North Carolina Orthopaedic Association

2015 Annual Meeting
Spine/Basic Science/Education/Foot & Ankle/Trauma

Sunday, October 11

October 9-11, 2015 • Kiawah Island Golf Resort
Kiawah Island, South Carolina

This continuing medical education activity is jointly provided by the NCOA and the Southern Regional Area Health Education Center
THE EFFECT OF COMPUTER-ASSISTED SURGERY TRAINING IN THE PLACEMENT OF ILIOSACRAL SCREWS

Elizabeth W. Hubbard, MD
NCOA October 11, 2015

Funding
- OREF
- Piedmont Orthopedic Society
- DUMC Department of Orthopaedic Surgery

Surgical Skills Acquisition
- Classic Education:
  - “See one, do one, teach one…”
- The changing healthcare system
  - 80 hour workweek
  - Reimbursement based on outcomes
- The Dilemma—creating competent surgeons when
  1. Trainees have less hands-on training
  2. Need to teach skills in a way that is safe for patients

Computer Navigation Assisted Training
- Goften et al JBiS 2007
  - Acetabular cup position
  - Computer navigation trained group:
    - Better accuracy
    - Better precision throughout training
- Nousianen et al JOT 2013
  - Guidewire placement for femoral neck fractures
  - Computer navigation trained group:
    - Faster
    - Fewer attempts
    - No evidence of dependence on computer navigation

Goal of Study
- Determine the effect of computer navigation assisted training on learning a complex surgical skill

Overall Structure
1. Pre-test
   - Instructional video
   - All participants place S1 and S2 guidewires using fluoroscopy
2. Randomization (Post-test)
   - Repeat instructional video
   - Expert instruction provided during guidewire placement
   - 21 subjects: fluoroscopy; 20 subjects: computer navigation
3. Retention test—4 weeks after pre-test
4. Transfer test—4 weeks after pre-test
Methods

- 41 Subjects
  - Surgical trainees
  - Senior medical students
  - 40 completed full study (97.5% follow-up)

Data Analyzed

- Total time to wire placement
- Total fluoroscopy time used
- Attempts at wire placement
- Perforation
  - Overall rate
  - Grade of perforation (Hinsche et al CORR 2002, Zwingmann et al CORR 2009)

Set-Up

Based on a design created by Riehl & Widmaier J Surg Ed 2011.

Fluoroscopy

Computer Navigation

BrainLab Trauma (BrainLab, Westchester, IL)

Computer Navigation (Cont.)
Discussion

- Trends towards improved accuracy regardless of training tool
  - Computer Navigation
    - Performed faster, even when using fluoroscopy
    - Less radiation exposure
    - Trend towards more accurate S1 placement
  - Retention and transfer test results
    - Lasting memory of motor skills
    - Subjects did not seem to develop a dependency on computer navigation

Limitations

- Simulated environment
  - Does not account for individual patient factors that affect surgery (body habitus, etc)
- Technical issues with pelvi
  - Variation in fluoroscopic images between pelvi
  - Design of some sawbones interfered with wire placement
- Subject knowledge/skill level
  - Variation between medical students and surgical trainees
Conclusions

- Computer navigation is a potential tool for teaching complex surgical tasks
  - Efficient
  - Safe
    - Less radiation exposure
    - Performed in a controlled environment rather than on a patient in the OR
- Results suggest that trainees can transfer skills
  - No evidence of dependence on navigation

References

A NOVEL LOCAL CANCELLOUS AUTOGRFT SOURCE FOR ANTERIOR CERVICAL DISCECTOMY AND FUSION: A TECHNIQUE DESCRIPTION AND COMPARATIVE STUDY

Conor O’Neill1,2, Zakk Walterscheid1,2, Dr. Caleb Behrend1,2, Dr. Jonathan Carmouche1,2

Virginia Tech Carilion School of Medicine
Carilion Clinic Orthopaedics-Musculoskeletal Education and Research Center

INDICATIONS FOR ACDF

A disc on top of a cervical vertebra looking from above

Degenerative changes in the disc were observed.

Degeneration is characterized by loss of disc integrity and integrity.

Alternative graft materials

- Allograft
- Demineralized Bone matrix
- Mineralized Bone matrix
- Xenograft
- Synthetic Bone Graft
- Ceramics
- Hydroxyapatite
- Bioactive Materials
- Bone Morphogenic Protein
- Bone Marrow Aspirate

HISTORICAL PERSPECTIVE

DISCLOSURES

- Conor O’Neill: None
- Zakkary Walterscheid: None
- Caleb Behrend: None
- Jonathan Carmouche:
  - Member, Exhibits Committee, AAOS
  - Member, Education Committee, Scoliosis Research Society

ILIAC CREST BONE GRAFT

- Donor Site Morbidity reported as high as 49%

ALTERNATIVE GRAFTS

- Alternative graft materials
- Alternative graft Sites
  - Manubrium
  - Clavicle
  - Rib
  - Patella
META-ANALYSIS FUSION RATES

» Range of Autograft Fusion Rate 90-100%

» Range of Allograft fusion ranges from:
  » 32-100%

» Meta-Analysis Allograft Fusion Rate 78%

» Graft Materials

» Alternative Graft Sites

NOVEL GRAFT SITE


RESULTS

Average Neck VAS Score
Pre-Op  | Post-Op
0   | 2
1   | 4
2   | 6
3   | 8
4   | 10
5   | 12
6   | 14
7   | 16
8   | 18
9   | 20
10  | 22

Average Arm VAS Score
Pre-Op  | Post-Op
0   | 1
1   | 2
2   | 3
3   | 4
4   | 5
5   | 6
6   | 7
7   | 8
8   | 9
9   | 10
10  | 11

RESULTS

Percent Fusion following ACDF
ICBG | Adjacent Vertebra
88   | 100

RESULTS

Percent Reported Iliac Crest Morbidity
ICBG | Adjacent Vertebra
93   | 0

RESULTS

<table>
<thead>
<tr>
<th>Complications</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>0%</td>
</tr>
<tr>
<td>Fracture</td>
<td>0%</td>
</tr>
<tr>
<td>Implant Subsidence</td>
<td>0%</td>
</tr>
<tr>
<td>Pseudoarthroses</td>
<td>0%</td>
</tr>
<tr>
<td>Revision Operation</td>
<td>0%</td>
</tr>
</tbody>
</table>

CONCLUSIONS

» The present study demonstrates:
  » Similar rates of reduction of neck and arm pain in the published literature
  » Safety and Efficacy of New Technique
  » Maintenance of high fusion rate characteristic of autologous bone graft
  » Technique avoids morbidity associated with second surgical site

LIMITATIONS

» Pilot study
» Small Sample Size
» Short follow-up
  » Average follow-up = 10.79 months
» Fusion based upon x-ray and resolution of clinical symptoms
Impact of Bone Morphogenic Protein-7 (BMP-7) on Cell Migration on the Meniscus

Victor Taylor II, Ph.D.
Ian Hutchinson, M.D.
Kerry Danelson, Ph.D.
Cristin Ferguson, M.D.

Introduction

- Osteoarthritis is the most frequent cause of disability among adults in the United States
- Damage or loss of meniscus tissue is associated with degeneration of the joint

Meniscus Repair

- Interleukin-1 is a pro-inflammatory cytokine
  - Inhibits repair processes
- BMP-7 is an anabolic growth factor
  - Supports matrix synthesis in articular cartilage even in the presence of IL-1
- Limited research involving BMP-7 and meniscus repair

Objective of the Study

- Examine the effects of BMP-7 on cell migration in an in vitro meniscus repair model
- Evaluating the potential of BMP-7 to augment meniscus repair

Method

- Tissue: Porcine knees from local abattoir
  - Female, ≥ 3 years old
- Turkey meniscus explants created with a biopsy punch
- Collagen type 1 scaffold sandwiched between meniscus explants in a cloning tube to create a one-dimensional growth factor diffusion gradient
  - Control
  - Treated scaffold
- BMP-7
- PDGF-AB
- IL-1α
- BMP-7 + IL-1α
- Incubation for 28 days in Dulbecco Modified Eagle Medium with 10% fetal bovine serum
  - In untreated scaffold-meniscus cells migrate toward media as source of nutrition away from scaffold

Results

**BMP-7**
- Inner zone: 26%
- Middle zone: 40%
- Outer zone: 35%

**PDGF**
- Inner zone: 23%
- Middle zone: 37%
- Outer zone: 40%

**Control**
- Inner zone: 26%
- Middle zone: 29%
- Outer zone: 45%

**IL-1 alpha**
- Inner zone: 23%
- Middle zone: 32%
- Outer zone: 45%

**BMP-7 + IL-1 alpha**
- Inner zone: 17%
- Middle zone: 25%
- Outer zone: 58%

Discussion

- Preliminary results suggest BMP-7 may induce cell migration in meniscus tissue.
- Impact of local BMP-7 on proteoglycan production will be analyzed.
- Additional cell culture based studies will compare local proliferation versus migration effects.

Acknowledgements

- Cristin Ferguson M.D. (mentor)
- Kerry Danelson, Ph.D.
- Ian Hutchinson, M.D.
- Institutional Research and Academic Career Development Awards (IRACDA) (NIH/NIGMS K12 PAR-13-290)

Questions
Whole Body Vibration Increases Cartilage Thickness and Cancellous Bone Strength, but Not Femoral Neck Strength or Bone Mineral Density.

William Runge, MS¹, Laurence Dahners, MD¹, Denis Marcellin-Little, DEDV², Ola Harryson, PhD², David Ruppert, MS¹, Paul Weinhold, PhD¹

¹University of North Carolina at Chapel Hill, Chapel Hill, NC, USA.
²North Carolina State University, Raleigh, NC, USA.

Introduction

- Whole body vibration (WBV) has been proposed as a non-pharmaceutical intervention for osteoporosis
- WBV provides mechanical stimulation that may drive bone growth
- Previous studies on WBV have shown modest changes in bone mineral density¹, but few have assessed changes in bone strength or cartilage properties
- Optimal parameters for whole body vibration are unknown²

Hypothesis

- Short duration exposure to WBV can produce measurable changes in
  - Bone mineral density
  - Cancellous bone strength
  - Femur neck strength
  - Medial epicondyle cartilage thickness
- Studying a range of treatment amplitudes might identify optimal parameters for the application of this therapy

Methods

- 80 adult Sprague-Dawley rats, divided into 5 groups of 16 animals each
- Each group was assigned to 0, 0.15, 0.3, 0.6, or 1.2g of sinusoidal vibration at 45 Hz, using an electromagnetic shaker
- 15 minutes of vibration therapy per day, for 6 weeks
- Animals sacrificed at end of 6 weeks, and femurs isolated
- Mechanical tests conducted at constant displacement rate on a load cell as described³
- Bone mineral density measured on Hologic QDR Discovery A DXA machine, using regions of interested modeled after those used in vitro⁴
- Cartilage thickness measured based on histologic sections of a subset of animals, using an ImageJ processing routine that averages the thickness of the cartilage across the weight-bearing area

Results: Bone mineral density

No significant difference in bone mineral density between individual groups or when vibrated animals are lumped and compared to control.
Results: Mechanical strength

- 70% increase in cancellous bone strength in the vibrated animals versus the control
- No change in femur neck strength between groups

Results: Cartilage thickness

- Vibrated animals had significantly thicker (30%) cartilage on the medial condyle compared to the control

Conclusion

- WBV over a 6-week treatment period causes a large improvement (70% increase) in strength of the distal femoral cancellous bone
- WBV also significantly increases the cartilage thickness at the medial epicondyle of the femur
- WBV does not alter bone mineral density on this treatment timeline
- WBV also does not alter femur neck strength on this treatment timeline
- No clearly optimal amplitude for vibration therapy

References

A Prospective Evaluation of Three Serum Biomarkers in Hip Arthroscopy Patients and Matched Controls

Austin V. Stone MD, PhD* | Elizabeth A Howse MD†
Christopher Stem* | Allston J. Stubbs MD, MBA*

*Department of Orthopaedic Surgery
Wake Forest School of Medicine, Winston-Salem, NC USA
†Department of Emergency Medicine,
Kaiser Permanente, San Francisco, CA USA

North Carolina Orthopaedic Association 2015 Annual Meeting, Kiawah Island, SC

Introduction

• Unknown predictive value of serum biomarkers
• FAI and hip dysplasia are implicated in articular cartilage destruction
• Vascular cell adhesion molecule-1 (VCAM-1) predictive of progressing to hip or knee replacement surgery
• IL-6 and cartilage oligomeric matrix protein (COMP)

Hip Arthroscopy
Surgical Candidates (n=20)

Surgical Controls

Serum Biomarkers
VCAM, COMP, IL-6

Age and Gender Matched Controls (n=10)

Serum Biomarkers
VCAM, COMP, IL-6

The serum biomarkers increased together.
R = 0.579; p=0.007

Serum Biomarkers

Hip Arthroscopy

VCAM-1 vs COMP

Disclosures

Allston J. Stubbs MD, MBA
Financial relationships with the following companies:
• Consultant: Smith & Nephew
• Stock: Johnson & Johnson
• Research Support: Bauerfeind
• Department Support: Smith & Nephew Endoscopy, Depuy, Mitek
• Boards/Committees: AOSM, ISHA, AANA

Austin V. Stone MD, PhD
• Research Support: Smith & Nephew

Dr. Howse and Mr. Stem have nothing to disclose.

This study funded by the Department of Orthopaedic Surgery, Wake Forest School of Medicine.
Age, BMI, VCAM-1 and COMP were significant predictors of the Vail functional Hip Score (p=0.012). Most significant predictors were VCAM-1 level (p=0.016) and the BMI (p=0.011).

**Vail Hip Score**

significant correlations

- modified Harris hip score (R = 0.671; p<0.001)
- SF-36 (R = 0.702; p=0.007)
- NHS (R = 0.880; p<0.001)
- MHOT total score (R=0.765; p<0.001)

**Discussion**

VCAM-1, IL-6, and COMP were not different between pre-arthritic hip pain patients and matched controls.

Elevated pre-arthritic markers may predict patient functional outcomes reported in the Vail Hip Score.

**Acknowledgements**

Wake Forest School of Medicine Hypertension and Vascular Center
Dr. Bridget Brosnihan
Hypertension Core Laboratory
Funding provided by a Wake Forest School of Medicine Medical Student Research Grant and the Department of Orthopaedic Surgery.
The July Effect:
Does Time During the Academic Year and Level of Resident Involvement Affect Complication Rates in Lower Extremity Orthopaedic Trauma?

Aaron J. Casp MD, Brendan M. Patterson, MD, Benjamin R. Parker MD, Joshua N. Tennant MD
1University of Virginia Department of Orthopaedic Surgery
2University of North Carolina Department of Orthopaedics

Introduction

• Surgical complications are becoming more important in the current regulatory landscape
• The “July effect”: is it real?

Methods

• Identified top 2 ACGME resident case requirements for lower extremity fractures:
  » Operative fixation of hip fractures
  » Operative fixation of femoral fractures, or tibial shaft fractures
• Utilized American College of Surgeons National Quality Improvement Program (NSQIP) database, 2005-2012

Methods - Cases Analyzed

<table>
<thead>
<tr>
<th>Procedure Description</th>
<th>CPT code</th>
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<tbody>
<tr>
<td>Percutaneous Hip Pinning</td>
<td>27235</td>
</tr>
<tr>
<td>Hip hemiarthroplasty</td>
<td>27236</td>
</tr>
<tr>
<td>Sliding hip screw for hip fracture</td>
<td>27244</td>
</tr>
<tr>
<td>Intramedullary nail fixation of hip fracture</td>
<td>27245</td>
</tr>
<tr>
<td>Intramedullary nail fixation of femoral shaft fracture</td>
<td>27506</td>
</tr>
<tr>
<td>Plate &amp; screw fixation of femoral shaft fracture</td>
<td>27507</td>
</tr>
<tr>
<td>Plate &amp; screw fixation of tibial shaft fracture</td>
<td>27758</td>
</tr>
<tr>
<td>Intramedullary nail fixation of tibial shaft fracture</td>
<td>27759</td>
</tr>
</tbody>
</table>

Methods - Analysis

• Compared complication rates in the first academic quarter with that of the rest of the year
• Analysis was completed for all residents, then separately for junior residents (PGY1,2 or 3) and senior residents (PGY4,5 or 6)
Methods – Outcome Variables

**Serious Adverse Events**
- Coma >24 hours
- On ventilator >48 hours
- Unplanned intubation
- Stroke/cerebrovascular accident
- Pulmonary embolism
- Cardiac arrest
- Myocardial infarction
- Acute renal failure
- Sepsis
- Septic shock
- Return to operating room

**Any Adverse Events**
- All Serious Adverse Events
- Wound disruption
- Superficial surgical site infection
- Deep surgical site infection
- Organ/space infection
- Urinary tract infection
- Pneumonia
- Progressive Renal insufficiency
- Graft/prosthesis/flap failure
- Peripheral nerve injury
- Deep vein thrombosis

Results – Serious Adverse Events

- †P-value = 0.0324
- ††P-value = 0.0238

Results – Any Adverse Events

- †P-value = 0.0444
- ‡P-value = 0.0238

Conclusions

- There is no evidence of a July effect in lower extremity orthopaedic trauma surgery
  - This holds true for all residents, and separately for junior and senior residents
  - In agreement with previous literature on elective orthopaedic surgery

- Senior residents have a higher Any Adverse Event rate than junior residents in the first half of the year
  - More supervision at the beginning of the year?
Thank You

References


• Edelstein et al., Impact of Resident Involvement on Orthopaedic Surgery Outcomes. JBJS 2014. 96(15):e131.

• Pugely et al., The Effect of Resident Participation on Short-term Outcomes After Orthopaedic Surgery. CORR 2014 472(7):2290-2300

Knee Arthroscopy Simulation Training: Does It Translate to Improved Proficiency in Wrist Arthroscopy?

Gabriella Ode, MD; Bryan Loeffler, MD; R. Chris Chadderdon, MD; Nikkole Haines, MD; Brian Scannell, MD; Joshua Patt, MD, MPH; Glenn Gaston, MD

Background

Wrist Arthroscopy
- Challenging discipline to gain proficiency
- Limited exposure during residency

Background

Computer Simulated Arthroscopy Training
- Shown to improve user proficiency in knee arthroscopy.
- No wrist arthroscopy simulation models are readily available.
- No studies exist which evaluate the translatable skill of joint-specific arthroscopy skills to other anatomic joints.

Purpose

- To investigate whether simulated knee arthroscopy training translates to improved wrist arthroscopy proficiency.

Methods

Subjects
- 26 orthopaedic residents (April 2014 – Aug 2014) participated in arthroscopy simulation training program over a 4-week period.
  - 21 PGY1 to PGYS from the 20132014 academic year
  - 5 matriculating PGY1 from the 20142015 year (PGY0).

Methods

- Preparation Materials
  - 5-minute Demo video of landmarks performed by experienced Hand Surgeon
  - Wrist Anatomy Review
  - 2 Book chapter excerpts on wrist arthroscopy
    - Green’s Operative Hand Surgery, “Chapter 18 – Wrist Arthroscopy: Anatomy and Diagnosis”
  - JAAOS Review on Wrist Arthroscopy
    - “Wrist Arthroscopy: Principles and Clinical Applications – Gupta et al”
  - VuMedi.com Videos
    - “Wrist Arthroscopy Portal Placement”
    - “Arthroscopic Anatomy of the Wrist”
Methods
Baseline Assessment

- Subjects video-recorded performing cadaveric diagnostic wrist arthroscopy
- 10 minutes allotted to ID 23 anatomic landmarks in 4 portals
- Arthroscopy footage synchronized with video of the trainees’ de-identified hands.

Methods
Test Objectives

Test Objectives (10 min allotted)
- 3, 4 portal:
  - Scaphoid
  - Scaphoid facet
  - RSC ligament
  - Long RL ligament
  - RSL ligament
  - Short RL ligament
  - Interossal ridge
  - Lunate
  - Lunate facet
  - TFCC
  - SL ligament
- 6, R portal:
  - Ulnar extrinsic ligaments
  - TFCC
  - LT ligament
- Mid-carpal ulnar portal:
  - Capitate
  - Capitohamate joint
  - LT ligament
  - Lunate
  - SL ligament
  - Arcuate ligament
- Mid-carpal radial portal:
  - Capitate
  - SL ligament
  - LT ligament

Methods
Intervention

- Subjects given 4 weeks to complete a diagnostic knee arthroscopy module on the ArthroSim knee simulator (Touch of Life Technologies, Aurora, CO).
- ArthroSim:
  - High fidelity, virtual reality simulator that features haptic feedback and real-time manipulation of a leg to simulate the movements of the leg when performing knee arthroscopy.
  - Endorsed by AAOS for knee simulation training

Completion = Achieve at least 80% proficiency in all modules for a simulated diagnostic knee scope.

Methods
Post-Simulation Assessment (@ 4 weeks)

- Repeat of video-recorded diagnostic arthroscopy procedure on same cadaver wrist
- Pre- and Post-Simulation performance on wrist arthroscopy performance reviewed and graded in double-blinded fashion by 3 experienced hand surgeons.

Objective Data

- Composite Score
  - ASSET Global Rating Scale
  - Task Completion Score
  - Completion Time Bonus
    - Max time allotted (600s) - Time spent (s) > 10

Total Score = ASSET + Completion Score + Time Score
Subjective Data

- Resident Pre- and Post-Simulation Surveys
  - Demographics
    - Age, Sex, Program year, handedness, video game experience
  - Estimated Arthroscopy Case Experience
  - Subjective level of comfort and proficiency

Results - ASSET

- Inter-rater Reliability
  - Good to Excellent Inter-rater Reliability between graders
- Construct Validity
  - Wrist arthroscopy competency → no correlation with previous wrist or knee arthroscopy experience or program level

Results - Pre vs Post-Sim Scores

- 65% of residents found ArthroSim intervention helpful and perceived improved wrist arthroscopy proficiency.
- Greatest improvements in Camera dexterity and flow of procedure
- More junior residents (PGY 0–2) found the intervention helpful than senior residents (PGY 3–5)

Results

- ArthroSim training → no significant change for all subjects
  - ASSET scores
  - task completion rates
  - completion times
  - overall score

Discussion

- Prospective study with standardized intervention and double-blinded assessment
- ASSET → validated objective measure of assessment
- Small sample size → Likely affected significance
- Minimal clinically significant difference for ASSET remains unknown
- Effect of increasing duration of knee simulation training unknown
Summary

- The ASSET Global Rating Scale is a reliable assessment tool for evaluating proficiency in wrist arthroscopy however, construct validity not demonstrated.
- A majority of subjects reported subjective improvement with greatest value among junior residents.
- Knee arthroscopy simulation training did not objectively improve wrist arthroscopy competency among orthopaedic residents.
- Wrist specific arthroscopy training exercises are needed to aid in wrist arthroscopy competency among orthopaedic residents.

References

Differences between Various Methods of Measuring the Size of Posterior Malleolus Fracture Fragments

D. Landry Jarvis, MD PGY2
Wake Forest Orthopaedic Resident
October 11, 2015

Authors
Sharon N. Babcock, MD; Alejandro Marquez-Lara MD; Kerry Danelson, PhD; Robert Morgan, BS; Eben A. Carroll, MD; Anna N. Miller, MD;
Primary Faculty Contributor: Jason J. Halvorson, MD

Disclosures
I have no financial relationship with or interest in any commercial entity that may have a direct interest in the subject matter of this presentation.

Background
Trimalleolar Ankle Fractures

• Poorer functional outcomes when compared to ankle fractures that do not involve posterior malleolus1-3
• Generally accepted to fix posterior malleolus fragments with greater than 25% of articular surface13
• Poor reliability and accuracy in measuring percentage involvement7-10

Measuring the Posterior Fragment
Linear Measurements

Lateral Radiograph
Midpoint Sagittal CT Scan
Measuring the Posterior Fragment
Surface Area Measurements

Study Design
Retrospective Chart Review

Subjects

- Single Hospital, Level 1 Trauma Center
- Trimalleolar fractures that underwent ORIF during a 5 year period (2009-2014)
  - Inclusion criteria: Skeletally mature, acceptable lateral radiograph, preoperative CT Scan with a located ankle, 3 month follow up.
- 270 charts reviewed; 91 patients included

Methods

- A single resident obtained measurements from all 91 subjects using the 4 previously described methods
- Primary Aims: Accuracy of different measurement methods, correlation to posterior fragment fixation
- Secondary Outcome Measures: Range of motion, complications, pain, length of stay
- Statistical analysis using ANOVA, Pearson correlation, and logistical regression models

Results

Demographics and Outcomes

Demographics

- 52.9 Years Old
- 72.5% Female
- 36.3% Smokers
- 73.6% Twisting injury Mechanism
- 91.2% Closed
- 85.7% Medial Malleolus Fracture
Variations in Measurements by Method

- Lateral X-Ray: 23.9% ± 11.1%
- Sagittal CT: 26.4% ± 8.6%
- 2D Surface Area: 16.4% ± 11.8%
- 3D Surface Area: 28.7% ± 12.0%

Posterior Fragment Fixation

- 53.8% treated without fixation (n = 49)
- 46.2% treated with fixation (n = 42)

Discussion

Analysis and Conclusions
Conclusions

- Although there was a moderate positive correlation between the 4 methods of measurement, there was a great variability in the estimated posterior fragment size.

- Axial CT scans underestimated size, where as 3D Reconstruction imaging overestimated size.

- There was no significant difference in the outcomes of fractures treated with or without posterior fragment fixation.

- Sagittal CT scan and lateral radiographs appear to both be sufficiently appropriate for measuring posterior malleolus fragments.

References

Major Perioperative Complications Are Higher In Ankle Fusion Than Total Ankle Arthroplasty: Results of a Matched Cohort Study

Susan Odum, PhD
Bryce Van Doren, MPA, MPH
Robert B. Anderson, MD
W. Hodges Davis, MD

Introduction

• Ankle fusion is the traditional surgical treatment for end stage arthritis
• Total ankle arthroplasty (TAA) utilization is increasing as technique and implants improve
• Evidence suggests that clinical outcomes are superior with TAA
• Little is known of the perioperative complication rate

Purpose

To compare the national rates of perioperative (in-hospital) complications between patients undergoing ankle fusion and total ankle arthroplasty

Methods

• 2002-2012 releases of the Nationwide Inpatient Samples were analyzed.
• 3,638 TAA patients and 15,053 ankle fusion patients were identified using ICD-9-CM procedure codes (81.11 and 81.56, respectively).
• ICD-9-CM diagnosis codes used to identify patients that experienced major or minor perioperative complications.

<table>
<thead>
<tr>
<th>Minor Complications</th>
<th>ICD-9 Codes</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory</td>
<td>41.90-41.93</td>
<td>cardiac, thoracic, venous embolism, cerebral infarction</td>
</tr>
<tr>
<td>Respiratory</td>
<td>416.0</td>
<td>respiratory insufficiency</td>
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<tr>
<td>Other systems, unclassified</td>
<td>997.0-997.99</td>
<td>cardiac, periphera; vascular, digestive, urinary, respiratory</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major Complications</th>
<th>ICD-9 Codes</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory and Respiratory</td>
<td>416.1, 416.2, 416.3</td>
<td>cardiac, peripheral, pulmonary embolism</td>
</tr>
<tr>
<td>Specific Procedure</td>
<td>996.0-996.11</td>
<td>external, internal, or graft, including infected</td>
</tr>
<tr>
<td>Other systems, unclassified</td>
<td>997.0-997.99</td>
<td>cardiac, periphera; vascular, digestive, urinary, respiratory</td>
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<tr>
<td>Other medical care, unclassified</td>
<td>999.0-999.99</td>
<td>cardiac, periphera; vascular, digestive, urinary, respiratory</td>
</tr>
</tbody>
</table>

Methods

• Statistical matching identified 3,424 exact matches of ankle fusion and TAA patients matched on:
  - age
  - gender
  - race
  - hospital type
  - geographical region
  - # comorbidities
  - diabetes status
• Perioperative complications (including in-hospital mortality) were compared between procedures using:
  - bivariate statistics (unadjusted rates)
  - multivariate logistic regression (adjusted rates)
### Results: Mortality

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle Fusion</td>
<td>6 (0.2%)</td>
<td>3418 (99.8%)</td>
<td>0.53</td>
</tr>
<tr>
<td>Total Ankle</td>
<td>4 (0.1%)</td>
<td>3420 (99.9%)</td>
<td></td>
</tr>
</tbody>
</table>

After controlling for patient demographics and case-mix, ankle fusion patients were 50% more likely to die during hospitalization than TAA patients (OR: 1.50, 95% CI: 0.42-5.35).

### Results: Major Complications

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle Fusion</td>
<td>482 (14%)</td>
<td>2,942 (86%)</td>
<td>.01</td>
</tr>
<tr>
<td>Total Ankle</td>
<td>220 (6%)</td>
<td>3,204 (94%)</td>
<td></td>
</tr>
</tbody>
</table>

After adjusting for patient demographics and case mix, ankle fusion patients were **2.43 times** more likely to experience major complications (OR: 2.42, 95% CI 2.05-2.88).

### Results: Minor Complications

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle Fusion</td>
<td>133 (4%)</td>
<td>3,291 (96%)</td>
<td>0.17</td>
</tr>
<tr>
<td>Total Ankle</td>
<td>156 (5%)</td>
<td>3,268 (95%)</td>
<td></td>
</tr>
</tbody>
</table>

After adjusting for patient demographics and case-mix, ankle fusion patients were 15.7% less likely to experience a minor complication (OR: 0.84, 95% CI 0.66-1.07).

### Conclusion

- Compared to a matched cohort of TAA patients, ankle fusion patients have significantly higher risk of a major perioperative complications.
- The risk of a minor perioperative complication and mortality are similar between the groups.
- These findings suggest that TAA may be a safer surgery than ankle fusion.

Thank you
Predictors of Failure for Delayed Surgical Management of Closed Ankle Fracture Dislocations

Andrew P. Matson, MD, Cynthia L. Green, PhD, Shepard R. Hurwitz and Robert D. Zura, MD
Duke University Medical Center
Department of Orthopaedic Surgery

Background
Ankle fracture-dislocations require urgent reduction

Protocol for management at DUMC
1) Reduction in ED
2) If congruent, splint and then clinic follow-up to schedule surgery
3) If incongruent, ORIF vs ex-fix based on soft tissue swelling

Difficult to predict which injuries can be adequately reduced

Fracture 1: Unstable

Fracture 2: Stable

None

Disclosures
Hypothesis

Unstable injuries will have:
- Greater initial fracture displacement
- Greater radiographic syndesmotic disruption
- Larger posterior malleolus fracture size

Methods

Operatively treated ankle fractures (2008-2012)

Included:
- Supination
- Pronation
- Bi/trimalleolar
- Isolated

Excluded:
- Open fracture
- Pilon
- No reduction
- Polytrauma

56 patients

36 patients

- Urgent ORIF or ex-fix

20 patients

- Delayed ORIF

Results: Categorical

<table>
<thead>
<tr>
<th>Injury Mechanism</th>
<th>Unstable</th>
<th>Stable</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supination</td>
<td>28 (77.8%)</td>
<td>17 (85.0%)</td>
<td>0.728</td>
</tr>
<tr>
<td>Pronation</td>
<td>8 (22.2%)</td>
<td>3 (15.0%)</td>
<td></td>
</tr>
<tr>
<td>Bi/mallegolre</td>
<td>20 (55.6%)</td>
<td>9 (45.0%)</td>
<td></td>
</tr>
<tr>
<td>Isolated</td>
<td>8 (22.2%)</td>
<td>5 (25.0%)</td>
<td></td>
</tr>
</tbody>
</table>

Results: Continuous

<table>
<thead>
<tr>
<th>Fragment Size</th>
<th>Unstable (mm)</th>
<th>Stable (mm)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>Fragment</td>
<td>12.6 ± 6.6</td>
<td>9.0 ± 7.0</td>
<td>0.073</td>
</tr>
<tr>
<td>Fragment</td>
<td>12.7 ± 9.2</td>
<td>8.4 ± 8.9</td>
<td></td>
</tr>
<tr>
<td>Length Displacement</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>6 (17.6%)</td>
<td>5 (26.3%)</td>
<td></td>
</tr>
<tr>
<td>0-50%</td>
<td>14 (41.2%)</td>
<td>10 (52.6%)</td>
<td></td>
</tr>
<tr>
<td>50-100%</td>
<td>10 (29.4%)</td>
<td>2 (10.5%)</td>
<td></td>
</tr>
<tr>
<td>&gt;100%</td>
<td>4 (11.8%)</td>
<td>2 (10.5%)</td>
<td></td>
</tr>
</tbody>
</table>

Results

<table>
<thead>
<tr>
<th>Fibular Shortening (mm)</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5</td>
<td>11 (28.9%)</td>
</tr>
<tr>
<td>&gt; 5</td>
<td>7 (17.7%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Posterior Malleolus Fracture Ratio</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.1</td>
<td>10 (26.3%)</td>
</tr>
<tr>
<td>&gt; 0.1</td>
<td>7 (18.9%)</td>
</tr>
</tbody>
</table>
Results

<table>
<thead>
<tr>
<th>Fibular Shortening</th>
<th>PM Ratio</th>
<th>Unstable</th>
<th>Proportion Unstable</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5mm and &lt; 0.1</td>
<td></td>
<td></td>
<td>55.6% (5/9)</td>
</tr>
<tr>
<td>&gt; 5mm and &gt; 0.1</td>
<td></td>
<td></td>
<td>88.9% (16/18)</td>
</tr>
<tr>
<td>&gt; 5mm and &gt; 0.2</td>
<td></td>
<td></td>
<td>100% (6/6)</td>
</tr>
</tbody>
</table>

Conclusions

Radiographic measurements can predict injury stability:
- Posterior malleolus fragment size
- Fibular shortening
- Medial malleolus fragment size

Syndesmotic measurements, and talar displacement did not predict injury stability

Further investigation
- Outcomes with early vs. delayed operative management
- Clinical utility of radiographic criteria
Treatment trends of clavicular shaft fractures

Brendan M. Patterson
North Carolina Orthopaedic Association
October 2015

Background
It is interesting that of 2,235 patients with middle-third fractures treated by closed methods in our clinic, only 3 (0.1%) had failure of union. On the other hand, of 45 patients treated by immediate open reduction, 2 (4.4%) had failure of bone union.

Neer, JAMA. 1960

"...reduction is practically impossible to maintain, and patients do well with non-operative management."

Neer, CS. Rockwood and Green. 2nd ed.

Nonoperative Treatment Compared with Plate Fixation of Displaced Midshaft Clavicular Fractures
A Multicenter, Randomized Clinical Trial
Sling Compared with Plate Osteosynthesis for Treatment of Displaced Midshaft Clavicular Fractures
A Randomized Clinical Trial
Elastic Stable Intramedullary Nailing Versus Nonoperative Treatment of Displaced Midshaft Clavicular Fractures—A Randomized, Controlled, Clinical Trial
Open Reduction and Plate Fixation Versus Nonoperative Treatment for Displaced Midshaft Clavicular Fractures
A Multicenter, Randomized, Controlled Trial

Non-op vs ORIF

- Higher satisfaction
- Improved cosmetic result
- Decreased complication rate
- Improved clinical outcomes
- Decreased non-union rate (3% vs 14%)
- Decreased time to union (16 weeks vs 28 weeks)
Purpose

• Investigate the trends of operative vs non-operative treatment
• Determine if treatment trends differ based on patient age or sex

Methods

• Data obtained from the PearlDiver patient records database
  » Database queried from 2007-2011
  » Patients >20 years of age
  » Diagnosis of closed clavicular shaft fracture. (ICD-9 810.02).
  » Treatment with open vs closed treatment. (CPT 23500 vs 23515)

Results

Rate of operative fixation

% treated with ORIF

Year

2007 2008 2009 2010 2011
Conclusions

- Trends in the treatment of clavicle fractures have increased from 2007-2011.
- These trends are more pronounced among a younger, male population.
- Increased rates of surgical management likely due to recent literature to support operative fixation.
- This data provides an example of the impact of evidence based medicine in orthopaedic surgery.
Radiographic Measurements of Hip Dysplasia Correlate with Decreased Size of Acetabular Posterior Wall Fractures

Jason J. Halvorson, MD  |  Austin V. Stone, MD, PhD
Anna N. Miller, MD  |  Eben A. Carroll, MD

Department of Orthopaedic Surgery, Wake Forest School of Medicine, Winston-Salem, NC

North Carolina Orthopaedic Association 2015 Annual Meeting, Kiawah Island, SC

Hypothesis

To determine if radiographic hip dysplasia measurements correlate to traumatic hip dislocation and posterior wall fragment size in acetabular fractures

Outcome Measures

- Radiographic
  - Injured LCE
  - Cross over sign
  - Posterior wall sign

**A**

LCE angle

- Posterior wall fragment (%)

P=0.004

**B**

Sharp Angle

- Posterior wall fragment (%)

P=0.57

Disclosures

Austin V. Stone MD, PhD
- Research Support: Smith & Nephew, LLC

Anna N. Miller, MD
- Consultant: Depuy-Synthes, Inc.
- Institutional Support: Smith & Nephew, LLC; Depuy-Synthes, Inc.

Eben A. Carroll, MD
- Consultant: Smith & Nephew, LLC; Depuy-Synthes, Inc.
- Institutional Support: Smith & Nephew, LLC; Depuy-Synthes, Inc.

Dr. Halvorson does not have anything to disclose.
Discussion

Traumatic hip dislocations with smaller posterior wall fractures are associated with increased hip dysplasia.

Classic definitions of stable posterior wall may not be reflect stability in dysplastic hips.
Older Patients Really do Break More Easily: Patient Age is Inversely Associated with Energy of Collision Causing Fracture
Austin Stone, MD, PhD PGY 4
Wake Forest Baptist Medical Center

CONTRIBUTING AUTHORS
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2Virginia Tech-Wake Forest University Center for Injury Biomechanics, Winston-Salem, NC
3Department of Radiology, Wake Forest School of Medicine, Winston-Salem, NC
4Department of Orthopedic Surgery, Wake Forest School of Medicine, Winston-Salem, NC

INTRODUCTION
Increasing Age of US Population
↓
Increasing Number of Older Drivers
↓
Increased Geriatric Trauma Involved in Motor Vehicle Crashes

STUDY DEMOGRAPHICS
HEAD/FACE
THORAX
UPPER EXTREMITY
SPINE
PELVIS/LOWER EXTREMITY
868 PATIENTS 60+ YEARS
900 PATIENTS 20 – 50 YEARS

RESULTS
Older Age is Associated with Decreased ∆V

R² = 0.005

∆V vs. Age - Pelvis/Lower Extremity

Crash Injury Research and Engineering Network (CIREN)
http://www.sbes.vt.edu/ciren/cirennetwork.html
Similar Trend Across Multiple Body Regions

Similar Trend Seen for ΔEnergy

Energy Levels By Age Group

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Ages 60+ p-value</th>
<th>Ages 20-50 p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorax</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Spine</td>
<td>&lt;0.0001</td>
<td>0.80</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>&lt;0.0001</td>
<td>0.93</td>
</tr>
<tr>
<td>Pelvis/Lower Extremity</td>
<td>&lt;0.0001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

CLINICAL IMPLICATIONS

• Geriatric drivers require less energy to sustain the same fractures as younger drivers
• Age is correlated with energy required to cause fracture
• Bone density may be important contributor to fracture (even in “high energy” motor vehicle crashes)