Basal Joint Arthroplasty: Osteochondral allografting for trapezium resurfacing – bending the cartilage to fit

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Disxlosure

Intellectual Property, Columbia University, for Cartibend
Licensed to AlloSource, Centennial, Colorado
FDA approved but not yet commercially available

Recently was awarded a DOD grant to study this tecnology and possible further extensions
DOD Grant # PR171360- $1.52 million / 3 years

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Focal Osteochondral Defects

Common in trauma at every joint
No good solution in young patient
Total joint arthroplasty not appropriate
Problem ripe for innovation

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Allografts

- Well known in orthopedic surgery
- Mainly for bone reconstruction- tumor, trauma but without infection
- Allograft dead- no blood supply
- However Fresh Never Frozen donor articular cartilage is ALIVE AND VIABLE for up to 4-6 weeks
- It is non antigenic and no tissue matching required
- Thus cartilage grafting/ resurfacing is feasible and also passes the bar of the FDA as " minimally altered material" i.e. it is not a cellular technology

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Orphan Joints

- Most small joints in hand , wrist, foot, and ankle
- No investment from industry
- Too expensive to develop
- and have clinical trial to validate
- A case in point the basal joint of the thumb
- Most common symptomatic arthritis in the hand
- Hundreds of thousands of operations each year for debilitating pain
- An idea was born

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BJA Common and often disabling

- Treatment conservative till the patient "cries Uncle"
- We tend to delay surgery till advanced stages of disease
- Surgical Treatment with minor iterations is unchanged for the last 50 years
- Trapeziectomy good for pain relief
- Does not restore joint motion and power
- Difficulty with twisting and tearing – laeral and tip pinch
- All reconstructions attempt to prevent subsidence post trapeziectomy
- All fail including the latest in suspensionplasty- " tightrope"

My Preferred Technique:
Tendon Interposition Arthroplasty with Dynamic Stabilization with Tendon Transfer

Intolerable pain and functional limitations

My Evolution in Thinking

I started to do the Carroll plus operation which I will describe and have published with long term follow

(> 9 years)

The reconstruction is stabilized by repairing the DRL and performing a tendon transfer which dynamically stabilizes the thumb ray in palmar abduction.

JHS 2009

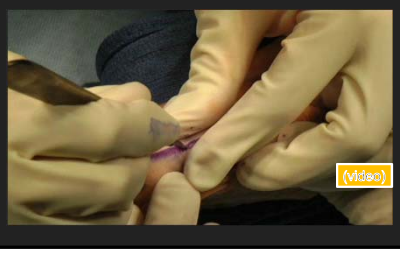
Long-Term Follow-Up of Basal Joint Resection Arthroplasty of the Thumb With Transfer of the Abductor Pollicis Brevis Origin to the Flexor Carpi Radialis Tendon

Benton E. Heyworth, MD, Charles M. Jobin, MD, James T. Monica, MD, Scott A. Crow, MD, Jonathan H. Lee, MD, Melvin P. Rosenwasser, MD

Tendon Interposition Arthroplasty with Dynamic Stabilization Tendon Transfer

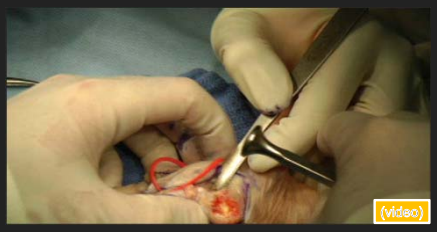
STEPS:

- Incision (Straight or Curvilinear)
- Trapeziectomy en bloc with preservation of capsular ligaments for later imbrication



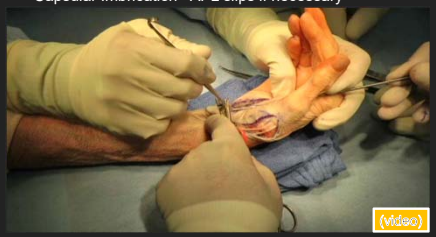
Tendon Interposition Arthroplasty with Dynamic Stabilization Tendon Transfer

- STEPS:
  - Thumb ray reducible into palmar abduction for DRL imbrication



Tendon Interposition Arthroplasty with Dynamic Stabilization Tendon Transfer

- STEPS:
  - Interposition "anchovy" Graft
    - PL or FCR (total
  - Capsular Imbrication - APL slips if necessary



Tendon Interposition Arthroplasty with Dynamic Stabilization Tendon Transfer

- STEPS:
  - Tendon Transfer (dynamic stabilization)
    FCR → APB or APL → APB

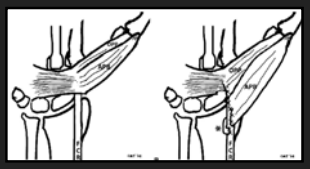
Dynamic Stabilization

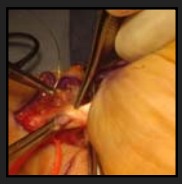
APB proximally detached from trapezium

Distally still attached to metacarpal

Proximally reattached to:

- FCR
- APL (if FCR used for graft)





Dynamic Stabilization with FCR-APB transfer

Corrects collapsed thumb web by repositioning thumb metacarpal in line with the scaphoid distal pole

Dynamic Stabilization with FCR-APB transfer

- **Accept the known subsidence**
- **Stabilization is dynamic not a tether**
- **Excellent restoration of thumb web space**
- **Start active motion at 2 weeks**

8 Month Follow Up

(video)

2 Year Follow-Up

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True Joint Arthroplasty for Thumb CMC Unsolved as of 2018

- Many Options over the years
- Silastic arthroplasty- Swanson, Dow Chemical- gone
- Pyrolytic Carbon- Integra, Tornier- poor results
- Artelon- polyurethaneurea, SBI- gone
- Orthosphere- Ceramic Wright Medical- gone
- Stablyx- Cobalt Chrome with titanium stem- Skeletal Dynamic- new presented here last year- no long term f/u
- All either have very short follow up or have failed and been withdrawn from market
- None superior to Trapeziectomy

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Most recent Hemiarthroplasty

Stablyx- Metal on eburnated Trapezial surface

Hemiarthroplasty contraindicated for fem neck fx in the face of hip OA

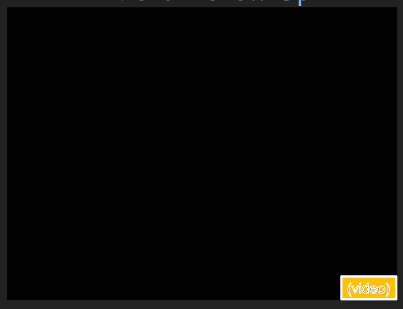
Case

- 45 y.o. male manual laborer with painful BJA
- Basal Joint hemiarthroplasty
- Never pain free post surgery
- Could not return to his job as laborer
- Thumb with persistent r adduction deformity, collapsed web space and hyperextension at MP joint
- Metal hemiarthroplasty resurfacing the metacarpal side of the joint
- Why should metal articulating on eburnated trapezial surface work?

Revision Implant Arthroplasty

3 Week Follow-Up

2 Month Follow-Up



Now for the Innovation

- We need a true joint arthroplasty
- Prosthetic designs to date have not been reliable
- We have long history of using osteochondral allografts for tumor and post traumatic indications
- Why not use a fresh allograft with healthy viable cartilage cells to resurface the trapezial side of the basal joint?
- That is where most of the wear always is.
- Allografts have been used as plugs from ribs as described by Dr. Thomas Tumble
- That is not a joint with double saddles
- Just an interposition

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The Innovaton

- Take osteochondral grafts from the trochlear notch-cadavers
- One arc of curvature mimics the trapezium already
- Let"s bend the cartilage in the other direction to reproduce the apposing double saddle design
- Never been done before
- We called it Cartibend with apologies to " Bend it with Beckham"
- Pilot studies funded by a juried award from the Coulter Foundation for Medical Entreprenuership
- Patented and now licensed to AlloSource, Centenial, Colo

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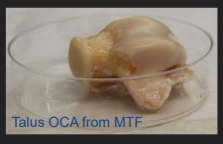
Osteochondral Allograft Bending

Osteochondral allografts (OCA) used to treat osteoarthritic (OA) joints

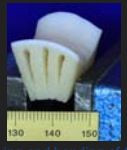
- Limited supply & 'shelf' life
- Difficult to match donor with recipient

Envisioned technology creates a new market

- More joints can be treated
- More efficient use of tissue bank inventory



Talus OCA from MTF



Grooving and bending of OCA

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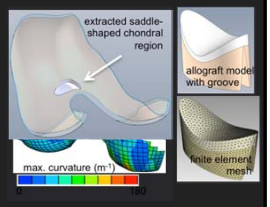
Solution/Envisioned Product

Enabling Technology

- Patent PCT/US15/20033 "Customized Bendable Osteochondral Allograft" filed March 11, 2015
- Method for bending allograft by cutting grooves in bony region
- Groove number and width determined from software algorithm to minimize mechanical damage to articular layer
- Hardware to automate scanning, cutting, grooving, bending



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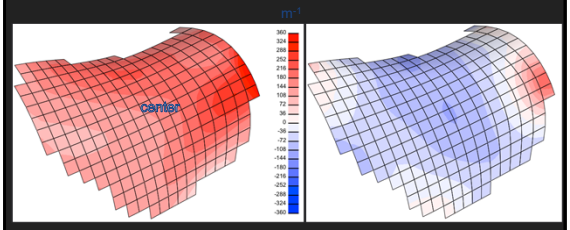
Curvature Maps: Trapezium



Maximum curvature | Minimum curvature

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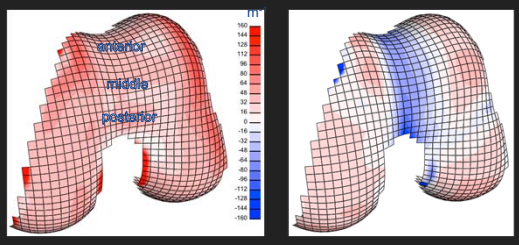
Curvature Maps: Femur



Maximum curvature | Minimum curvature

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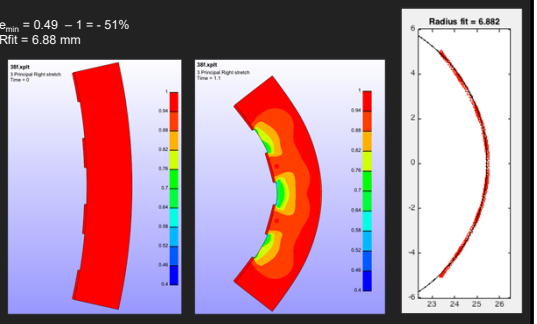
3 x 1.6mm groove

e_{min} = 0.49 – 1 = - 51%
Rfit = 6.88 mm



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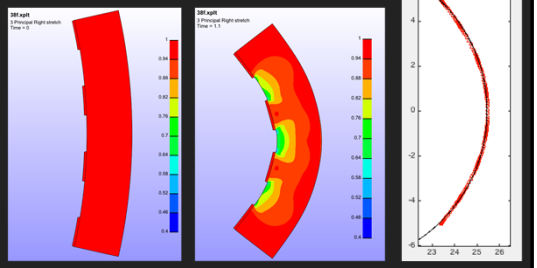

Technical Results

Technical Results

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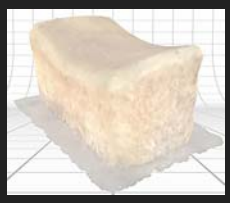
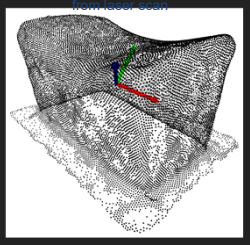
Technical Results

Software for groove path planning

Laser scan of osteochondral allograft



3D point cloud from laser scan



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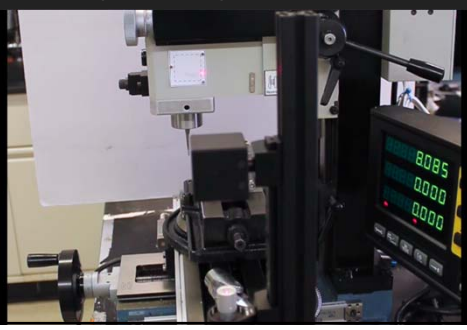
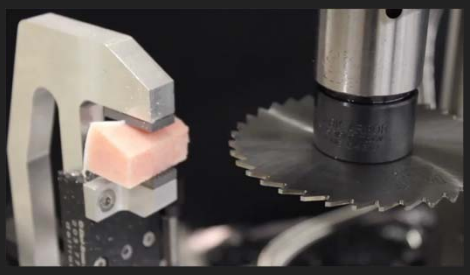
Technical Results

Technique for groove cutting on manual tabletop mill



Technical Results

Slitting saw blades now used to cut thinner deep grooves



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Technical Results

Grooved and bent allografts are not fragile

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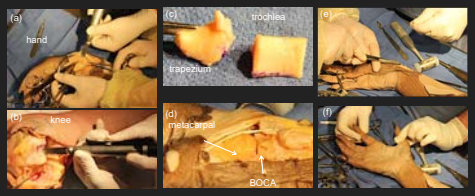
Technical Results

Surgical Procedure



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Technical Results

Surgical transplantation technique: Screw fixation

Technical Results

Surgical transplantation technique: Screw fixation

Conclusions

This biologic resurfacing of the carpal trapezium will be clinically available soon

I plan an IRB RCT vs. standard trapeziectomy

My hope is that this will preserve joint mechanics for a faster and more physiologic recovery


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Thank You
AMAZING THINGS ARE HAPPENING HERE
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College of Physicians & Surgeons