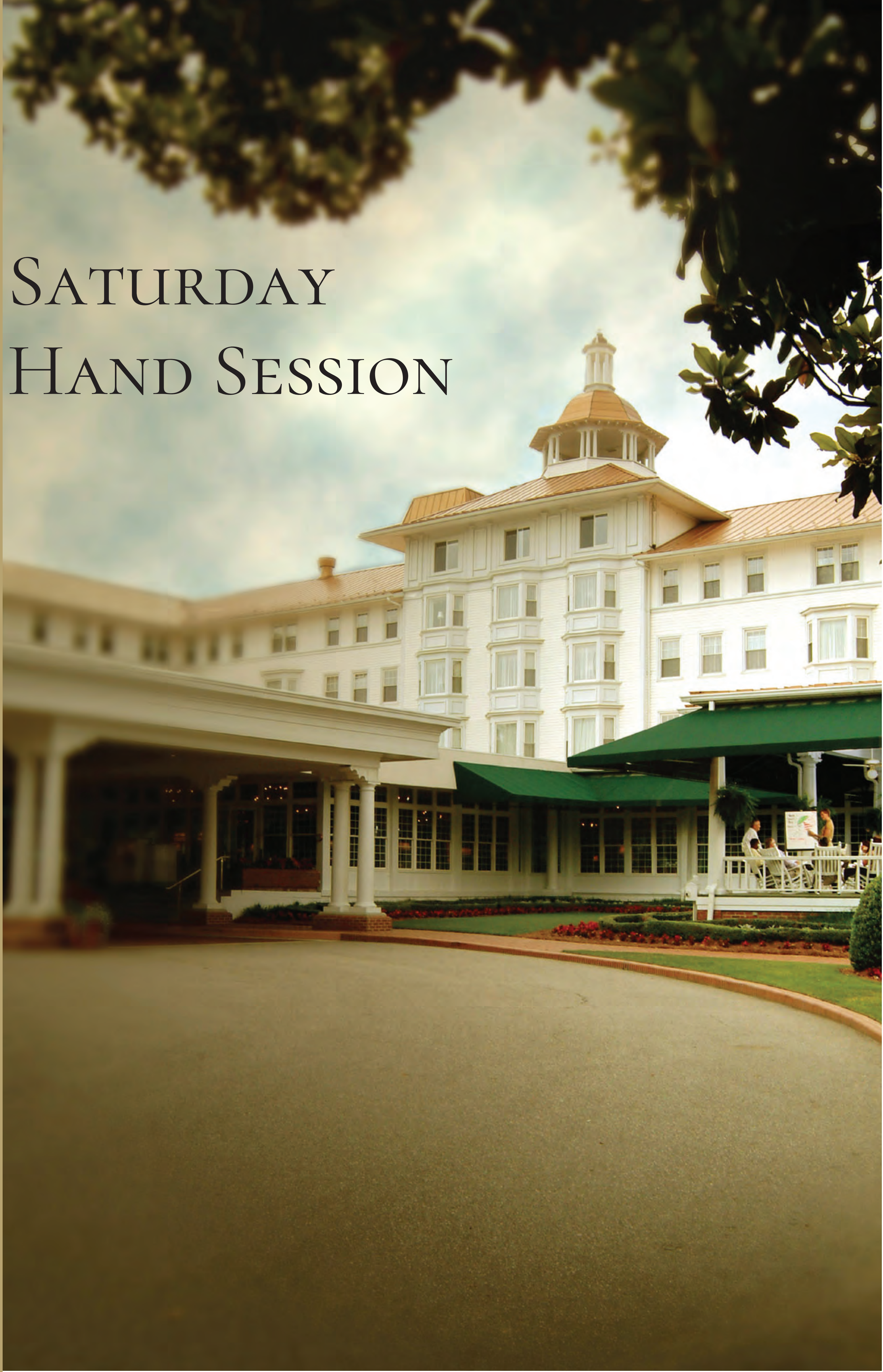
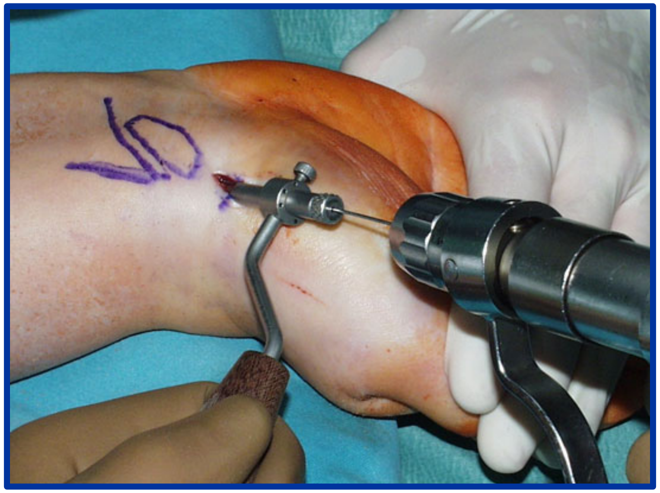
Saturday Hand Session

2016 NCOA Annual Meeting



Percutaneous Treatment of Unstable Scaphoid Waist Fractures

Andrew P. Matson, MD[1]
Ryan M. Garcia, MD[1,2]
Marc J. Richard, MD[1]
Fraser J. Leversedge, MD[1]
J. Mack Aldridge, MD[3]
David S. Ruch, MD[1]



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1. Duke University Medical Center, Durham, NC
2. OrthoCarolina Hand Center, Charlotte, NC
3. Triangle Orthopaedic Associates, Durham, NC

The authors have no relevant conflicts of interest to disclose.

Duke Orthopaedics

Introduction

Scaphoid fractures

- 60% of carpal fractures
- Nonoperative vs operative
- Displaced (unstable)

Percutaneous fixation

- Morbidity, return to work or play, blood supply

Introduction

Purpose

1. Evaluate fracture union for percutaneous treatment of Displaced scaphoid waist fractures (DSWF)
2. Evaluate pain scores, functional outcomes, and complications in a series of consecutive patients

Materials and Methods

Institutional Review Board Approval

28 consecutive patients met inclusion criteria, 4 surgeons

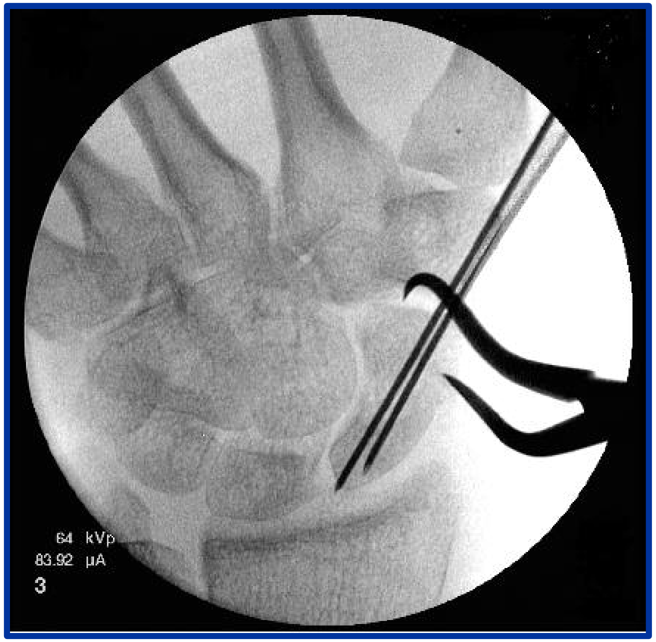
Displaced

- >1mm gapping/translation
- >15^{o} lunocapitate angulation
- >60^{o} scapholunate angulation

Materials and Methods

Reduction

- Traction, pronation, ulnar deviation, pressure
- Pointed tenaculum reduction clamp



14/28 successful closed

1.6 mo (range, 0.1-5.2) from injury

10 men, 4 women

Average age 32 (range, 19-51)

Materials and Methods

Fixation

– Single screw 10/14, dorsal 9/14

Thumb spica splint→2 wks→Removable thumb spica orthosis→6wks→hand therapy

Outcome Assessment:

– Union, pain, ROM, complications
– Quick DASH telephone survey

Results

Union (13/14)

- 2.8 months (1.9-3.4)

Outcomes

- Pain: 0.9/10 (0-3)
- ROM: 52 flex, 59 ext
- DASH: 9.6 (0.0-27.7)
  - At 2.5 yrs postop (1.5-8.3)

Results

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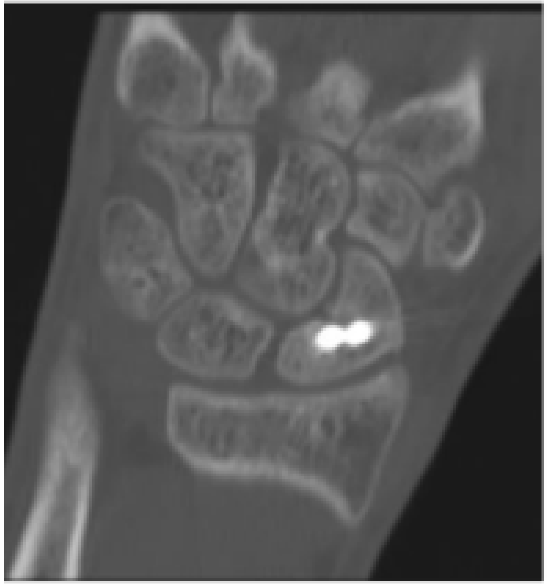
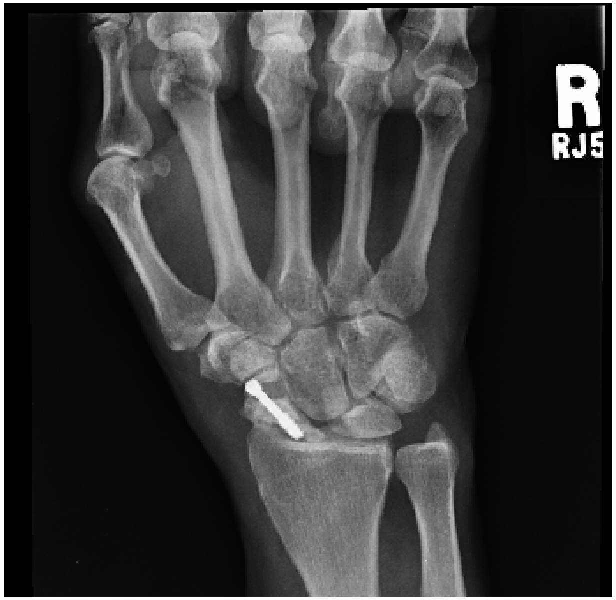


Results

Complications (2/14)

- 1 Major: Nonunion→AVN
  - 51 yo, 2.7 mo delay
- 1 Minor: intraop wire breakage



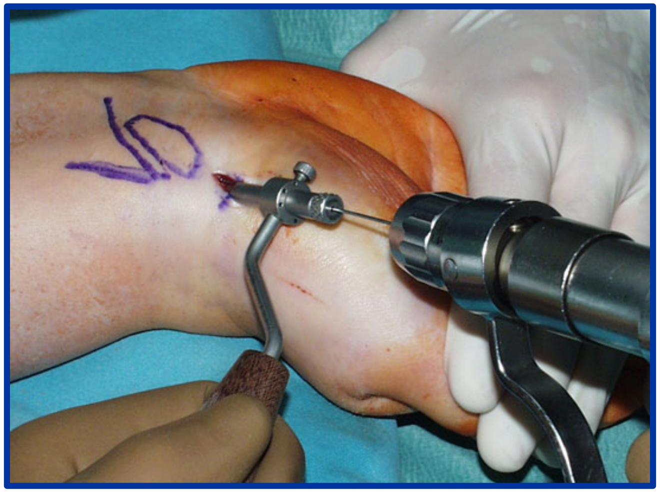
Discussion

Patient selection

- Age, acuity, displacement

Limitations

- Retrospective design
- Reduction assessment
- Short term
- No dynamic instability



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Conclusions

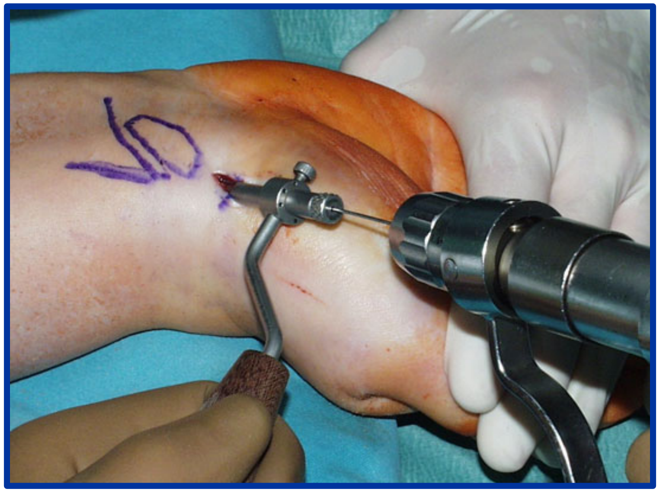
50% of DSWF can be closed reduced

13/14 achieved union, avg 2.8 months

Acceptable clinical outcomes, few complications

Future directions

– Randomized, comparative studies



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Volar Anatomy of the Proximal Phalanx: Implications for Screw Length Selection for Fixation of Shaft Fractures

P. Barrett Honeycutt, MS-3

Reid W. Draeger, MD

University of North Carolina School of Medicine

UNC Department of Orthopaedics

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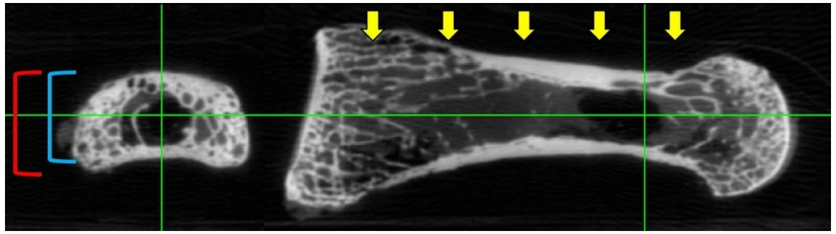
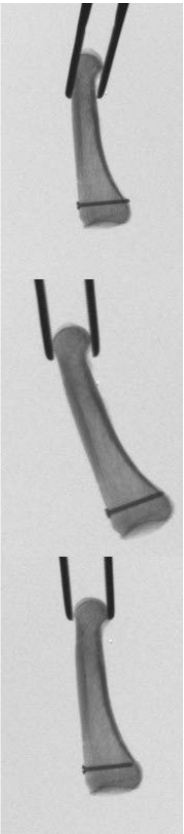
Introduction

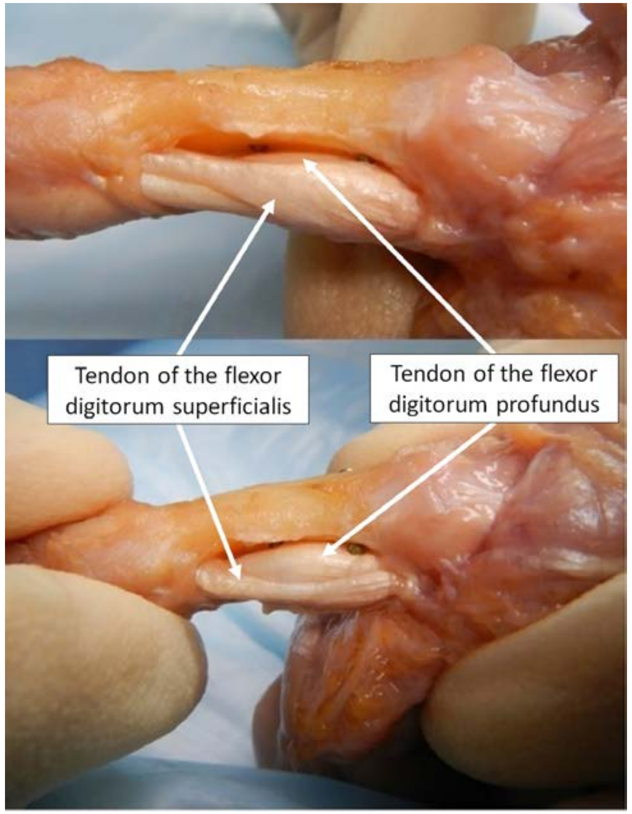
- Hand fractures represent up to 19% of all fractures presenting to the emergency department
  - 59% of these involve the phalanges
- Open reduction and internal fixation is indicated for unstable, comminuted, or otherwise complicated fractures of the phalangeal shaft
  - Lag screws are placed dorsally into the bone through an incision made on the dorsal aspect of the finger
  - Intraoperative fluoroscopy is used to view the hand laterally to ensure the lag screws have made purchase on the volar cortex without protruding through the palmar aspect of the bone
- We hypothesized that the volar aspect of the proximal phalanx is not flat as described in the literature, but grooved to accommodate the movement of the flexor tendon
- The edges of this groove could obscure the tips of protruding surgical screws when viewed laterally on intraoperative fluoroscopy
  - Protruding screw tips can irritate the flexor tendons, leading to pain, stiffness, or tendon rupture

Methods

- Quantitative characterization
  - Skeletonized proximal phalanges of 5 human cadavers were measured at 5 equidistant points along the shaft (yellow arrows)
    - Difference between total bone thickness (red bracket) and midline thickness (blue bracket) yielded the depth of the volar groove
    - Difference between these thicknesses tested for statistical significance
- Visualization
  - Micro-CT 3D reconstruction of a representative phalanx
  - Fluoroscopic observation of screws in a simulated operative environment
  - *In situ* placement of screws in cadaveric hands to illustrate impingement of soft tissues







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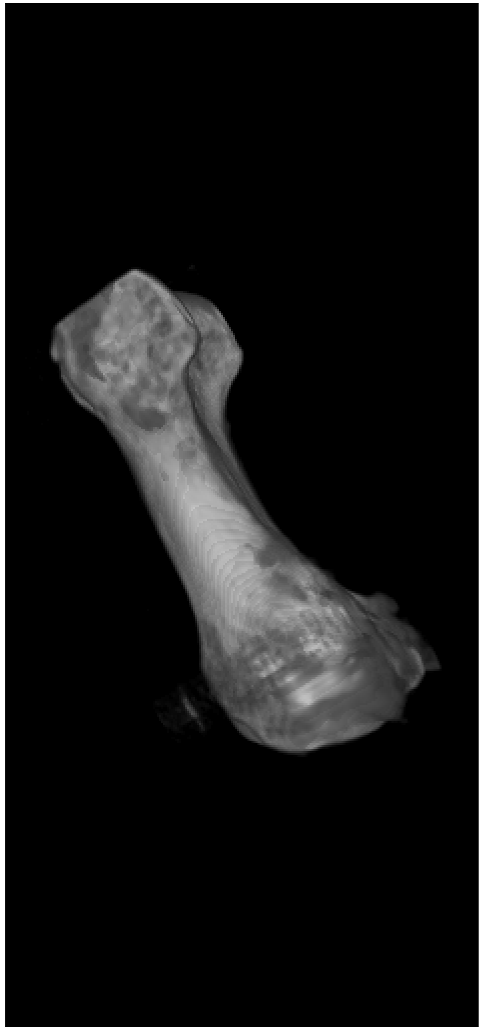
Summary

- Absolute depth measurements ranged from 0.01 mm to 2.20 mm
- Depth of the groove relative to total bone thickness averaged 7.8%
  - Range: 3.5% to 13.9%
- For all 5 sites of measurement on each of the 5 digits of the hand, the difference between total and midline bone thickness was significant



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Conclusions

- Our data support a longitudinal groove on the volar aspect of the proximal phalanx of the hand
- The depth of the groove averaged 7.8% of the total thickness of the phalangeal shaft
- Accounting for the depth of this groove when placing screws into the phalanx dorsally could reduce postsurgical complications caused by excessively long screws

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Acknowledgements

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- UNC Biomedical Imaging Research Center, supported in part by NCI Cancer Center Grant #P30-CA016086-35-37

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Union Rate and Return to Activity of Navicular Stress Fractures with Vascularized Bone Graft

Joel Morash, MD
James A Nunley, MD

Duke Orthopaedic Surgery

- The authors have no conflicts related to this presentation

Navicular Stress Fracture

- First described in 1970 by Towne et al.
- Incidence has increased:
  - 1970: 0.7% - 2.4%
  - 1980: 14% - 35%
  - Of all Foot and Ankle stress fractures
- 1/3 of all stress fractures

Why is the Navicular Susceptible to Stress fractures?

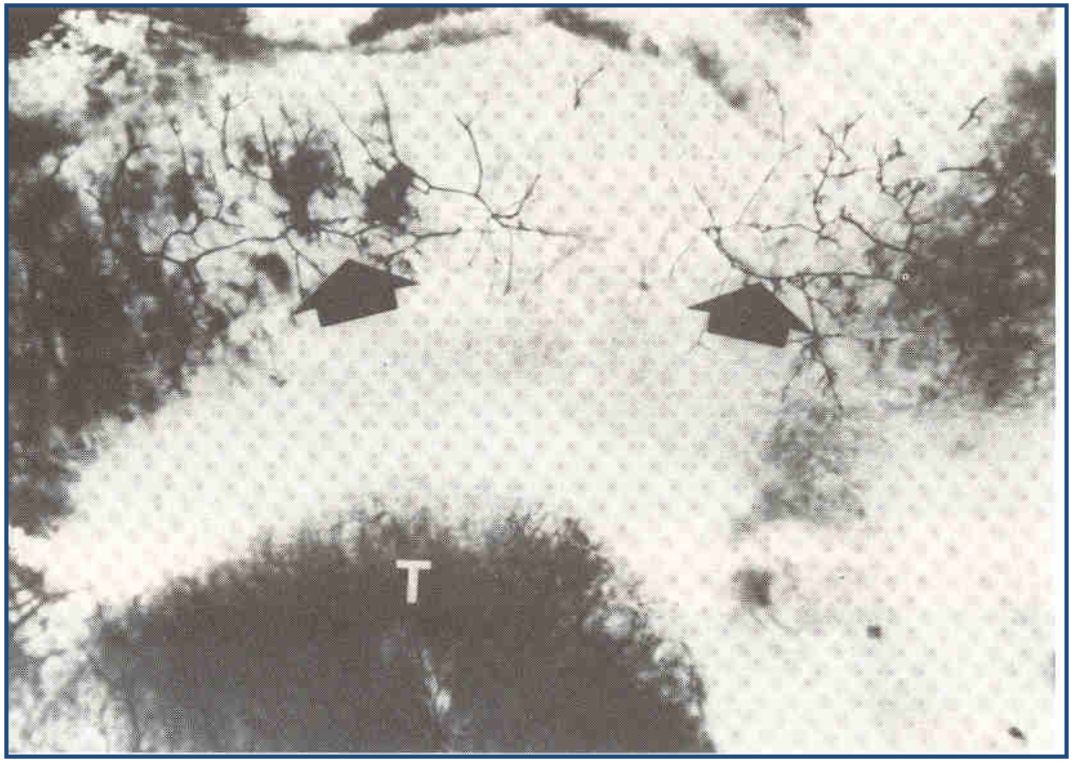
- Vascular anatomy
- Foot Biomechanics

Vascular Anatomy

- Numerous small vessels
  - Branches of the anterior and posterior tibial arteries
- Most of the surface area of the tarsal navicular covered with articular cartilage
  - Small waist of cortical bone available for vessels to enter and leave
  - Enter through medial and lateral non-articular surfaces and radiate toward the center

Anatomy

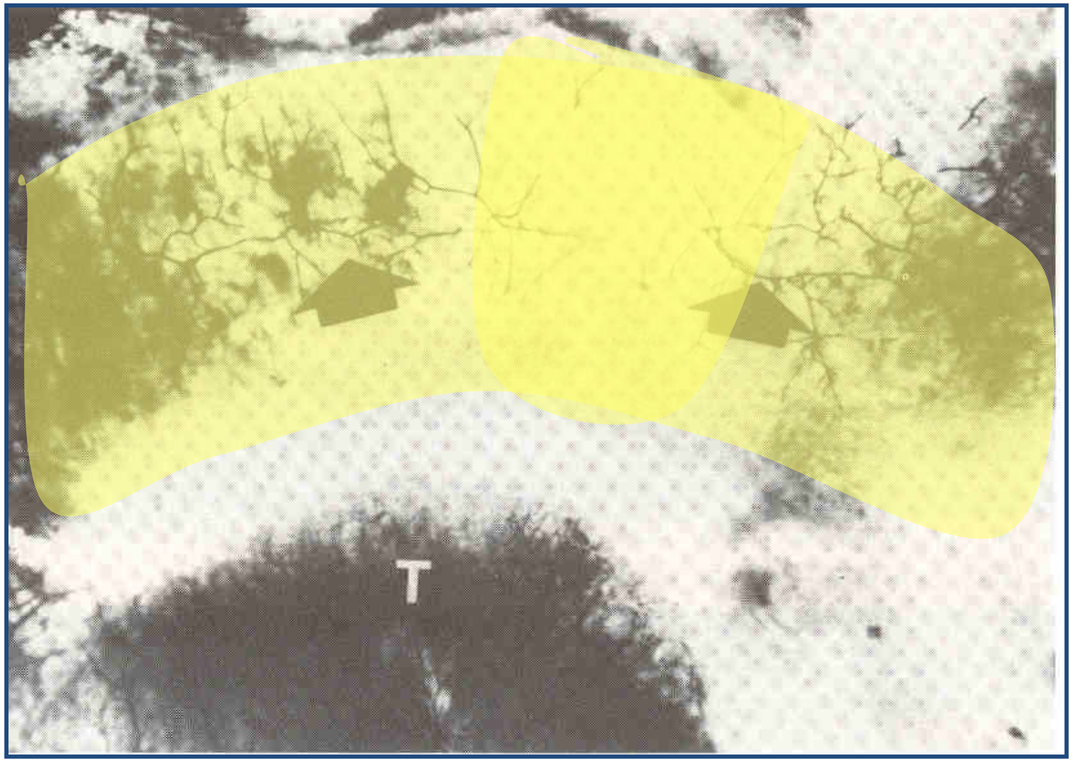
- Medial and lateral vessels leave the central one-third relatively avascular



Torg JS, et al. Stress fractures of the tarsal navicular. A retrospective review of twenty-one cases. JBJS 1982;64-A:700-712.

Anatomy

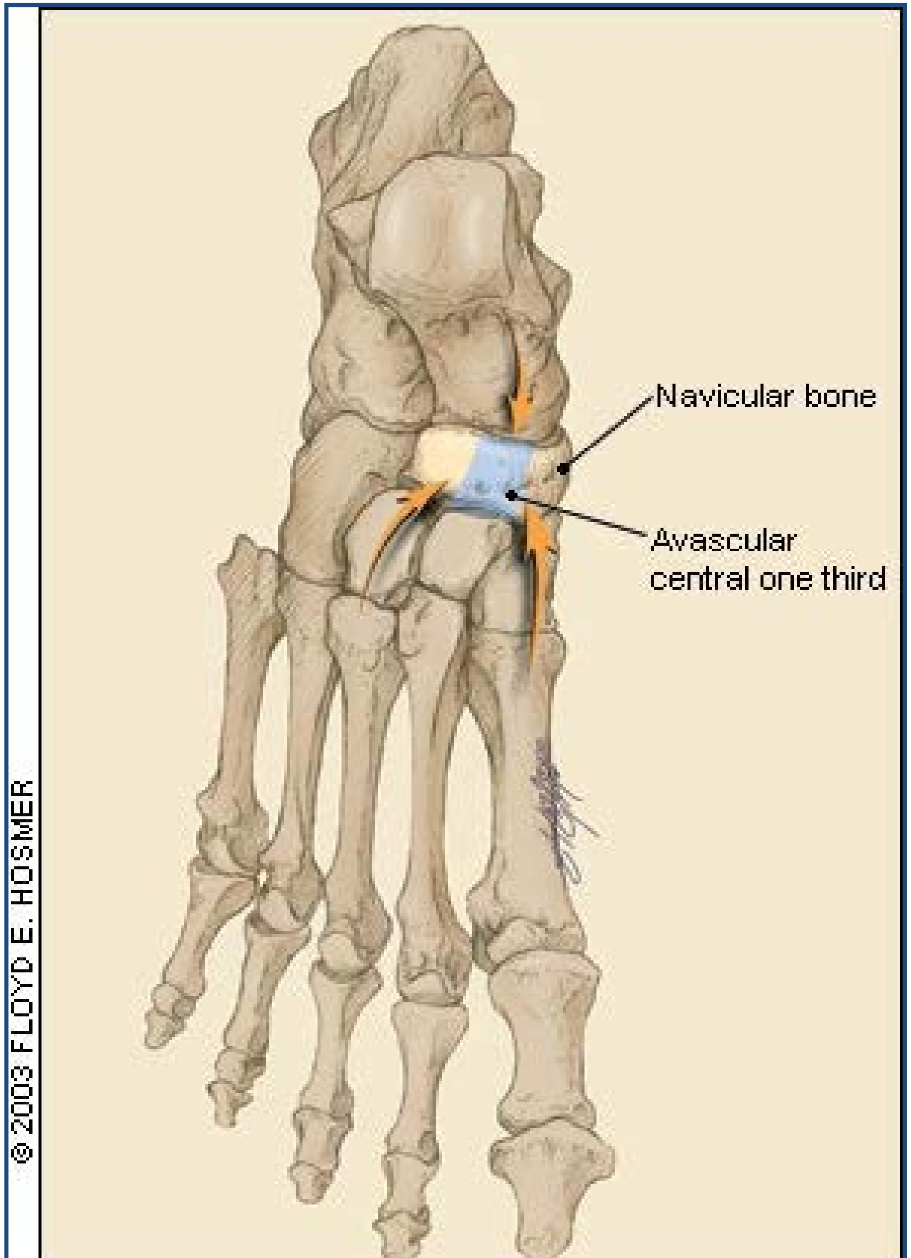
- Medial and lateral vessels leave the central one-third relatively avascular



Torg JS, et al. Stress fractures of the tarsal navicular. A retrospective review of twenty-one cases. JBJS 1982;64-A:700-712.

Foot Biomechanics

- During toe off, the navicular becomes impinged between the talar head and cuneiforms
  - Allows propulsive forces to be channeled effectively to the forefoot
  - Posterior tibial tendon contraction further compresses the navicular against the head of the talus



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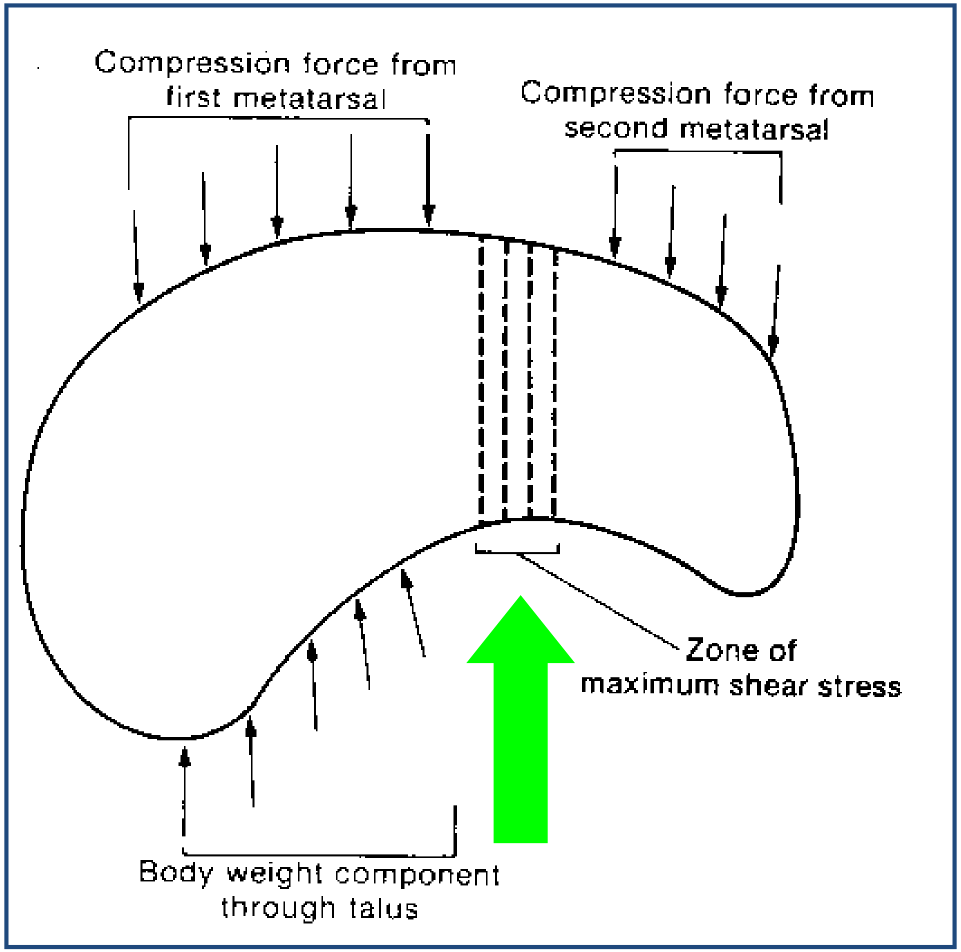
Foot Biomechanics

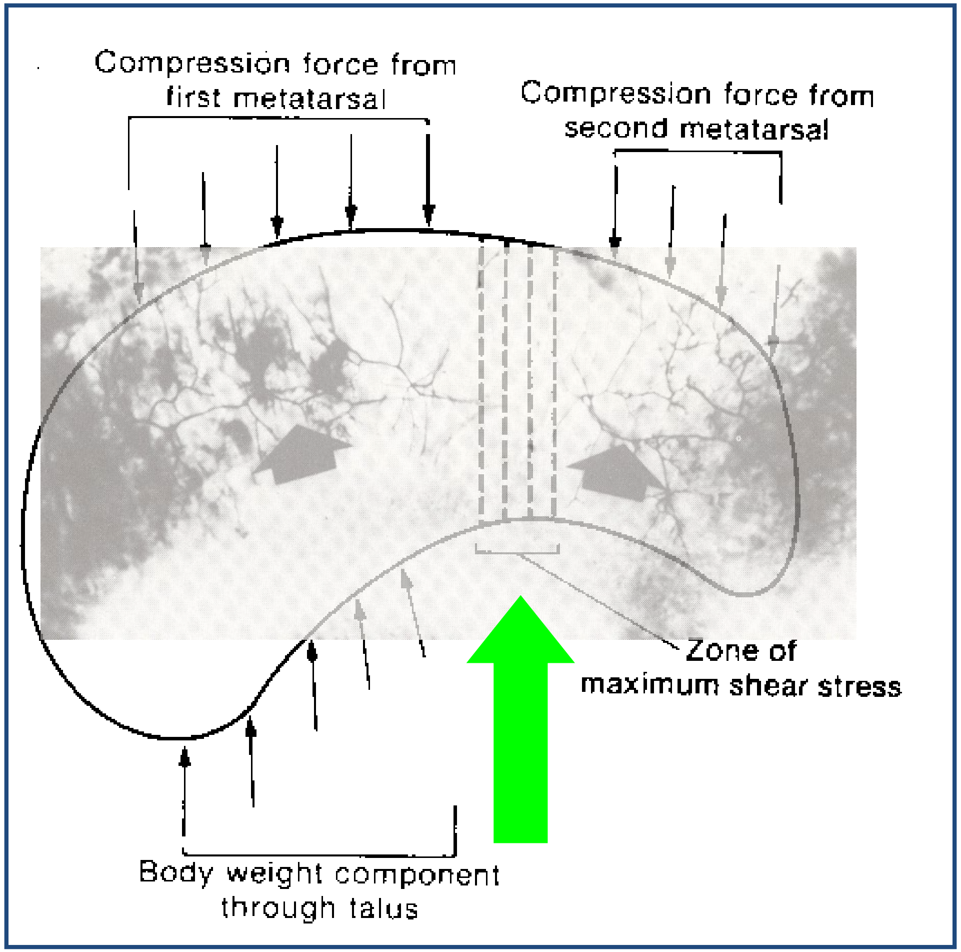
- Plane of maximum shear stress through the central portion of the navicular



Khan KM, et al. Tarsal navicular stress fracture in athletes. Sports Med 1994;17:65-76.

Foot Biomechanics

- Plane of maximum shear stress through the central portion of the navicular
  - Fracture line often at the junction of central and lateral thirds



Khan KM, et al. Tarsal navicular stress fracture in athletes. Sports Med 1994;17:65-76.

Treatments

- Many factors may influence the treatment:
  - Onset of symptoms
  - Time of diagnosis
  - Age
  - Activity level of the patient
  - Fracture pattern
    - displaced vs non displaced
    - complete vs partial fracture
    - comminuted vs simple fracture pattern
    - cystic or sclerotic changes within the bone.

Treatment

- Initial Treatment
  - Conservative
    - Bracing during activity,
    - Reduction of activity,
    - Weight bearing CAM boot or cast
    - Strict non weight bearing in a below knee cast
  - Operative
    - Percutaneous vs open reduction and internal fixation.
    - Bone graft
      - Autologous vs Allograft vs none
      - Vascularized vs Non -Vascularized
    - ? biologics

Previous Research

- Torg et al. 1986
- Compared weight bearing protocols
- 100% healing rate without complications in the 10 patients treated with non–weight bearing casts for 6 to 8 weeks.
- 78% of his 9 patients treated with a walking cast could not resume sports because of pain.

Torg JBJS 1986

- Unfortunately this article is misleading
- There were 21 patients from 4 different institutions, 14 of the 21 fractures were identified only by bone scan.
- Patient’s were diagnosis at 7.5 months after onset of symptoms
- Only 10 of the 21 were treated nonweightbearing in a cast
- There were no postoperative CT scans to confirm union
- Four of the 21 were considered disabled and 3 patients required surgical treatment all of which healed

Previous Research

- Khan et al. 1992
- 86% of patients that were treated for 6 weeks in a non weight-bearing cast returned to full activity

- To date, there is little literature or evidence available to guide the surgeon on the best treatment of navicular stress fractures.
- It remains unclear if one form of ORIF with or without bone graft is superior in treating navicular stress fractures.

Hypothesis

- We hypothesize that the treatment algorithm proposed by the senior author will lead to equivalent results in pain/return to activity and radiographic healing for simple and complex navicular stress fractures

Proposed Algorithm

Acute Fracture

Open Reduction and Internal Fixation

Chronic Fracture (> 3 months)

Open Reduction and Internal Fixation and Iliac Crest Bone Grafting

Chronic Fractures with evidence of sclerosis, avascular necrosis or previous surgery for fracture

Open Reduction and Internal fixation with new hardware, iliac crest grafting and vascularized bone grafting

Methods

- A retrospective chart review was performed using the Foot and Ankle Research database at Duke Orthopaedics to determine the incidence and outcomes of patients undergoing operative treatment for navicular stress fractures between 1996 to present.
- For each patient identified, we assessed post-operative pain, functional outcome, radiographic appearance, and demographics.

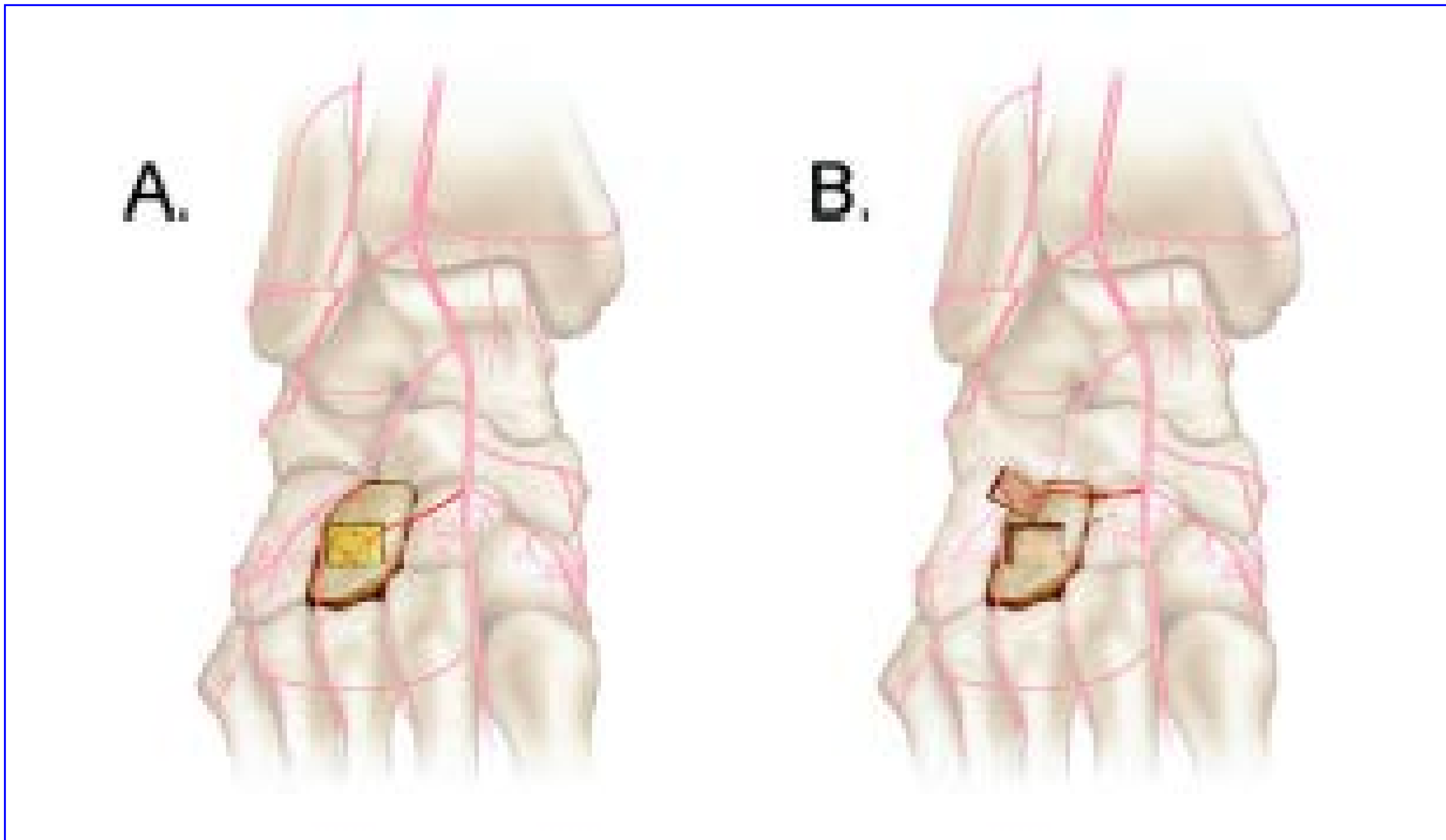
Selection of Subjects

- Inclusion Criteria:
  - Age 14– 100 years
  - Complete history and physical examination
  - Minimum of 3 month follow-up

- Exclusion Criteria:
  - No follow-up

ORIF with Vascularized Bone Graft

Vascularized (local rotational cuneiform)



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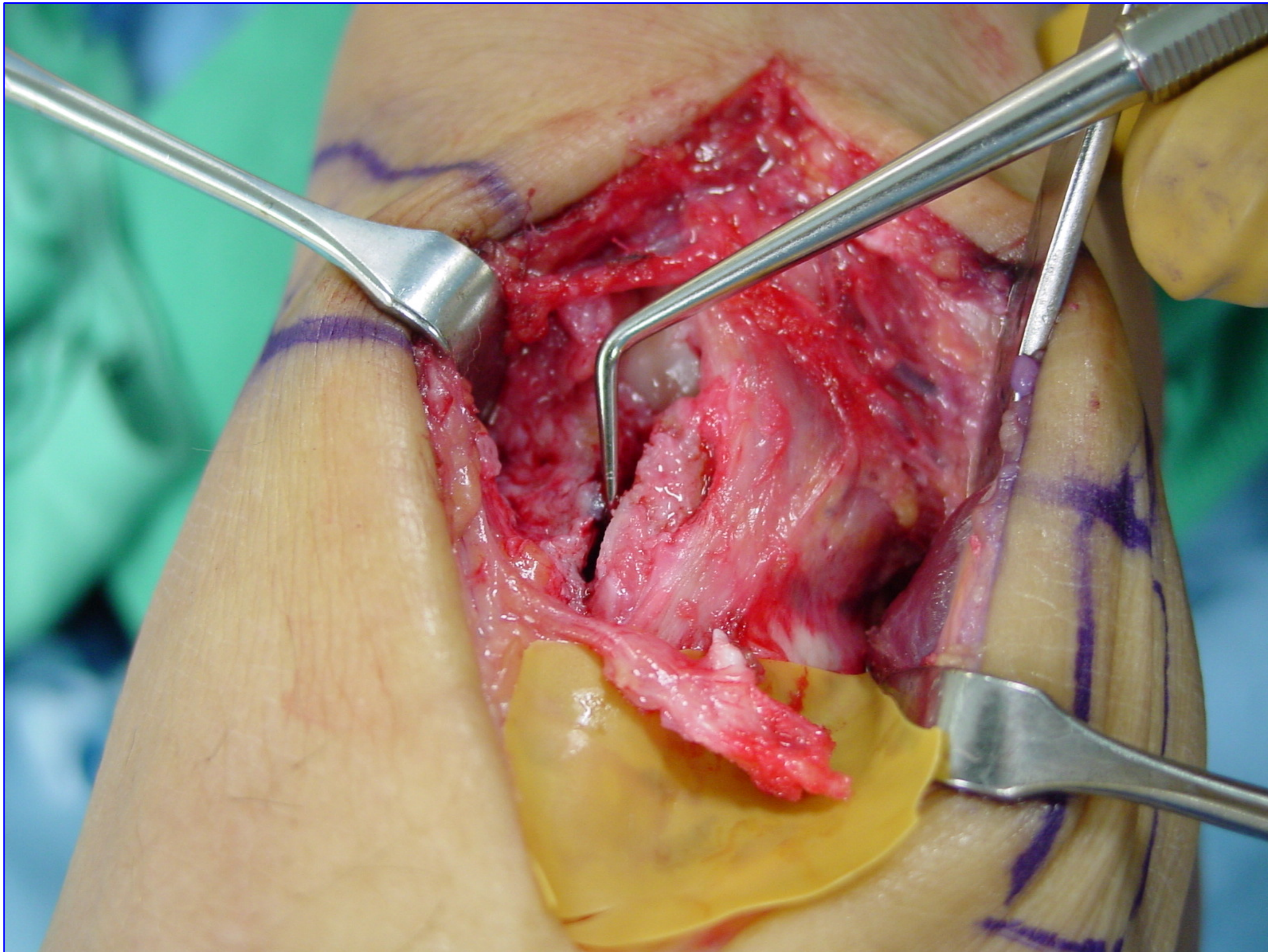

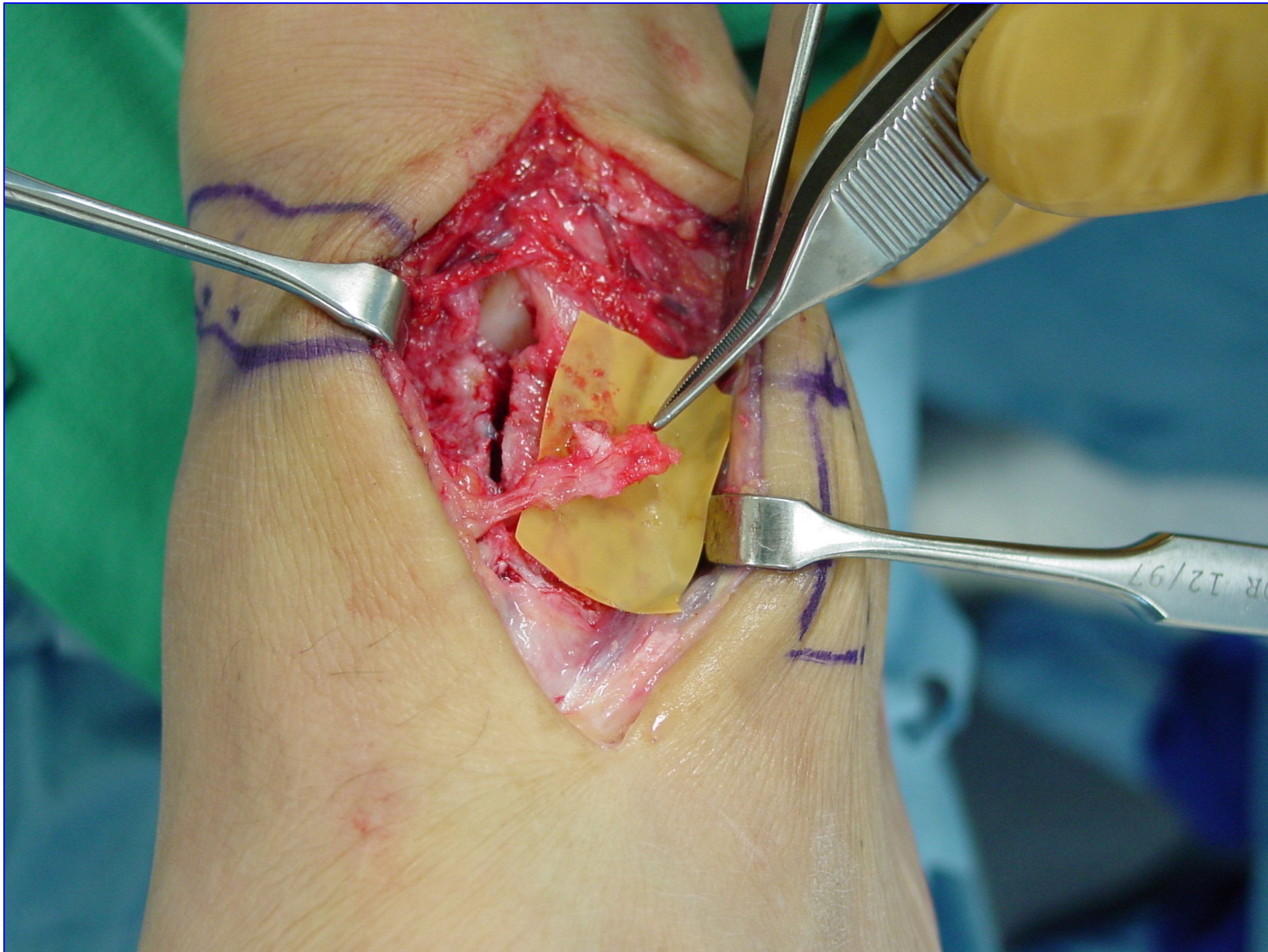
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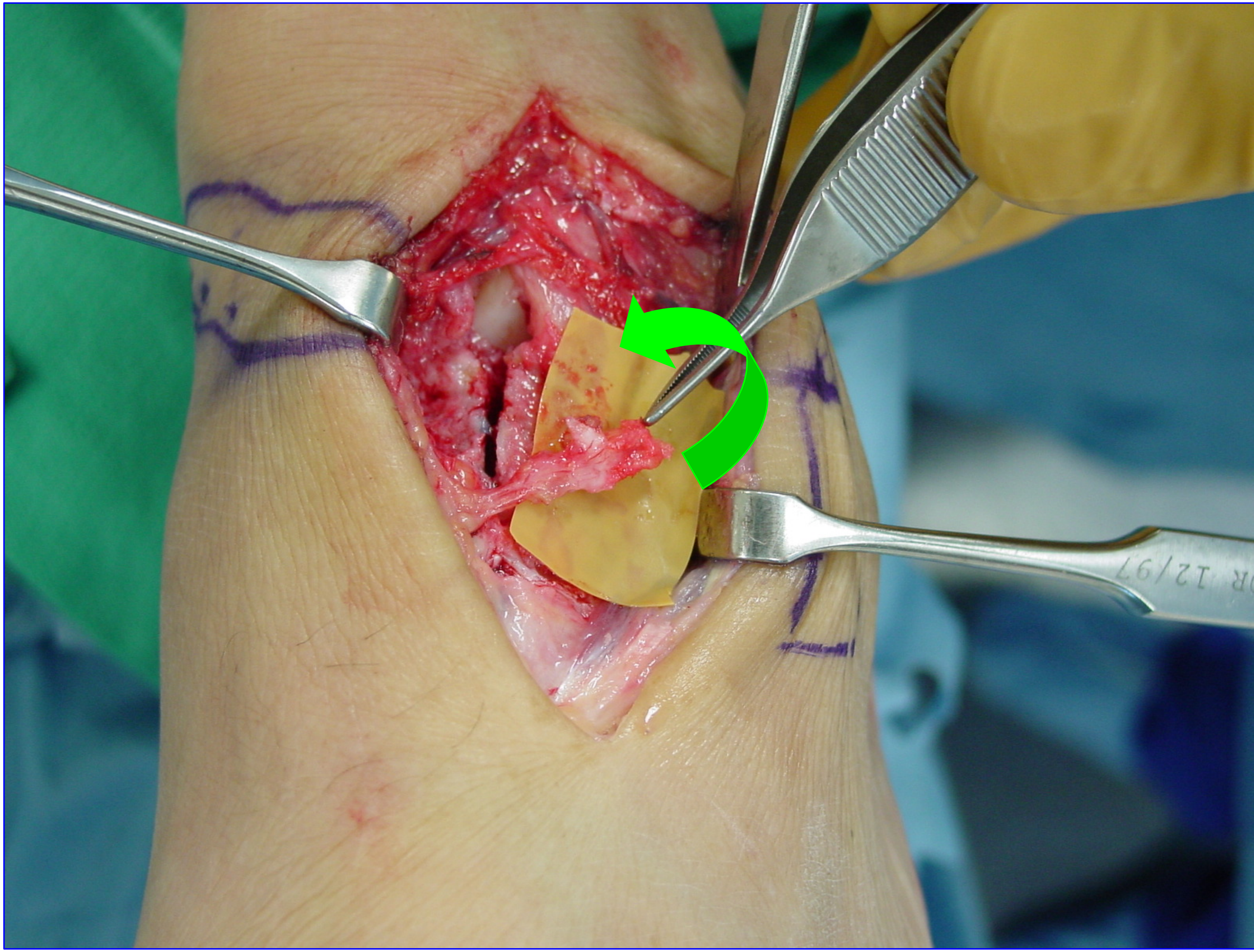
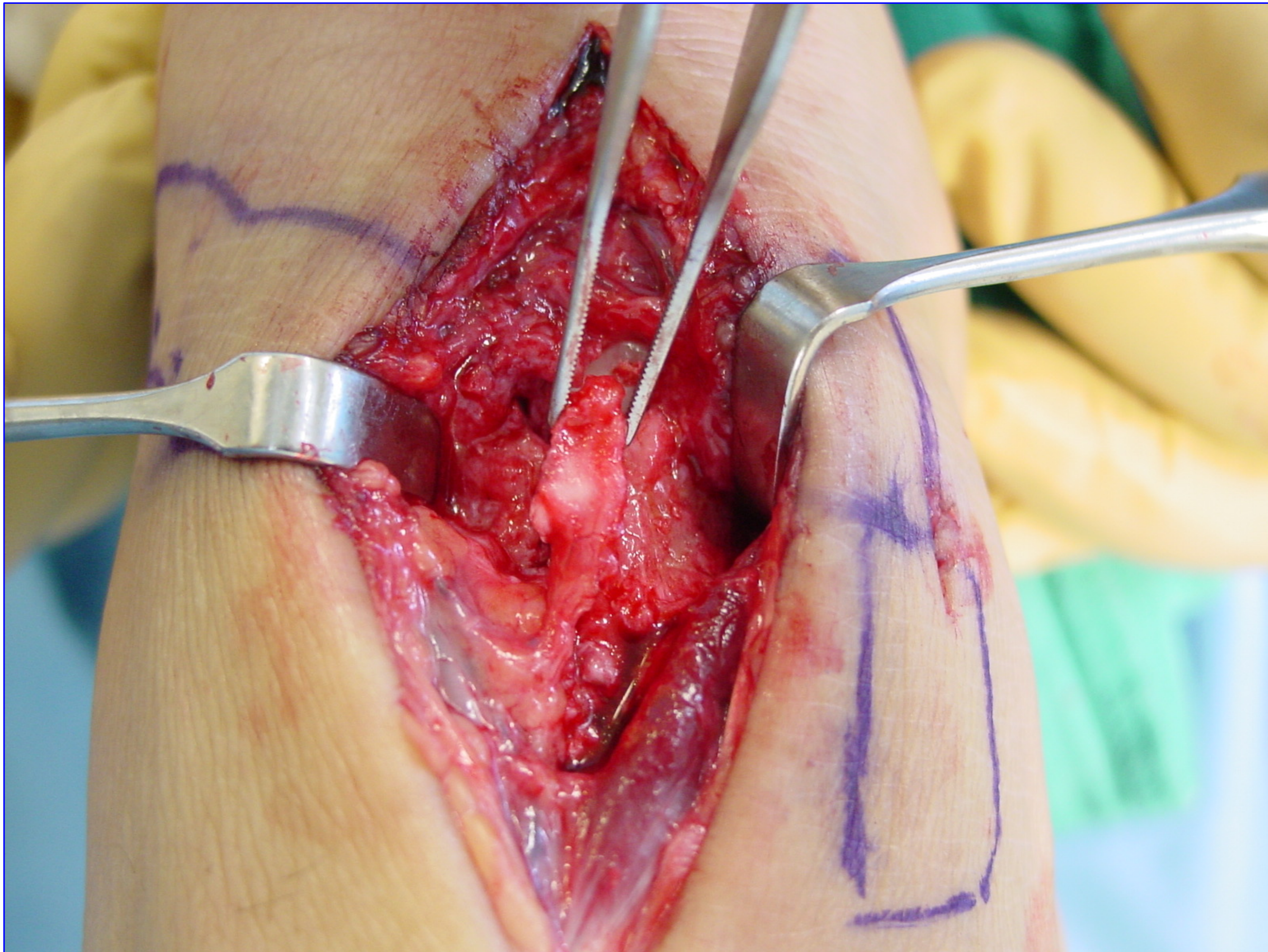




Results

- N-40
- ORIF- 15
- ORIF w/ bone graft- 12
- ORIF w/ vascularized bone graft – 13

- Male/ Female- 22/18
- Right /Left- 20/20

Age (yrs)

Group	N	Mean	Min	Median	Max	
ORIF	15	20.8	15	17	59	
ORIFBG	12	31.9	15	20.5	65	
ORIFVBG	13	23.7	15	18	54	
						P=0.144

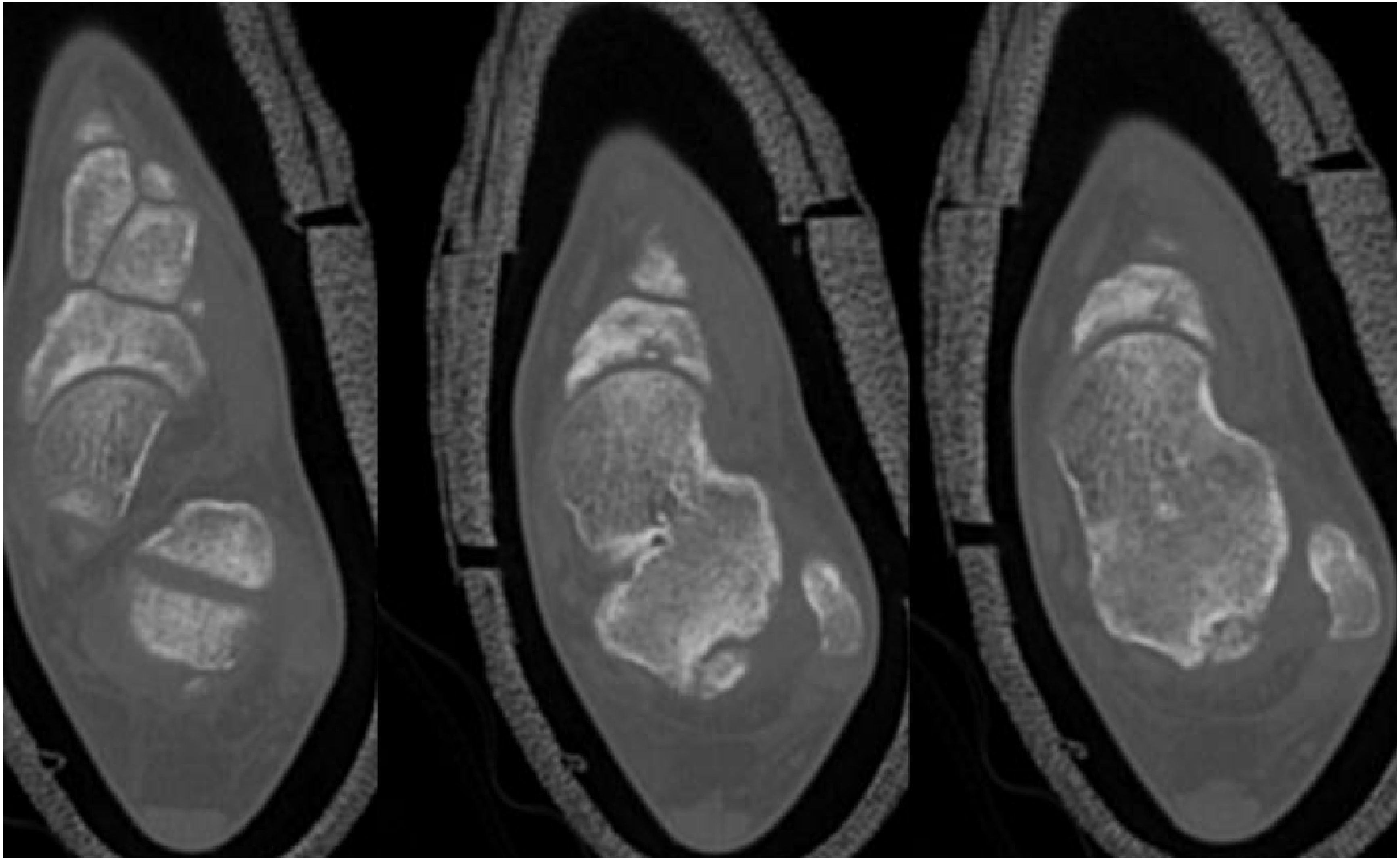
Follow Up (months)

Group	N	Mean	Min	Median	Max	
ORIF	15	12	5	9	36	
ORIF-BG	12	33.5	6	12	240	
ORIF-VBG	13	10.6	3	12	24	
						P=0.316

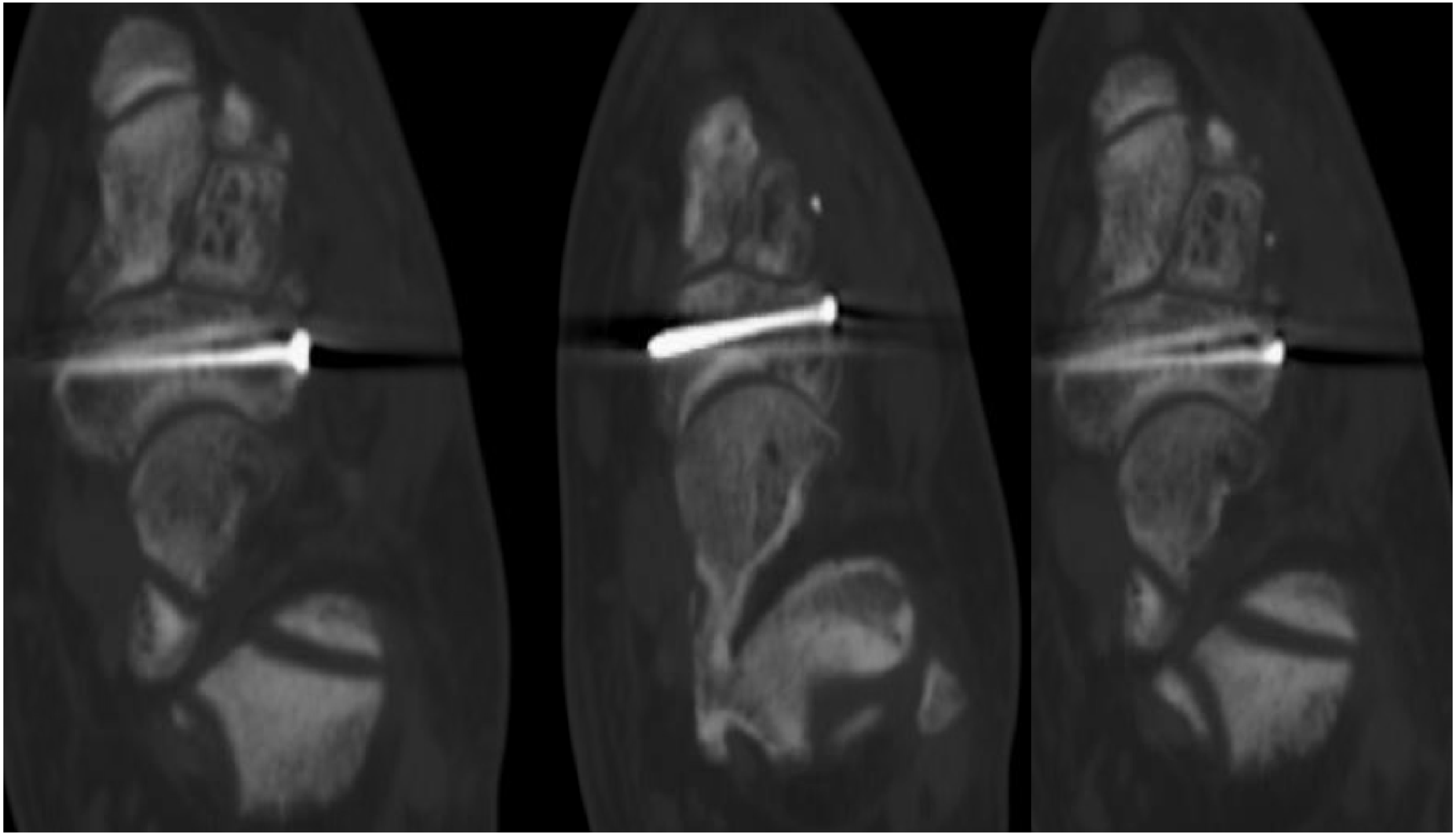
Radiographic Healing

Group	N	Healed	Non-Union	% Healed	
ORIF	15	12	3	80	
ORIF-BG	12	9	3	75	
ORIF-VBG	13	13	0	100	
				Fisher's Exact Test	Pr <=P- 0.183

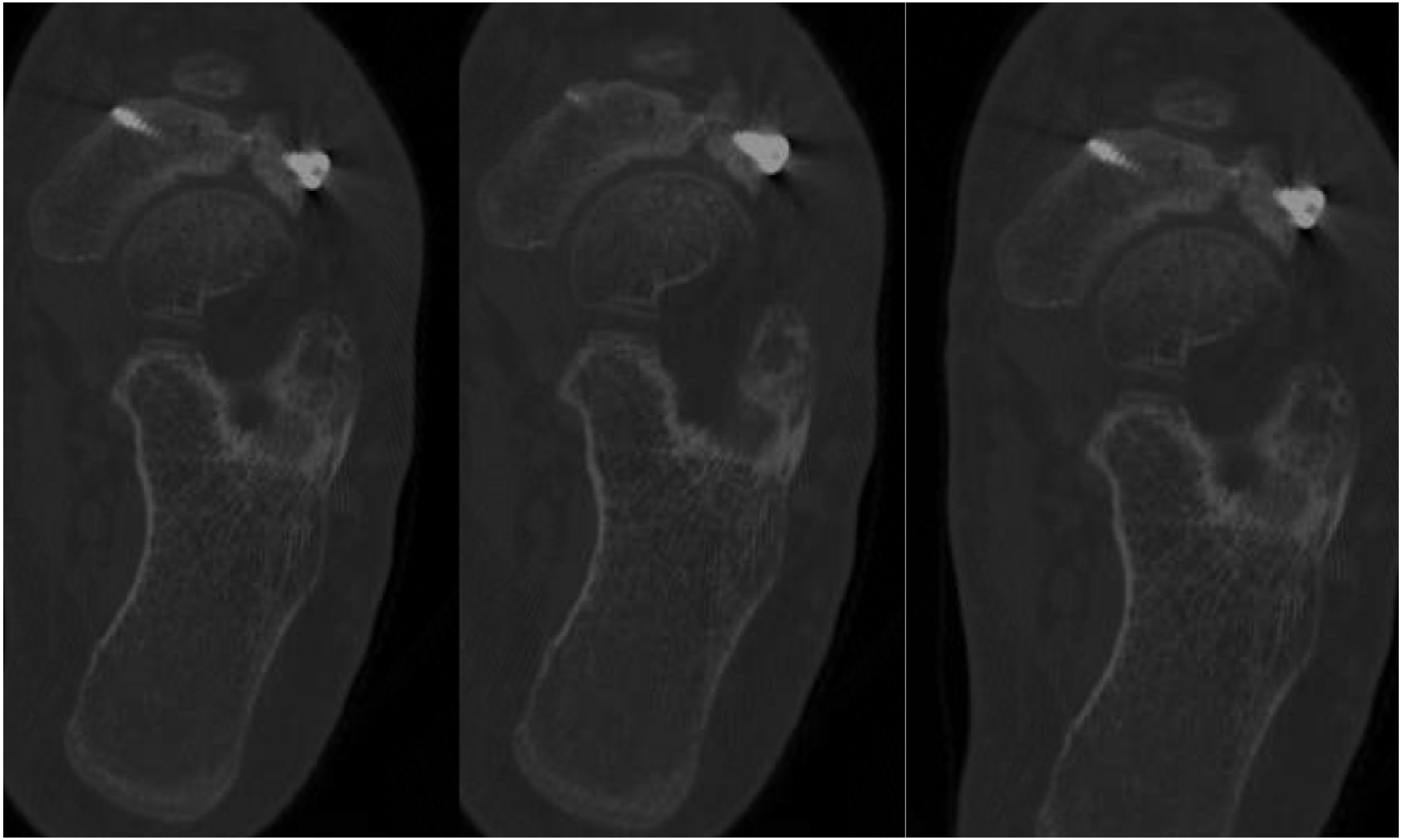
15 F Pre-op



15 F Post-op 11 Months



20 M Post-op 15 Months



Return To Activity

Group	N	Returned	Returned to lower level with mild pain	Unable to return due to pain	% Returned to activity without pain	
ORIF	15	13	1	1	87	
ORIF-BG	12	9	2	1	75	
ORIF-VBG	13	9	3	1	69	
					Fisher's Exact Test	Pr<= P-0.836

Returned to Activity vs Healing

Group	N	Healed	Non-Union	
Returned	31	26	5	
Returned to lower level with mild pain	6	6	0	
Unable to return due to pain	3	2	1	
			Fisher’s Exact Test	Pr P<= 0.395

Conclusions

- By using the treatment algorithm proposed we were able to achieve 100 percent radiographic union for complex and revision cases of navicular stress fractures.
- These cases showed the equivalent rate of return to sport and radiographic union as less severe primary cases using ORIF with and without bone graft.
- We would therefore suggest this algorithm be used when assessing a navicular stress fracture in patients, especially those who have already undergone a previous surgery or have more advance radiographic disease.

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How to cut a nerve; morphological implications of instruments utilized in the preparation of lacerated nerve endings for primary repair

NCOA Annual Meeting

Edward Jernigan, J. Megan Patterson,
Wayne Rummings, Brandon Smetana,
Donald Bynum, Reid Draeger

UNC Department of Othopaedics

Disclosures

None

Background

- Preparation of the severed endings of a lacerated nerve is vital to successful anastamosis

- goal = remove injured neural tissue until sprouting fascicles are visualized

Background

- No consensus on optimal instrument to use for nerve preparation

- Some advocate use of a scalpel and others use of microvascular scissors (1-3)

- Paucity of literature comparing instruments

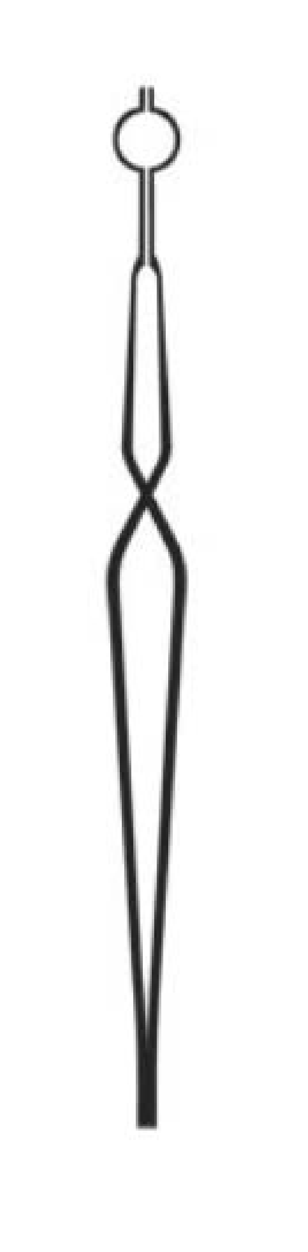
[1] Binda et al, *Operative Techniques in Orthopaedic Surgery (Weisel)*; [2] Dvali, Mackinnon *Hand Clinics* 2007; [3] Birch et al, *Green's Operative Hand Surgery)*

Background

- Anecdotally, the slotted circumferential cutting guide has provided acceptable cuts

- Takes more time to set up
- Not available in standard hand tray

- Is it worth the extra effort?



Aims

To evaluate the relationship between the instrument used in preparation of a cadaveric median nerve section and nerve morphology

Hypothesis

Sections of median nerve prepared with a slotted, circumferential nerve cutting guide will have superior morphologic appearance compared to sections of nerve prepared with other instruments

Methods

- 11 fresh frozen UE cadaveric specimens
  - No h/o UE pathology

- Median nerve harvested at the level of the humerus

Methods

- Each end of the harvested nerve secured to the end of a commercial spring gauge using 3.0 prolene
- Gauge set to 100g

Methods

Determining tension

- Excessive tension = ischemia
- Animal studies have demonstrated a strain of 8–15% have lead to nerve ischemia (4,5)

[4] Lundborg et al, *JBJS* 1973; [5] Clark et al, *JHS* 1992

Determining tension

- Prior studies in ulnar nerve transposition models have demonstrated 100g setting to simulate a strain of 2–5% (6)

- Below the 8–15% threshold from animal studies

[6] Abrams et al, *JHS* 1998

Methods

- 1-cm sections of harvested nerve were cut with 5 instruments

  - microvascular scissors
  - iris scissors
  - tenotomy scissors
  - 15 blade scalpel with a tongue depressor placed behind the nerve
  - slotted, circumferential nerve cutting guide

Methods

- 50x sagittal and axial photomicrographs of each cut were obtained
- Mounted commercially available digital microscope (Dino-Lite)

Methods – Grading

- Panel of 3 hand fellowship physicians
- Blinded to instrument used

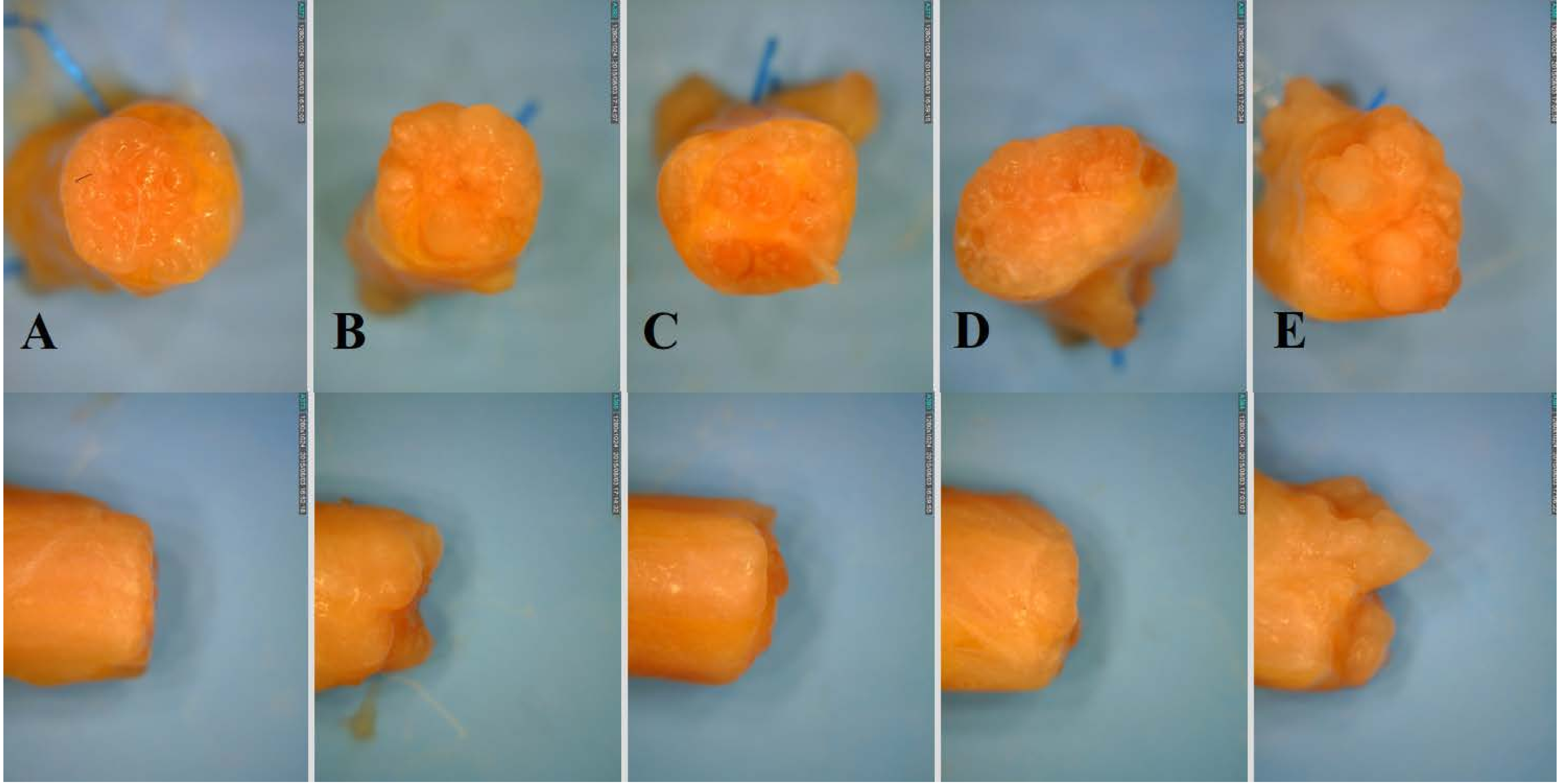
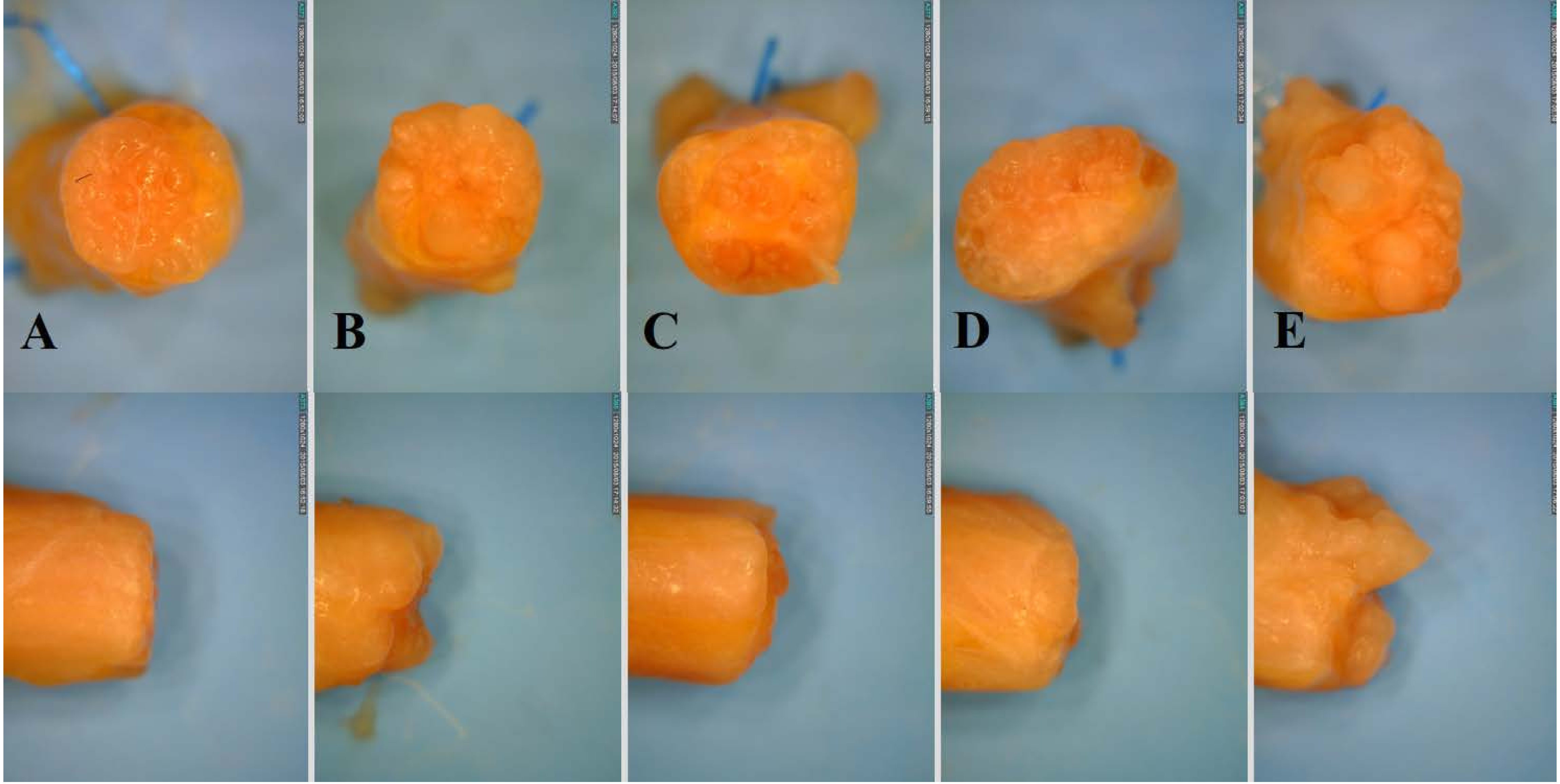


Figure 1. Representative axial and sagittal photomicrographs of a segment of medial nerve prepared by five different instruments. Three fellowship-trained hand surgeons blinded to device used graded 22 sets of images. Each prepared nerve ending was graded as acceptable or not-acceptable for proceeding with primary repair. Additionally, a relative grading scale from 1-5 was utilized, with 1 denoting the morphologically superior cut of the group, and 5 denoting the worst cut.

Methods – Grading

- Binary scale
  - "Yes" – acceptable cut, appropriate for primary nerve repair
  - "No" – unacceptable cut, would require re-preparation prior to nerve repair
- Relative grading scale



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Methods – Grading

- Binary scale
- Relative grading scale for each nerve segment
  - 1 = best cut
  - 5 = worst cut

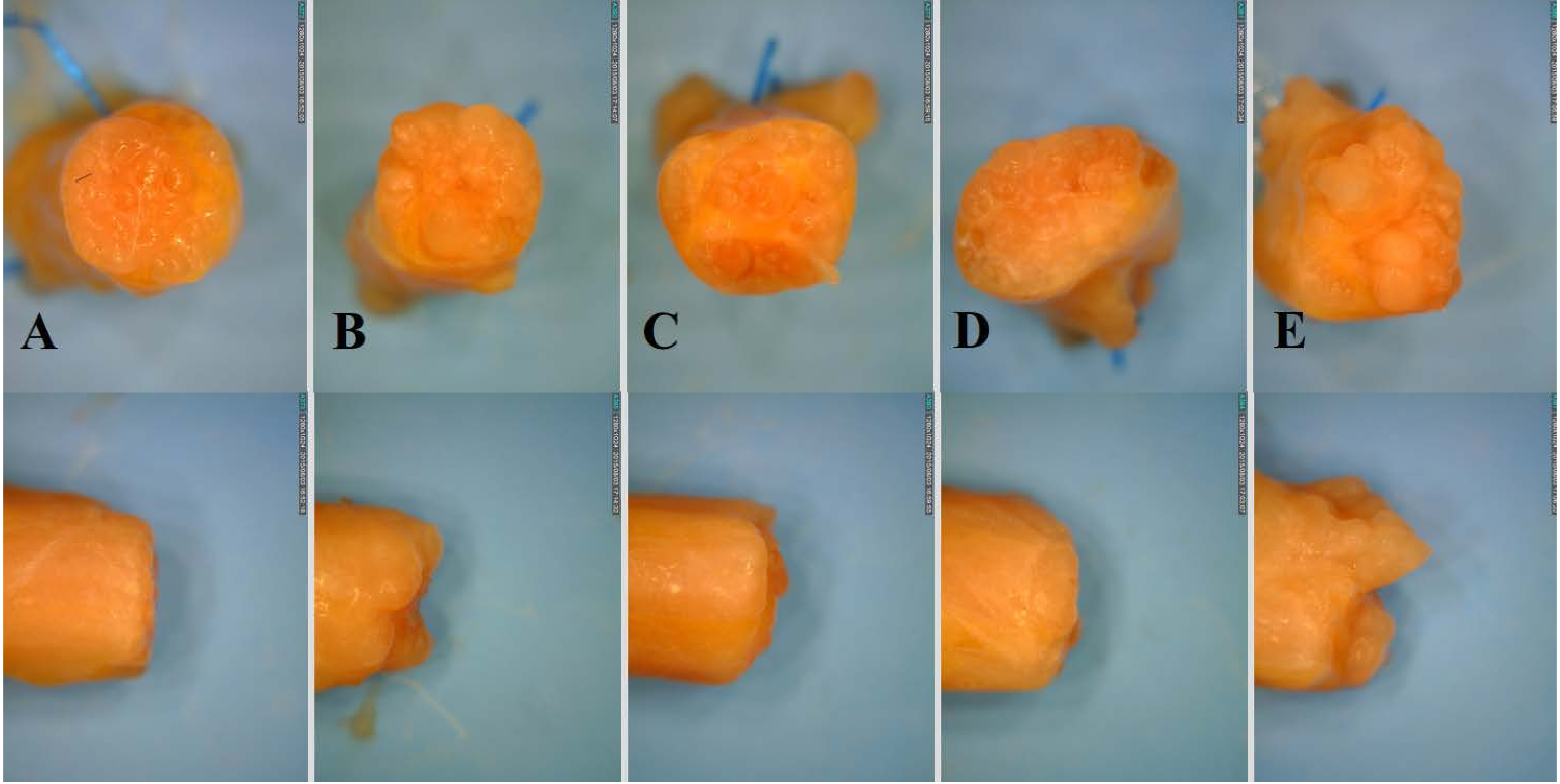

Figure 1. Representative axial and sagittal photomicrographs of a segment of medial nerve prepared by five different instruments. Three fellowship-trained hand surgeons blinded to device used graded 22 sets of images. Each prepared nerve ending was graded as acceptable or not-acceptable for proceeding with primary repair. Additionally, a relative grading scale from 1-5 was utilized, with 1 denoting the morphologically superior cut of the group, and 5 denoting the worst cut.

Methods – Stats

- Rates of acceptable cuts
  - –chi–squared tests

- Mean grading scores
  - –pairwise t–testing of means

- Statistical significance for all testing was set at alpha = 0.05

Results

- 22 segments of median nerve
- 110 cuts
- 220 50x photomicrographs (120 axial, 120 sagittal)
- 3 hand fellowship trained surgeons

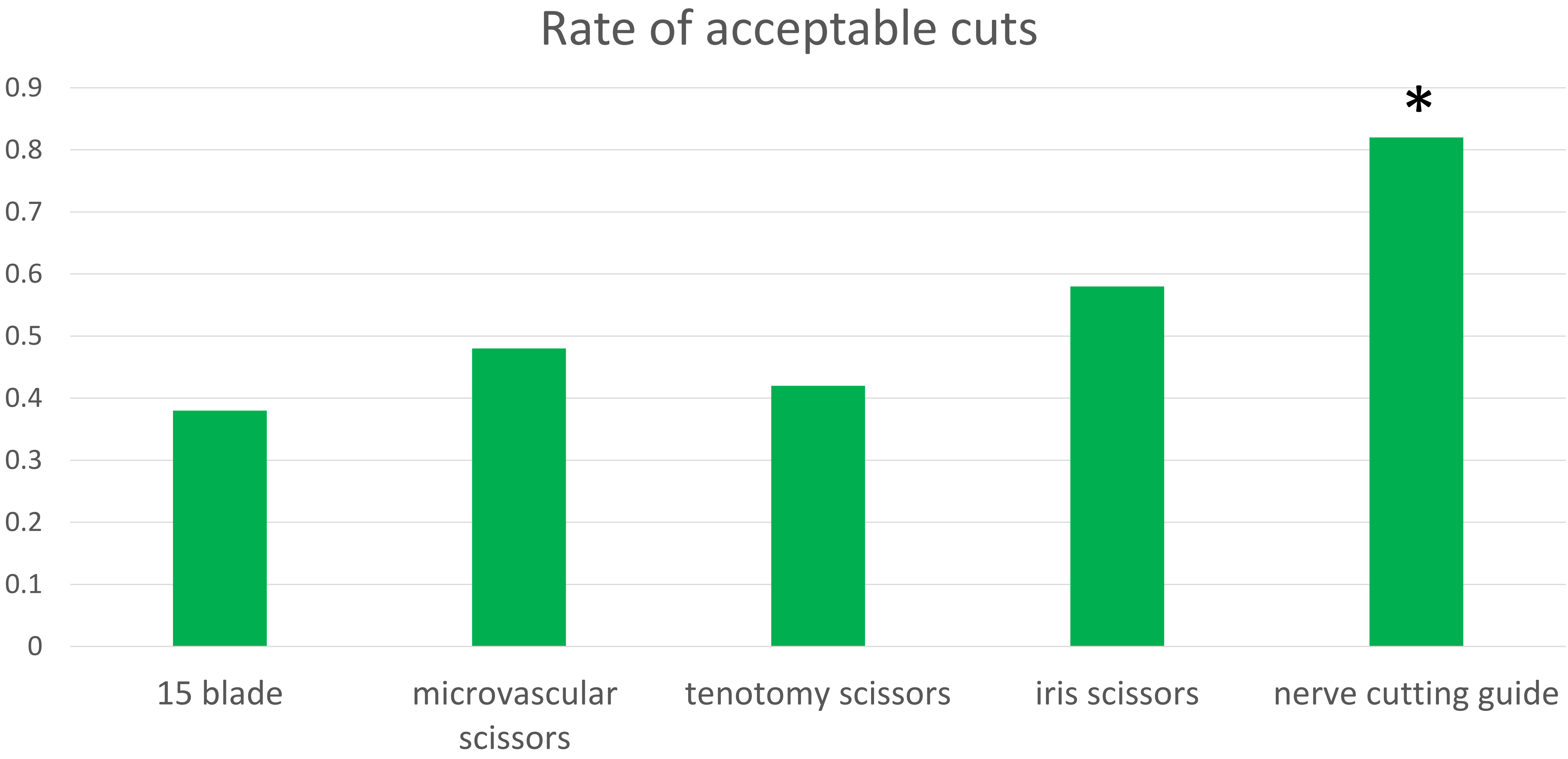

Figure 2. Rates of prepared nerve endings deemed acceptable for proceeding with primary nerve repair as graded by fellowship-trained hand surgeons for each instrument

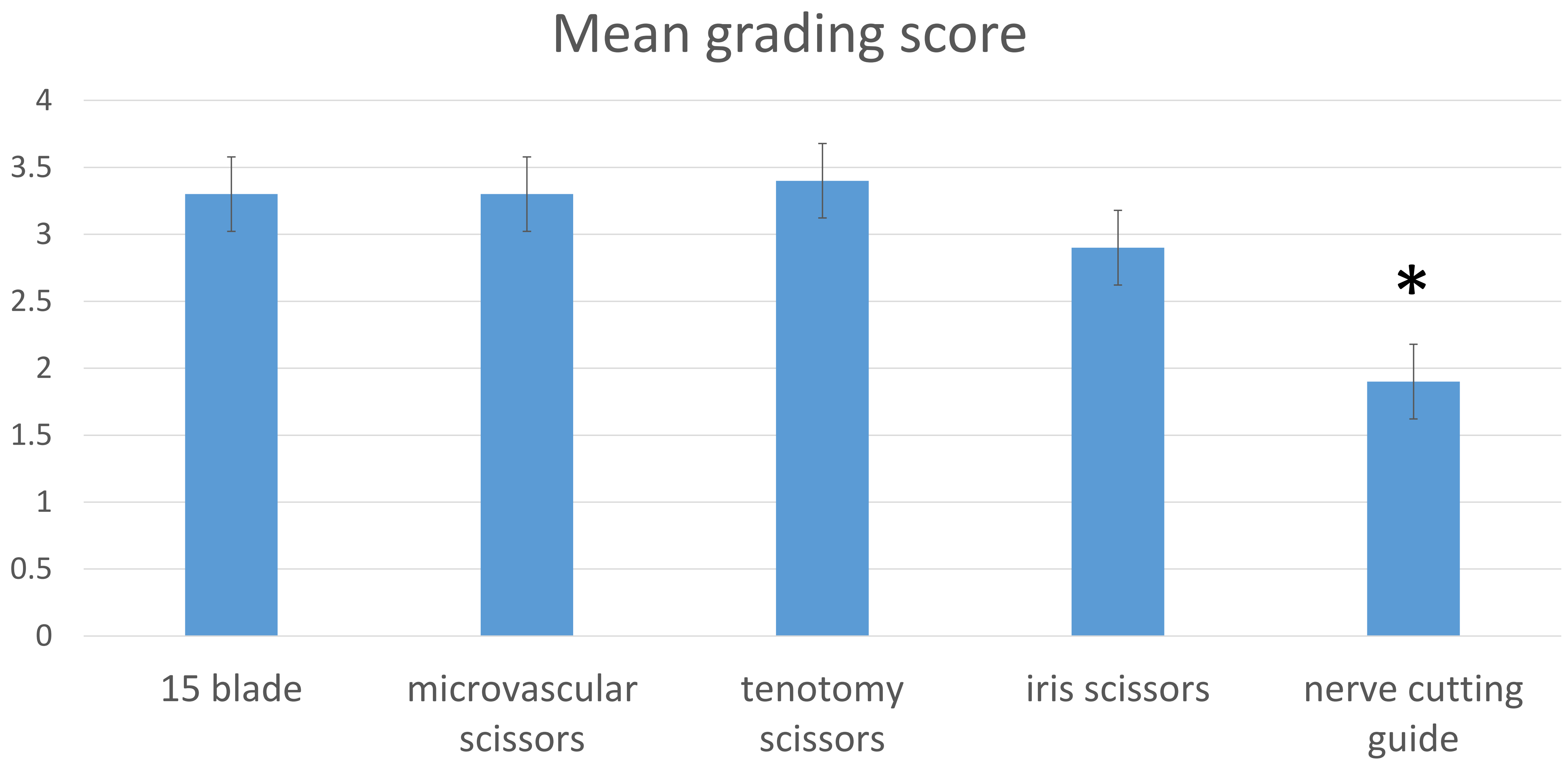

Figure 3. Mean grading score of prepared nerve endings deemed (1 – best, 5 worst) for each nerve segment as graded by fellowship-trained hand surgeons for each instrument

Clinical applications

- Primary nerve repair
- Amputations
  - Decreased size/rate of painful neuroma formation?

Limitations

- Cadaveric study
  - Future research to focus on physiologic implications
  - Neuroma formation
  - Rate of successful nerve repair

- Single person making all cuts

Future Study

- Animal models
  - Evaluate physiologic implications

- Nerves of different sizes

Conclusions

- slotted, circumferential nerve cutting guide = "cleaner cut"
  - Worth the extra effort

- Further research will be needed to determine clinical relevance
  - primary nerve repair
  - neuroma formation in amputations

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Thank you

- Questions?