Osteochondral Grafting in Proximal Row Carpectomy: An old idea in a new place

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Proximal Row Carpectomy
Indications:

• Scapholunate Advanced Collapse
• Scaphoid Nonunion Advanced Collapse
• Kienbock’s disease with carpal collapse
• Other arthritides of the wrist
Proximal Row Carpectomy

Benefits:

• Pain relief
• Motion preserving
• Grip strength improvement

Proximal Row Carpectomy

Contraindication:

• Significant capitate arthritic degeneration

since the new articulating surfaces will be the capitate and lunate fossa of the radius . . .

Proximal Row Carpectomy

• With an arthritic capitate, other procedures should be chosen:
  scaphoid excision and midcarpal fusion or total wrist fusion
Proximal Row Carpectomy

• When there is minimal involvement (i.e. < 3 mm, J Hand Surg 1990), PRC or PRC with capsular interposition may still benefit the patient.

What is the limiting problem?

CARTILAGE

Hunter stated in 1743 that,

“from Hippocrates down to the present age, we shall find, that an ulcerated cartilage is universally allowed to be a very troublesome disease; that it admits of a cure with more difficulty than a carious bone; and that, when destroyed, it is never recovered.”

(Surgery of the Knee 2001)

CARTILAGE

• Is a unique tissue lacking vascular, nerve and lymphatic supply

• Lack of vascular and lymphatic circulation thought to be one reason for the poor intrinsic capacity to heal

• No inflammatory response elicited unless the subchondral bone is violated

• Any healing is with fibrocartilage which lacks the biomechanical properties of hyaline cartilage
In the knee . . .

Symptomatic Treatment

• Lavage
  - allows removal of loose articular particles, released enzymes, and inflammatory mediators
  - effect only temporary, underlying pathology not addressed

• Debridement
  - Removes mechanical symptoms
  - Symptomatic relief, 80% improvement in first year with gradual decline

How have other fields dealt with this problem?

(Surgery of the Knee 2001)

• Multiple Drilling
  – Pridie 1959
  – Insall showed 40% success at 6 yrs

• Multiple Microfracturing
  – Introduced by Steadman and Rodrigo
  – 75% success at 7 yrs

• Abrasion Arthroplasty
  – Introduced by Johnson who showed success rate of 77% at 2 yrs

Treatments that increase vascularity

(Surgery of the Knee 2001)

Multiple Microfracturing

(Oper Tech Orthop 1997)
Abrasion Arthroplasty

Autologous chondrocyte transplantation

- chondrocytes harvested from patient and cultured

- cultured chondrocytes transplanted under periosteal flap

Autologous chondrocyte transplantation
Autologous chondrocyte transplantation

17 y.o. female 1 year after pinning of osteochondral fragment

Autologous chondrocyte transplantation

Two years after autologous chondrocyte transplantation

Autologous chondrocyte transplantation
Osteochondral Autografting

- Matsusue first reported in 1993
- Hangody reported a 2 – 5 yr follow-up with good or excellent results in 86% to 90% of cases
- Histologic evaluation from animal studies show:
  1. Survival of transplanted hyaline cartilage
  2. Composite of 80% transplanted hyaline cartilage and 20% fibrocartilage
  3. Deep matrix integration at the recipient site

Osteochondral Autografting – Mosaicplasty (Cobblestoning)

- OPEN
- ARTHROSCOPIC
Osteochondral Autografting

5 1/2 years after mosaicplasty

Sandow in 1998 reported using rib bone/cartilage autografts in 22 pts for deficiency of the proximal scaphoid due to fx or necrosis

- Found good to excellent results at median 24 mos follow-up with the use of the costo-osteochondral autograft

(J Hand Surg Br 1998)

Osteochondral Autografting

In the wrist . . .

- Salon reported in 2003, 2 cases of Kienbock’s disease in which peri-lunate chondral lesions contraindicated classical PRC or 4 corner arthrodesis
- In one case the lunate fossa of the radius was damaged
- An osteochondral graft was harvested from the triquetrum and implanted into the fossa

(Chirurgie de la Main 2003)
Osteochondral Autografting in Proximal Row Carpectomy

THE PITTSBURGH SERIES

Osteochondral Autografting in PRC

Essentials:
- Identify patients in whom PRC was planned, but found to have capitate chondrosis intraoperatively
- Utilize the resected scaphoid, lunate, and triquetrum as sources of osteochondral grafts
- Osteochondral autograft these arthritic lesions

To date:
- 5 patients have undergone grafting to their capitate
- Chondrosis rated: Grade 3 in three pts, grade 3-4 in two pts
- Size of defects: 5x5 mm (x4) and 10x6 mm
- 1 patient underwent grafting from the triquetrum to the lunate fossa of the radius
Summary:
- Osteochondral autografting can be successfully done in the PRC with capitate chondrosis
- The resected carpal bones provide an adequate source of autograft
- PRC with osteochondral autografting extends the indications of PRC and
- broadens the treatment options for arthritides of the wrist
Sponsors & Acknowledgements

We would like to thank Arthrex for their kind donation of grafting tools for this research.

Thanks to our Arthrex Representative Carol Pribela for her support and interest.

Thanks to our Arthrex Engineer Robert Sluss.
Descending Geniculate Artery flaps for reconstruction of the recalcitrant scaphoid nonunion

James Higgins, MD
Chief of Hand Surgery
Raymond Curtis National Hand Center
Baltimore, MD

Medial femoral condyle corticoperiosteal flap:
Scaphoid Nonunions

Doi K et al.
- 10 patients with established nonunions
- 10 achieved union at avg 12 weeks

Jones DB, Buerger H, Bishop AT.
PRS 125:1176-84. 2010.
- 12 patients
- All achieved union avg 13 weeks (6-26)
Suggested approach
Subfascial dissection protects skin perforators

Branches to muscle
Branches to skin
20y/o male with 3 year hx scaphoid nonunion
Reconstruction 2006.

Kalick T, Burger H, Muller EJ.
Unfallchirurg 2008; 111:201-205.
Vascularized osteochondral graft from the medial femoral trochlea: anatomical study and clinical perspective

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39 y/o male surgeon
Injury Sept 2005
- January 2006 ORIF Herbert style screw dorsal approach
- June 2006 ORIF nonunion with accutrak screw, iliac crest graft, volar approach
- Currently with 5 year recalcitrant nonunion

Bürger & Higgins
One week postop

1 week postop
27 y.o. RHD male proximal scaphoid fx 2 years ago
- Initially treated conservatively > non-union.
- One year ago treated with 1,2-ICSRA vascularized bone-grafting and screw fixation. Continued to have pain and difficulty with function.
Example of skin paddle used for monitoring MFT flap for scaphoid nonunion osteocartilagenous arthroplasty

Skin paddle is removed after two months for contour/cosmesis.
Alternative volar approach

Courtesy Dr. Heinz Bürger
Overview

- Multiple techniques currently available for stabilization, and reconstruction of the basal joint of the thumb.
- Ultimate goal is to provide substantial pain relief while maintaining TM height, stability, and overall strength and function.

Demographics

- 58 patients; 66 thumbs.
- Eaton Stage III STT sparing pattern OA.
- Age range 40-88 years
- 48 female, 10 male.
- No patients were insulin dependent diabetics, or suffered from inflammatory arthropathies.
Technique

• Curvilinear incision is made along the volar radial aspect of the thumb CMC joint. EPB tendon, DRSN, and deep branch of the radial artery are carefully dissected and retracted volarly and dorsally of the incision.

Technique

• The capsule including, including the APL insertion, are sharply dissected off the metacarpal, and later reattached with braided, non-absorbable, sutures through drill holes.

Technique

• An arthrotomy is performed and the STT joint is inspected to confirm that it is free of degeneration.
• The trapezium is then partially resected using an oscillating saw.
Technique
-The FCR tendon is split longitudinally, and a length of 12cm is harvested through a longitudinal incision at the junction of the distal medial thirds of the forearm.
-Drill holes are placed from the base of the metacarpal to the radial aspect of the thumb metacarpal, and from the palmar surface of the trapezium to the distal articular surface.

Litter ref
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Technique

• A costochondral allograft is shaped into a disc to fit the dimensions of the resected portion of the trapezium.

Technique

• 22 gauge cerclage wire is used to weave the FCR tendon through the trapezium, the allograft cartilage, and the metacarpal. The tendon is then sutured back on itself with a non-absorbable braided suture.

Post-operative

• 0-6 weeks: The patient is placed in a forearm based thumb spica cast
• 6-12 weeks: A removable splint is then fitted, and the patient begins AROM of the MCP, and abduction and rotation of the CMC. PROM is not started to avoid stress to the ligament reconstruction.
• At 8-10 weeks unrestricted thumb motion is started.
Results

• DASH questionnaires were completed by each patient.
• Grip strength and lateral pinch.
• TM height.
• TM subluxation.
• Radial abduction
• Palmar abduction.
• MCP ROM
• IP ROM

Results - Radiographic

• TM Height is measured by taking the distance from PA radiographs.
• Measurements are taken from the proximal edge of the trapezium to the distal end of the subchondral bone of the metacarpal.
• The proximal phalanx of the thumb was used as a comparative standard.

Outcomes

• Avg. DASH postop was 11
• Grip increased by 32%
• Pinch increased by 38%
• TM height well maintained (53.1mm pre; 52.9mm post.)
• TM alignment maintained, minimal subluxation (0.21mm pre; 0.22mm post.)
• Radial abduction increased by 3° (± 6°)
• Palmar abduction increased by 1° (± 8°)
• MCP and IP ROM did not significantly increase or decrease
Outcomes

• Postoperative pain relief and pinch/grip strength had a direct correlation with patient satisfaction.
• Grip and pinch improved with maintenance of TM height and decreased TM subluxation.
• DASH score decreased as function and stability were maintained, as evident in the maintenance of pinch, grip, and overall TM stability.

Complications

• 1 patient in the series progressed to develop stage IV OA of the STT joint.
• A complete trapeziectomy was performed. A silastic tie-in prosthesis was used to maintain TM height. At one year follow up, the patient had excellent pain relief, and was able to return to all pre-operative activity.
Discussion


Thumb Stability and Function

• Conclusions: Interposition arthroplasty to maintain height and ligament reconstruction for stability provided the most stable construct.

Figure 5. The average axial displacement (proximal metacarpal migration) ratio with loading of the tendons. Trap, trapeziectomy.
Discussion

- This technique of interposition arthroplasty and ligament reconstruction showed improved patient outcomes, based on clinical measurements obtained postoperatively, including DASH, TM height, TM subluxation, grip, pinch.
Thank You
Scaphoid Nonunion

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II Curso Internacional de Post Grado
Actualización en Cirugía de la Mano, Muñeca y Codo
August 8, 2013

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  3. Consulting income
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  4. Research and educational support
      Arthrex
  5. Editorial Honoraria
      Elsevier, Lippincott
  6. Speakers Bureaus
      Arthrex, Trimed

Treatment Options for Scaphoid Nonunions

– Bone Graft
  • Iliac Crest, Russe Method, Volar Wedge Graft (Humpback)
– Vascularized Bone Grafts
  • 1,2 ICSRA
  • Vascular Bundle Implantation (Hori)
  • Pronator Pedicle Graft
  • Volar carpal artery pedicled graft
  • Free medial femoral condyle graft
Treatment Options for Scaphoid Nonunions, Cont.

- Salvage Procedures
  - In the case of DJD
  - Denervation
    - PIN, AIN
  - Radial Styloidectomy
  - Proximal Row Carpectomy
  - Partial or Total Wrist Arthrodesis
  - Scaphoid Arthroplasty

What About a Unsalvagable Proximal Pole Scaphoid Nonunion with no DJD?

History

- 20 y/o football lineman sustained a L scaphoid fracture during a game
- Treated with CRPF
- 5 months later, resumed high impact activity, developed pain with wrist motion
CT Reconstructions

Options?

- Proximal pole excision
  - Too large
- Salvage Procedures
  - Too young
  - No DJD
- Excision and Interposition
  - Silastic - synovitis
  - Pyrocarbon - more data
  - Tendon - carpal height
  - Scaphoid allograft - ? healing potential
  - Rib osteochondral autograft?

Rib Osteochondral Autograft

- Used for mandibular reconstruction
  - Stone, Arch Otolaryngol.
  1965
- Also described for:
  - Plastic surgery
    - Nasal reconstruction
  - Treatment of osteochondral articular defects
- Scaphoid Reconstruction
  - Sandow (1989)
Fragmented Proximal Pole

Void Following Excision

Bleeding at the Remaining Waist
Rib Osteochondral Autograft from 7th Rib via Submammary Incision

Cartilage / Bone

Autograft Implanted
Autograft Pinned

Post-Operative Regimen

- Chest radiograph in PACU
- 7-10 days: Splint immobilization
- 2-6 weeks: Cast immobilization
- After healing is confirmed (6-12 weeks): Pins are removed and onset of ROM exercises, advance to strengthening exercises as tolerated
- 12 weeks: Weight-lifting, pushups
- 4-5 mos: Contact sports

2 Weeks Post-Op
24 Months Post-Op

• DASH: 9.1
• PRWE: 18
• ROM:
  – Flexion: 80/70
  – Extension: 60/65
  – RD: 20/15
  – UD: 40/40
• JAMAR: 100/110

Scaphoid Nonunion Failed VBG

Exposure to the 7th Rib
Harvest Rib Graft

Harvested Graft

Harvest Rib with Saw
Elevate the Rib from the Pleura

Scaphoid Defect

Shape the Graft
Inset the Graft

Graft Implanted

Repair SLIL
Case #2

- 24 y/o with L proximal pole scaphoid nonunion treated with 1,2 ICSRA VBG 8 months ago
- Continued to have painful ROM
3 Years Post-Op Rib Osteochondral Autograft

- DASH: 4.5
- PRWE: 11
- ROM:
  - Flexion: 85/60
  - Extension: 80/70
  - RD: 30/10
  - UD: 40/38
- JAMAR: 95/75

Case # 3

- 18 y/o with L scaphoid nonunion treated with 1,2 ICSRA VBG 12 months prior
- Continued to have painful ROM
2 months Post VBG

12 months Post VBG

Post-Op Rib Osteochondral Autograft

Returned to work as a heavy laborer
9 Years Post-Op Rib Osteochondral Autograft

• DASH: 36
• PRWE: 56
• ROM:
  – Flexion: 80/50
  – Extension: 66/40
  – RD: 25/12
  – UD: 45/35
• JAMAR: 100/62
Outcome Studies

• Sandow (JHS Br, 1998)
  – 19/22 G/E results at median 24 month f/u
    • Improved grip (59-80%), ROM, less pain
    • No deterioration of carpal alignment
    • No non-unions, no major complications (1 mild hemothorax)

• Sandow (Techniques H&UE, 2001)
  – 47 patients
  – 85% G/E results at median 15 month f/u
    • No apparent non-unions, no major complications (1 mild hemothorax, 1 pleural effusion)

• Veitch (JBJS Br, 2007)
  – 13/14 G/E results at mean 64 month f/u
  – Improved grip, ROM, less pain
  – No non-unions, no complications
Unsalvageable Proximal Pole Scaphoid Defects

• Uncommon
• Osteochondral autografts
  – Viable alternative
    • Chronic scaphoid nonunions
    • No evidence of arthritis
  – where salvage procedures may not be ideal
    • Younger patients
    • No DJD
  – Outcomes studies remain promising

Thank You!
Osteochondral Autograft Transplantation for Articular Defects in the Hand and Wrist

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Disclosures

- I have no conflicts of interest.

Purpose

- The osteochondral autograft transfer system (OATS) procedure has been described for osteochondral defects
  - i.e., knee/talus
- Hypothesize that this procedure can be used for articular defects in the hand and wrist, with good functional results
Background

- Hyaline cartilage has a poor intrinsic healing capacity
  - treatment of focal osteochondral defects remains a challenging problem
- Osteochondral defects in the hand and wrist are relatively infrequent injuries and often present in young patients with high levels of activity or trauma
- No gold standard of treatment
- Joint preserving techniques
  - Debridement, microfracture, ACI, OATS
- Salvage techniques predictable for pain relief
  - Expense of strength/motion
- OATS advantages
  - Hyaline cartilage transplantation
  - Low morbidity

Methods

- Retrospective chart review of four male patients
- Treated with an OATS procedure for an articular defect of their hand or wrist
  - May 2010 and February 2011.
- Avg age: 30 y/o
- All pts had failed months to years of conservative management

Methods

- Injuries consisted of osteochondral defects in:
  - proximal lunate (2)
  - proximal scaphoid
  - index metacarpal head
Outcome variables

- four month postoperative grip strength
  - Jamar III position
- range of motion (wrist/MCP)
- time to return to normal activity
- radiographic evidence of osteochondral plug ingrowth

Patient #1

- 20 y/o M student
- Recreational hockey
- LHD
- 17 mths prior – fall off roof
- R distal radius fx and L both bone fx – ORIF
- Persistent R wrist pain despite PT
- ROM
  - F/E: 60°/55°
  - R/U: 20°/45°
- Jamar III grip (R/L): 52/65 PSI

Patient #1 (pre-op)
Patient #2

- 36 y/o M financial advisor
- Avid golfer
- RHD
- Fall off ladder 1 ½ yrs earlier
- R min displaced radial/ulnar styloid fx – non-op tx
- Failed 5 mths of PT
- ROM
  - F/E: 25°/40°
  - R/U: 20°/45°
- Jamar III grip (R/L): 100/110 PSI

Patient #2 (pre-op)

Patient #3

- 40 y/o M CFO
- Recreational golf/hockey
- RHD
- 2 yrs s/p R wrist arthroscopy and TFCC repair
- Persistent R wrist pain, crepitus radio-lunate joint
- ROM
  - F/E: 40°/40°
- Jamar III grip (R/L): 55/80 PSI
Patient #3 (pre-op)

- 23 y/o M minor league baseball player
- RHD
- Hit by pitch 16 mths prior
- Pain at index MCP
- Steroid injection – minimal relief
  - ROM (MCP) w/ crepitus
    - F/E: 60°/0°
  - Jamar III grip (R/L): 75/140 PSI
Patient #4 (pre-op) – 5 mths after injury

Surgery

- All cases were performed by me
- Appropriate-sized graft from pt’s contralateral lateral femoral condyle was performed by our sports medicine colleagues
Technique for lunate/scaphoid injuries

- Diagnostic wrist arthroscopy initially used to assess the articular surface for carpal injuries (patients #1-3)
  - No distal radius lesions noted
  - Adhesions debrided
- 3rd/4th compartment extensor interval approach used and graft tapped into position using press-fit technique into recipient site
- Articular congruity confirmed via direct visualization and fluoroscopy
- Full ROM achieved with no crepitus

Technique for MC head injury

- EDC/EIP interval and dorsal capsulotomy utilized
- Osteophyte removed
- Base of proximal phalanx uninjured
- Donor/graft site technique same as for carpal injuries
- Direct/fluoroscopic visualization again confirmed articular congruity
Post-op Protocol

• Active range of motion was initiated following the first post-operative visit
• Removable splint for comfort
• WBAT to lower extremity
• Strengthening w/ formal OT/PT began at 4 weeks post-operatively
• Post-operative radiographs were obtained at 6 weeks

Post op Results

• Patient #1 (lunate)
  o ROM (F/E): 55°/50°
  o Grip (R/L): 80/80

• Patient #2 (scaphoid)
  o ROM (F/E): 30°/35°
  o Grip (R/L): 60/95

• Patient #3 (lunate)
  o ROM (F/E): 50°/40°
  o Grip (R/L): 70/88

• Patient #4 (MC head)
  o ROM (F/E): 0°/90°
  o Grip (R/L): 90/100

Patient #1 (pre-op)
Patient #3

• No digital post-op films available – outside films showed graft in-growth

Patient #4 (pre-op) (17 mths after injury)

Patient #4
Patient #4 (post-op (4 mths))

Results

- Avg time from injury to surgery: 29 mths
- Minimum follow up: 6 mths
- Avg gain of motion: 6° (range: -5-20°)
- Avg gain of grip strength: 18 PSI (range: 40-28°)
- XR evidence of graft position and in-growth seen in all cases
- 1 pt w/ knee stiffness that resolved
- All patients satisfied with outcome and resumed their prior levels of activity
  - Golf/hockey/baseball

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10/11/2013
OATS Procedure Conclusions

- Viable treatment option for the treatment of hand and wrist osteochondral defects in young, active patients who have failed conservative management
- Technically demanding
- Incorporates hyaline cartilage plug into the defect site
  - Capabilities of regrowth/regeneration
  - Biomechanically superior to fibrocartilage
- Successful outcomes:
  - Congruent articular surface is achieved
  - Motivated patient is able to complete an appropriate course of occupational hand therapy

Thank you!

- Questions?