**AUTOLOGOUS BONE GRAFT**

**IS THERE ANY LIFE LEFT IN IT?**

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**DEDICATED TO MY MENTOR**

**HOWARD ROSEN, M.D.**

*(1925-2000)*

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**WHY DO WE EVEN USE A BONE GRAFT?**

- **NONUNIONS**
- **BONE DEFECTS**
- **ARTHRODESES**
Flourens conclusively showed that periosteum was osteogenic and was the chief agent in the healing of bone defects.
De la production artificielle des os au moyen de la transplantation de périoste et des greffes osseux.

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

OSTEOPERIOSTEAL GRAFTS
(Delageniere = 1921)

AKA “Judet Decortication”
INLAY GRAFTS

- NO PLATES AVAILABLE
- KANGAROO TENDON

Onlay with screws
Simple Inlay
Sliding Inlay
Diamond Inlay
Intramedullary Peg
FLORIDA ORTHOPAEDIC INSTITUTE

TIBIAL CORTEX ONLAY BONE GRAFT
1946

FLORIDA ORTHOPAEDIC INSTITUTE

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

FLORIDA ORTHOPAEDIC INSTITUTE

“ROBBING PETER TO PAY PAUL”
1950’s

FLORIDA ORTHOPAEDIC INSTITUTE

RIGHT TIBIA

LEFT TIBIA
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

**TABLE 1**

<table>
<thead>
<tr>
<th>Bone</th>
<th>Cancellous Bone Graft Only</th>
<th>Cancellous Bone Graft + Cortical Chips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td>10 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Head and Iliac crest</td>
<td>12 weeks</td>
<td>6 weeks</td>
</tr>
<tr>
<td>Femur</td>
<td>13 weeks</td>
<td>7 weeks</td>
</tr>
</tbody>
</table>

**HARVESTING ILIAC CREST**

ORIGINALLY USED FOR ITS FASTER HEALING PROPERTIES
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-fish skin 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.

Technique for Human Marrow Grafting

By J. B. O’DAY, THOMAS AND PETER S.M.

A technique is described for marrow aspiration from living human donors and for preserving the marrow for subsequent injection to marrow-graft recipient patients.

REVIEW Vol. 36, No. 4 (October), 1979

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.
OSTEOGENIC = contains living cells that can differentiate into bone

OSTEOGENIC

ASPIRATE  TRICORTICAL GRAFT

(BOTH CONTAIN OSTEOGENITOR CELLS)

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

ALLOGRAFT

TRICORTICAL GRAFT

OSTEOINDUCTIVE = induces cells to turn into osteoblasts

(TGF superfamily)

ILIAC CREST BONE GRAFT

REMEMBER:

- NO DISEASE TRANSMISSION
- NO IMMUNE RESPONSE
- AMPLE SUPPLY

NO DISEASE TRANSMISSION
NO IMMUNE RESPONSE
AMPLE SUPPLY
ILIAC CREST BONE GRAFT

SIMPLY IS
THE GOLD STANDARD

CANCELLOUS BONE GRAFT

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

A Technique for Obtaining Bone Graft

Roy Sanders and Thomas DiPasquale

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

Summary: A technique is described for obtaining large amounts of mandibular cancellous bone to fill significant bony defects. This method uses an accurate bone reamer placed against the outer wall of the posterior part. 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 prosthetics—Open fracture.
1. OUTER TABLE
2. CANCELLOUS BONE
3. STOP @ INNER TABLE!

ILIAC CREST BONE GRAFT

COMPLICATIONS

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAJOR</td>
<td>2.5 – 10%</td>
</tr>
<tr>
<td>MINOR</td>
<td>~ 40%</td>
</tr>
<tr>
<td>PAIN</td>
<td>20%</td>
</tr>
</tbody>
</table>

Goulet et al, CORR 1997 (339): 76-81
Arrington et al, CORR 1996 (329):300-309
Banwart et al, Spine 1995 (9):1055-1060

INTRAMEDULLARY REAMING

KÜNTSCHER:

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

- Increased stability
- Increased periosteal flow.
- Improved healing.
- Decreased mal & non-unions

EFFECTS OF REAMING

Even though there is a loss of endosteal blood flow

Reaming stimulates periosteal blood flow

REAMING + NAIL

BIO + MECHANICS
POTENTIAL DISADVANTAGES OF REAMING

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

ENDOSTEAL THERMAL NECROSIS

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

K.M. Stummer
Universitätsklinikum
Akteilnahrung Unfallchirurgie
47051 Essen, Germany

INJURY, 1993. VOLUME 24
PRESSURE IN THE CANAL IS A HYDRAULIC SYSTEM (PISTON)

MAIN DETERMINANTS ARE:

- MEDULLARY VISCOSITY
- REAMER – CORTEX SPACE

MEDULLARY PRESSURIZATION WITH REAMING
PRESSURE INCREASES WITH:

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

PRESSURIZATION 20° REAMING

REAMER IRRIGATOR ASPIRATOR SYSTEM (RIA)

- REDUCES MEDULLARY PRESSURE
- ALLOWS SINGLE-PASS REAMING
- BONE HARVESTING APPLICATION
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 Eike-Christian Pen, MD, Boris A. Zell, MD, Frank R. Hermann, MD, Pierre V. Galmonnet, BThSc, Christian Brünell, Bpph, and Beatrice van Garssen, MSc, PhD.

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

![Graph showing hematoma volumes](image)

*In vivo* hematoma volumes measured in the femoral area after reaming with irrigation and aspiration, respectively. Note that aspiration led to lower hematoma volumes.

*JBB* Vol 87 A # 11, Nov 2005
RIA REAMING

- Irrigation Aspiration protects against embolic problems
- Does it prevent healing by removing all the marrow reamings?

Does “Aspiration” of marrow negatively affect healing?

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

No effect in animals...

C Klein ARI, Vienna
RIA AS GRAFT

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

RIA vs ICBG: CONSISTENCY

RIA (Sludge)    ICBG (Chunks)
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 Sugi, MD; Nigar E. Stang, MD; Louis Coteinfeld, MD; Thomas J. Fangman, MD, and Paul E. Suen, MD
Investigation performed at Emory University Hospital, Atlanta, Georgia; and Emory University School of Medicine, Atlanta, Georgia.

JBJS, December 2012

PEPTIDES IN REAMINGS > ICBG

Fig. 1: Quantitative RT-PCR (ng/μg sample) of the cortex reaming sites.

Fig. 2: Quantitative RT-PCR (ng/μg sample) of the core reaming sites.

RIA AS GRAFT

- REAMINGS SIMILAR TO ICBG IN VOLUME & CONSISTENCY
- RIA REAMINGS ARE EQUAL TO ICBG BIOLOGICALLY
MUST BE VIGILANT WITH SIZE OF REAMER & TECHNIQUE

SO HOW DO WE USE RIA BONE GRAFT TODAY?
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.

Free flap and cement spacer
MCA

SEVERE TYPE IIIB
- IRRIGATE
- DEBRIDE
- STABILIZE
7 DAYS LATER,

- ANTIBIOTIC SPACER
- ANATOMIC PLATING
- FREE LAT FLAP
6 WEEKS LATER,
- SPACER REMOVED
- FLAP LIFTED
- ICBG PLACED

6 MONTHS LATER,
- BACK FROM MIAMI
- SLIGHT PROBLEM.....
3 MONTHS LATER
RIA
GRAFT
&
IM NAIL
CONCLUSIONS

We have come a long way in our understanding of bone healing and defect treatment over the last century, and certain truths have appeared.
**RIA AS GRAFT**
- REAMINGS SIMILAR TO ICBG IN VOLUME & CONSISTENCY
- RIA REAMINGS ARE EQUAL TO ICBG BIOLOGICALLY

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

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**CURRENT STATE OF THE ART**