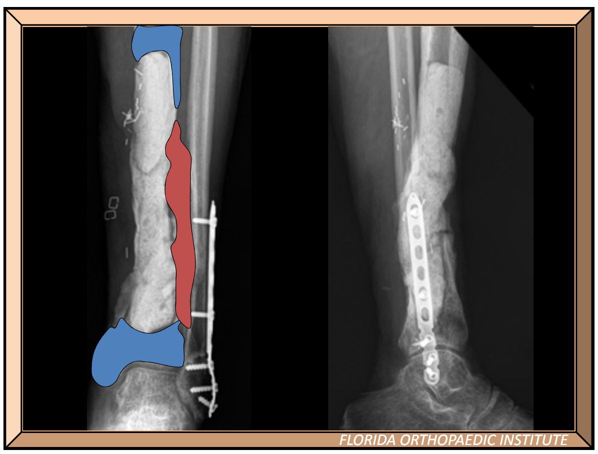
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3 MONTHS LATER
RIA
GRAFT
&
IM NAIL
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17 MONTHS
FROM MCA
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CONCLUSIONS
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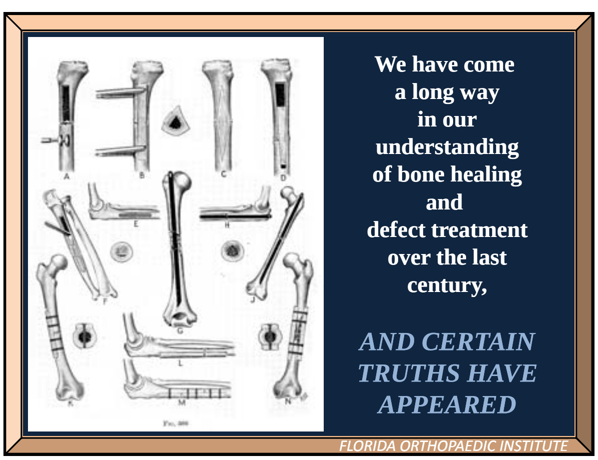
We have come a long way in our understanding of bone healing and defect treatment over the last century,
AND CERTAIN TRUTHS HAVE APPEARED
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ILIAC CREST BONE GRAFT

- OSTEOGENIC
- OSTEOCONDUCTIVE
- OSTEOINDUCTIVE

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ILIAC CREST BONE GRAFT

REMEMBER:

- NO DISEASE TRANSMISSION
- NO IMMUNE RESPONSE
- AMPLE SUPPLY
  (AND YOU ACTUALLY GET PAID TO DO IT!)

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RIA AS GRAFT

- REAMINGS SIMILAR TO ICBG IN VOLUME & CONSISTENCY
- RIA REAMINGS ARE EQUAL TO ICBG BIOLOGICALLY

MASQUELET TECHNIQUE

- CEMENT SPACER PROTECTS CAVITY FROM FIBROUS TISSUE
- STIMULATES FORMATION OF A MEMBRANE THAT RELEASES BMPs

CURRENT STATE OF THE ART


Orthopaedic
Trauma
Service
Florida
Orthopaedic
Institute
FLORIDA ORTHOPAEDIC INSTITUTE