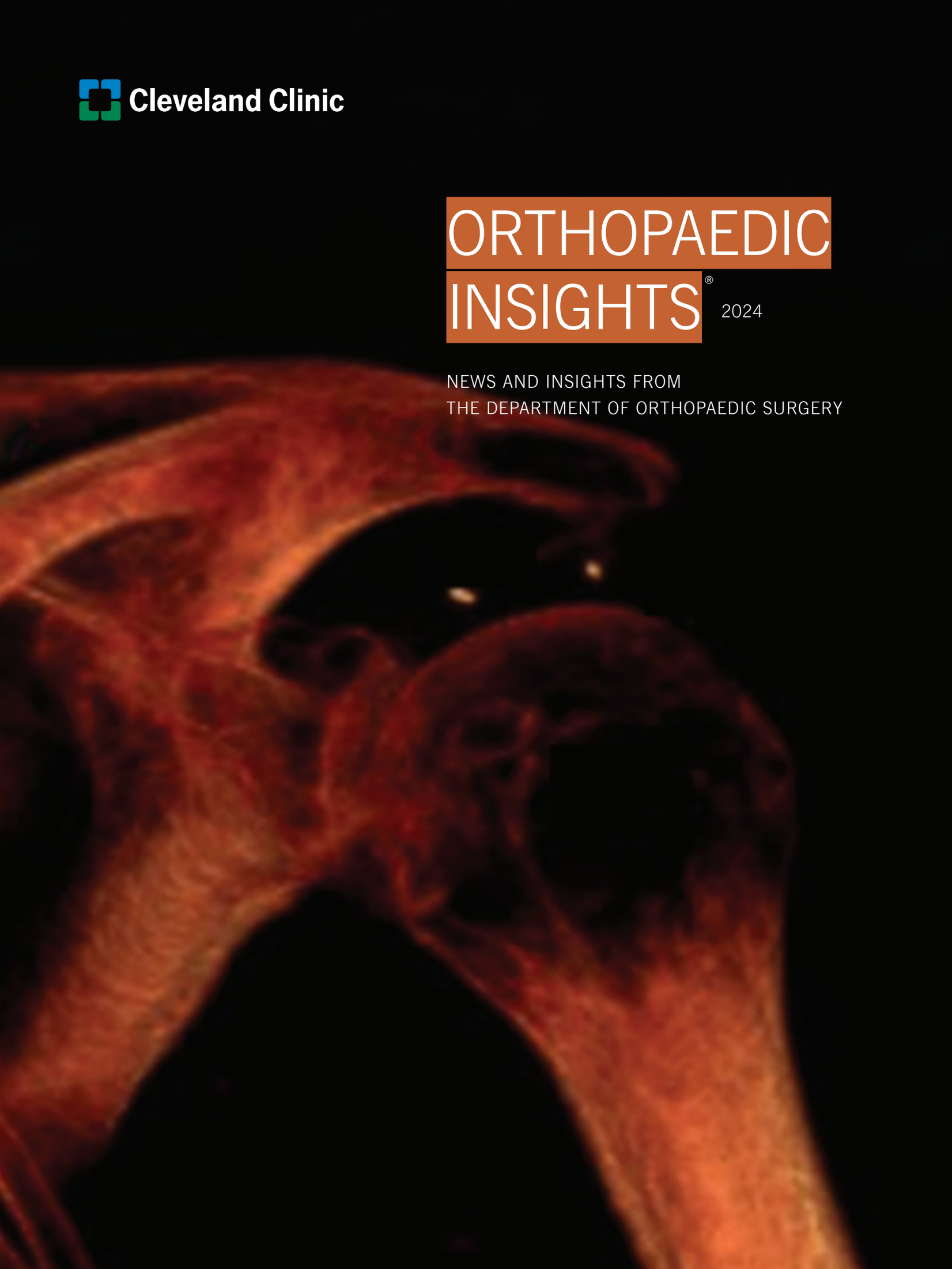
Cleveland Clinic

ORTHOPAEDIC INSIGHTS®

2024

NEWS AND INSIGHTS FROM
THE DEPARTMENT OF ORTHOPAEDIC SURGERY



Dear Colleagues,

One of the distinct privileges of delivering care at a quaternary medical center is witnessing new and exciting treatments for rare (and often unique) conditions. Not a week goes by without the arrival of a patient with a one-off condition requiring novel care by Cleveland Clinic's Department of Orthopaedic Surgery. Perhaps even more gratifying, however, is the standardization of care across our health system and our tremendous focus on quality and high reliability for patients with more routine conditions.

In this issue of *Orthopaedic Insights*, we highlight both. Articles feature our leading-edge approaches to treating patients with:

- **Congenital thumb hypoplasia**, including the latest concepts in surgically creating a functional opposable thumb (p. 3)
- **Knee osteoarthritis**, including how up to 50% of patients could be candidates for unicompartmental knee arthroplasty (p. 7)
- **Lower extremity nonunion** secondary to trauma, including how limb salvage can be a viable treatment alternative to amputation or arthroplasty (p. 9)
- **Rotator cuff disease**, including advances in assessing healing after rotator cuff repair (p. 12)

We also include a shoutout to our adult reconstruction group for its 10,000th robotic-assisted total joint replacement. We are in the midst of a sea change in orthopaedic surgery, with the integration of advanced technologies in navigation and augmented reality. This integration embodies our team's pioneering spirit and displays our ability to bring innovation to the bedside.

As always, we welcome collaboration with you and your practice. If we can support the care of your patients, please contact us.

Sincerely,

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ORTHOPAEDIC INSIGHTS | 2024

Orthopaedic Insights is published by Cleveland Clinic's Department of Orthopaedic Surgery to inform musculoskeletal specialists about advances in diagnosis, medical and surgical management, and research.

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Pollicization or Reconstruction?
Managing Congenital Thumb Hypoplasia

LATEST CONCEPTS IN THE SURGICAL CREATION OF FUNCTIONAL OPPOSABLE THUMBS IN EARLY CHILDHOOD

There are a multiplicity of congenital conditions resulting in hypoplasia or absence of a child's thumb. These include:

- Symbrachydactyly, hypoplasia with webbed interconnection of the digits
- Cleft hand, with a variety of presentations including a split in the hand, fused metacarpals, transverse phalanges, underdeveloped digits or central polydactyly
- Duplicate (polydactylous) thumb
- Radial hypogenesis or agenesis, with underdevelopment of the radial side of the forearm, wrist, hand and thumb
- Isolated hypoplasia or aplasia of the thumb

Each of these conditions provides a challenge for developing thumb opposition and, therefore, functional prehension in the developing child. At Cleveland Clinic, decades of experience in managing the spectrum of these conditions have enabled us to develop multiple techniques to achieve prehensile hand function in patients requiring an opposable thumb or a thumb positioned in opposition to which other fingers can converge to grasp and pinch.

In all cases, the goal for opposed prehension is positioning a thumb pronated 90 degrees from the broad plane of the hand, palmarly abducted 45 degrees from the hand, and able to cross the midline of the palm with a wide and adequately deep first webspace. From this position, even a thumb acting as a rigid post can provide a very precise and sensate tip pinch and chuck pinch by bringing the ulnar digits to its distal end.

Ideally, however, the ability of the thumb to flex, extend, abduct and actively oppose can be achieved in many cases. Our experience has enabled us to develop techniques for reconstruction of thumbs previously believed to be unreconstructible. In those that are truly unreconstructible, we can convert a healthy index finger into a mobile, opposable, functional thumb through refinement of prior techniques of pollicization.

Modified Blauth classification

Determining the need for reconstruction versus pollicization is based partly on the modified Blauth classification system of congenital thumb hypoplasia.[1]

- Type I includes underdeveloped thumbs with slender metacarpals and two phalangeal skeletal components, flexor and extensor tendons, some thenar musculature, a narrow first webspace, and an incompetent metacarpophalangeal (MP) joint ulnar collateral ligament.
- Type II also has slender, underdeveloped metacarpals and two phalanges; narrowed webspace; incompetent MP joint ulnar collateral ligament; minimal thenar musculature; and incomplete extrinsic flexor and extensor function.
- Type III has an incomplete thumb metacarpal, usually no extrinsic muscle and tendon function, narrowed webspace, an incompetent MP joint ulnar collateral ligament, and no thenar musculature. These conditions are subcategorized as type IIIA (with more than half of the metacarpal), type IIIB (with approximately half the metacarpal) and type IIIC (with only the metacarpal head and neck). We have found that type III conditions are reconstructible if there is healthy, broad skin connection with the hand. Those with only a small stalk of skin usually are not reconstructible.
- Type IV contains only phalangeal remnants with an extremely tight, narrow skin connection. These conditions have been called *pouce flottant* (floating thumb). The extremely narrow skin connection contains only a single artery, vein and rudimentary digital nerve. Type IV conditions are not reconstructible.
- Type V has a completely absent thumb. (Figure 1)

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Figure 1. Before and after pollicization to treat type V hypoplastic thumb.

Addressing parental concerns

Accepted surgical practice presumes that any attempt to reconstruct a type III hypoplastic thumb will be unsuccessful. As such, it has become the convention to amputate type III thumbs and proceed with pollicization, typically using the index finger.

Pollicization does have the advantage of being a single-stage surgery, although some cases require secondary opponensplasty. It offers a relatively fast and simple recovery by preserving the neurovascular bundles and tendons of the index finger as it becomes a thumb.

Nevertheless, it can be difficult for parents to choose pollicization, essentially prioritizing function over form. Amputating the hypoplastic thumb and performing a pollicization means the child will not have all 10 digits. Parents often seek a functional alternative. Therefore, we always present reconstruction and pollicization options during our consultations.

Reconstruction techniques

Creation of a functional, mobile, stable opposable thumb requires appropriate skeletal substance and support; stable carpometacarpal (CMC) and MP joints; flexion, extension, abduction and opposition motors; appropriate thumb positioning; and an adequately wide and deep first webspace.

In types I and II conditions, this will require stabilization of the MP joint through augmentation of the ulnar collateral ligament with suture imbrication of the capsule and either an abductor digiti minimi (ADM) (Huber) or flexor digitorum superficialis (FDS) opponensplasty through an ulnar sling. In these cases, usually there is existing extrinsic flexor and extensor function.

Type III conditions usually require the transfer of bone. At Cleveland Clinic, we have been highly successful in transferring one or two autologous second-toe proximal phalanges, harvested extraperiosteally, to create a metacarpal as well as a carpal receptacle/capsular pouch to create a CMC joint. The joint is sutured around the base of the most proximal transferred toe phalanx. All physeal plates are preserved with their periosteal sheath.

At the same time, a Z-plasty widening and deepening of the first webspace is performed to position the new thumb anatomically. Through the Z-plasty incision, a capsulorrhaphy/collateral ligament imbrication is performed.

These reconstructions are held with one or two fine K-wires and appropriate thumb position in a long arm cast for six weeks. At that point, the cast and K-wires are removed, and a soft splint is fabricated from foam material and used for support for another month.

Six months after the initial surgery, secondary surgery is performed, which generally includes Huber opponensplasty, transfer of the ring superficialis flexor tendon for flexor pollicis longus function, and transfer of the extensor indicis proprius tendon for extensor pollicis longus function (Figure 2).

Long-term follow-up has demonstrated remarkable functional outcomes in these patients, with continued growth.

Indications and techniques for pollicization

Although pollicization has been accepted as a treatment of choice for most forms of thumb hypoplasia, it certainly is a reasonable option for patients with types IV and V conditions.

The presence of a stable CMC joint is also a determining factor. A hypoplastic thumb without a stable CMC joint is better treated with pollicization versus reconstruction. In addition to the technical skill of the surgeon, the success of the pollicized digit depends on whether the index finger is supple and whether the thumb hypoplasia is in isolation or part of an absent radius.

At Cleveland Clinic, we have used combinations of techniques to best position the new thumb; provide healthy, minimally scarred first webspace through broad full-thickness flaps of skin and subcutaneous tissue; and shorten the metacarpal with ablation of the physeal plate at the neck of the metacarpal to prevent overgrowth. The metacarpal head acts as a trapezium, allowing the three phalanges of the index finger to replicate the metacarpal and two phalanges of the thumb. Advancement and tensioning of flexor tendons of the index and its extensor tendons provide the needed flexion, extension, opposition and abduction (Figure 3).

Temporary stabilization is provided by suture and K-wire fixation. Again, long arm cast immobilization is recommended for six weeks followed by one month of foam splint protection. Functional use of the hand proceeds with occupational therapy.

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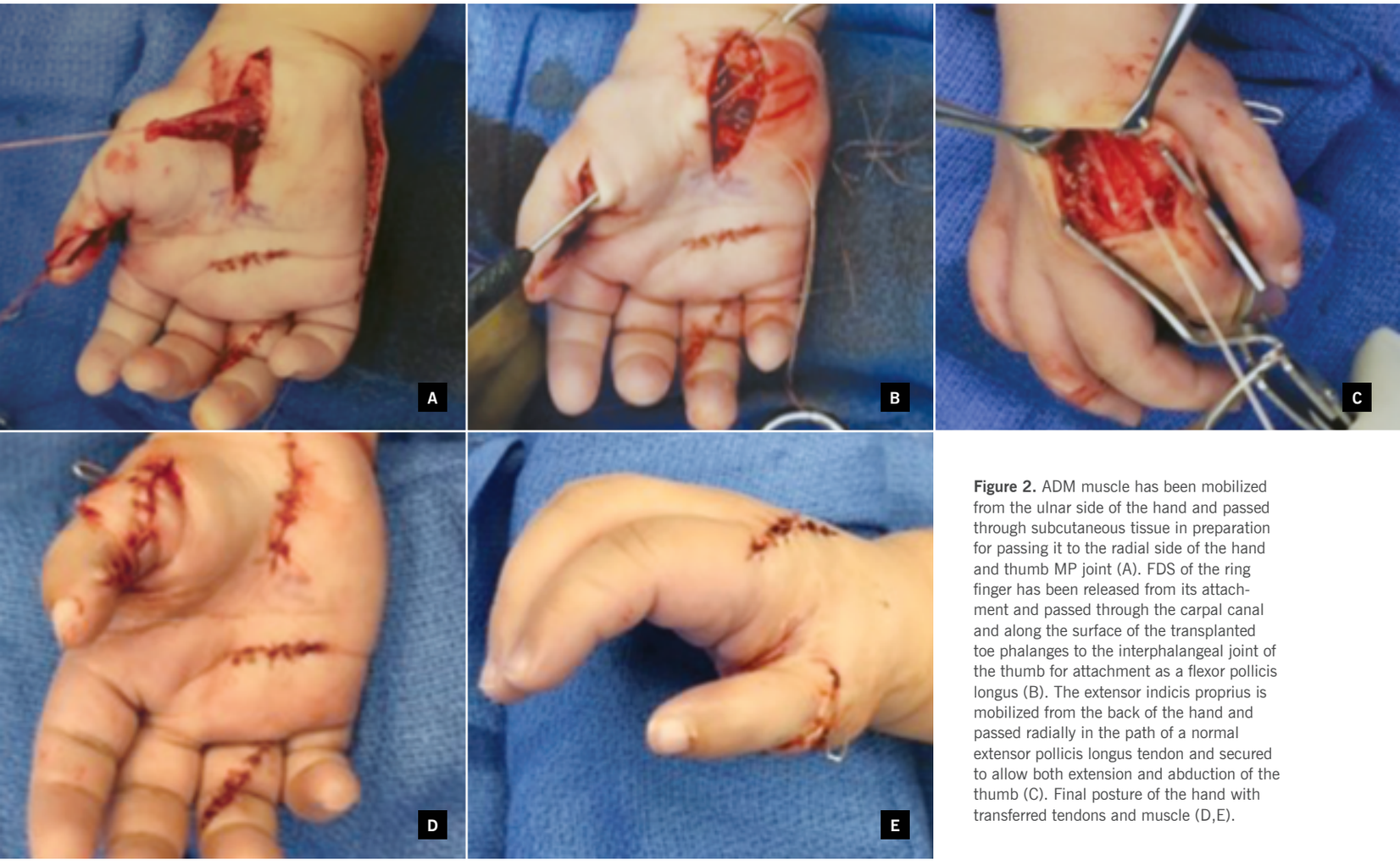

Figure 2. ADM muscle has been mobilized from the ulnar side of the hand and passed through subcutaneous tissue in preparation for passing it to the radial side of the hand and thumb MP joint (A). FDS of the ring finger has been released from its attachment and passed through the carpal canal and along the surface of the transplanted toe phalanges to the interphalangeal joint of the thumb for attachment as a flexor pollicis longus (B). The extensor indicis proprius is mobilized from the back of the hand and passed radially in the path of a normal extensor pollicis longus tendon and secured to allow both extension and abduction of the thumb (C). Final posture of the hand with transferred tendons and muscle (D,E).

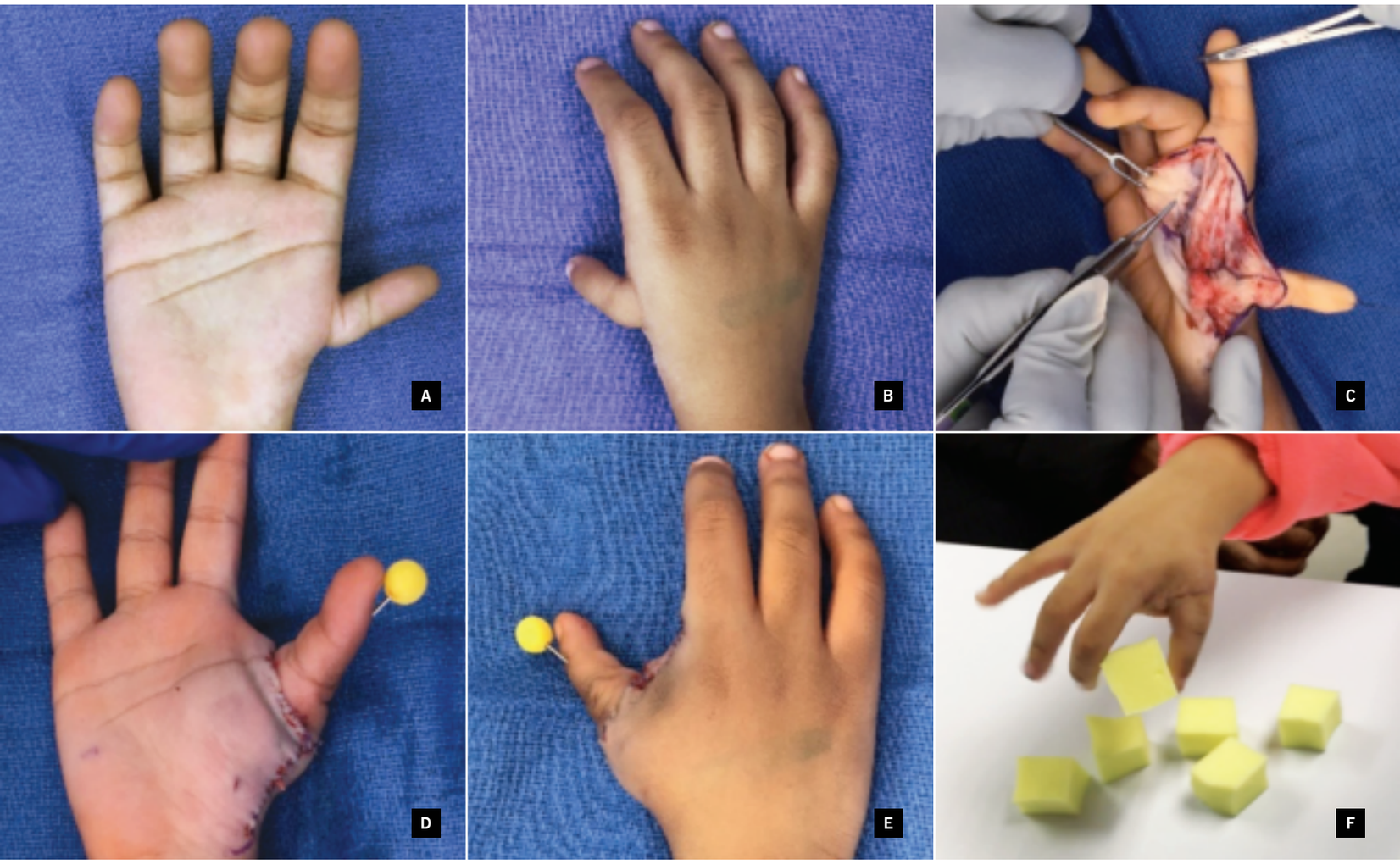

Figure 3. Volar and dorsal views of a right hand with type IIIB hypoplastic thumb (A,B). Intraoperative view of the neurovascular structures dissected (C). Volar and dorsal views of the hand after pollicization (D,E). Six weeks after pollicization, the patient uses the hand to manipulate foam blocks with fine pinch (F).

Surgery in children as young as six months

Precise timing for the initiation of surgical intervention in thumb hypoplasia has been debated. However, with our extensive congenital hand reconstruction experience, we have found that the earlier we can safely begin intervention, the more readily the child incorporates their new hand function into everyday activities.

We must remember that hands are the "antennae" of the developing child. Children use their hands to explore their universe and manipulate objects. As they demonstrate developmental milestones, the brain's cerebral cortex develops an image of the hand and thumb and incorporates experiences into enhancing hand function.

We have found that commencing reconstruction of thumb function is most effective as early in development as possible. Ideally, this includes assessment shortly after birth, with the first stages of surgery as early as six months following full gestation. As surgical intervention may require more than one stage, our goal is to provide a child with a functional thumb before they begin preschool.

For the full article, including more photos, postoperative videos and complete references, see clevelandclinic.org/thumbhypoplasia.

Drs. Styron and Seitz are hand and upper extremity surgeons in the Department of Orthopaedic Surgery at Cleveland Clinic.

Reference

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Unicompartmental Knee Arthroplasty Could Be Right for 50% of Patients With Osteoarthritis

WHEN PROCEDURE IS PERFORMED BY HIGH-VOLUME SURGEONS, OUTCOMES ARE COMPARABLE OR SUPERIOR TO TOTAL KNEE REPLACEMENT

Prevalence of knee osteoarthritis is high and rising among U.S. adults, with demand for knee arthroplasty estimated to increase 600% by 2030.[1] According to one study, 85% of cases present with isolated single-compartment degeneration, most commonly in the medial compartment.[2]

An alternative to total knee arthroplasty (TKA), unicompartmental knee arthroplasty (UKA) can preserve some ligaments and bone in patients with isolated single-compartment end-stage osteoarthritis. However, while an estimated 45%-50% of patients with knee osteoarthritis could be candidates for UKA, it is pursued in only 5%-8% of cases.[2]

Low adoption of UKA is attributed primarily to the long learning curve for surgeons as well as registry data that show high revision rates of UKA compared with TKA.[3,4] However, recent data challenge conventional concerns and show that UKA is a safe and effective procedure that may be a better option for many patients.

Short- and long-term benefits

UKA is less invasive than TKA and spares noninvolved ligaments and bone. The approach requires limited exposure and no dislocation of the knee joint, which results in significantly less soft-tissue damage (Figure 1). Operative time is shorter, blood loss is reduced and hospital stays are decreased compared with TKA.

In the immediate postoperative period, patients achieve greater range of motion and a higher overall level of activity. In the longer term, UKA offers significantly higher rates of forgettable joints due to preservation of knee kinematics, preservation of bone stock and overall lower morbidity.[2]

Indications have expanded

Patient selection is considered crucial for long-term success of UKA. Conventionally, indications for UKA have been narrow, with the ideal patient being younger than age 60 and weighing less than 180 pounds, with isolated medial, lateral or patellofemoral osteoarthritis or osteonecrosis; correctable angular deformity less than 15 degrees; flexion contracture less than 5 degrees; and range of motion greater than 90 degrees. Patients have been considered nonideal if they have a high level of activity, exposed bone in the patellofemoral compartment, anterior knee pain, chondrocalcinosis, osteophytes in the opposite compartment, inflammatory arthritis or anterior cruciate ligament (ACL) insufficiency.

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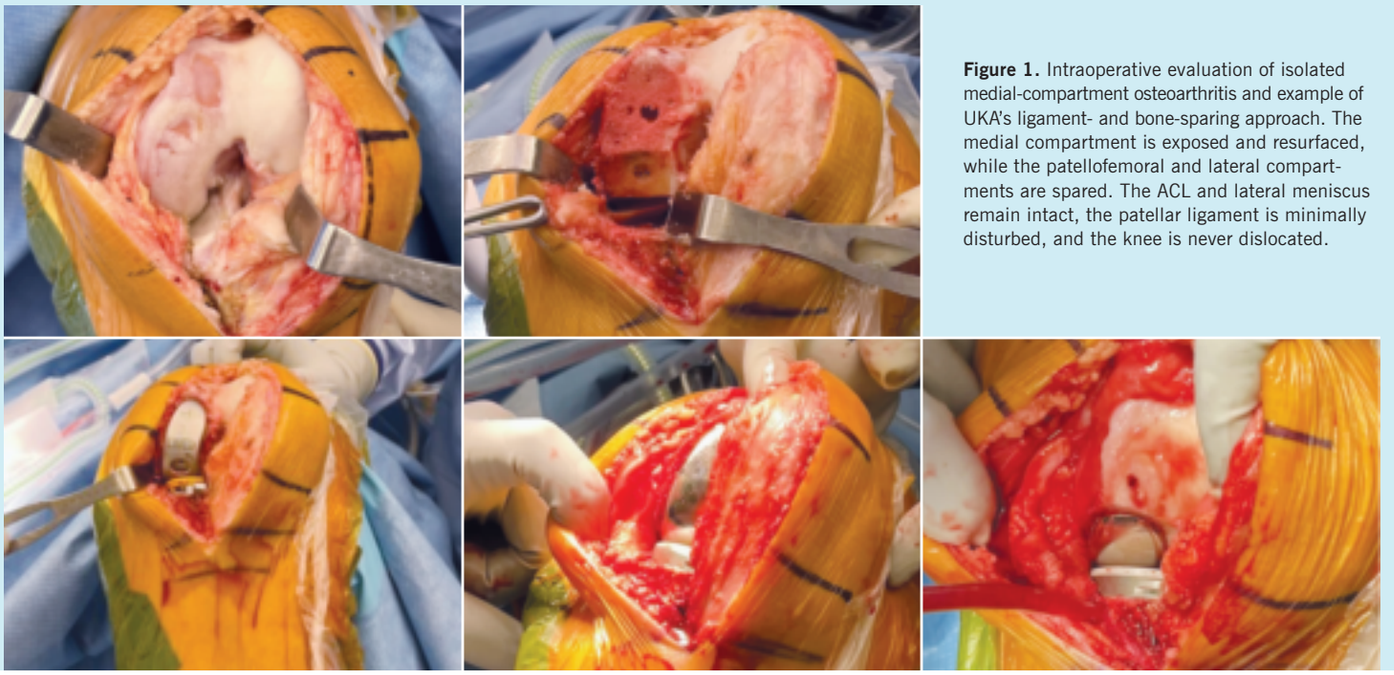

Figure 1. Intraoperative evaluation of isolated medial-compartment osteoarthritis and example of UKA's ligament- and bone-sparing approach. The medial compartment is exposed and resurfaced, while the patellofemoral and lateral compartments are spared. The ACL and lateral meniscus remain intact, the patellar ligament is minimally disturbed, and the knee is never dislocated.

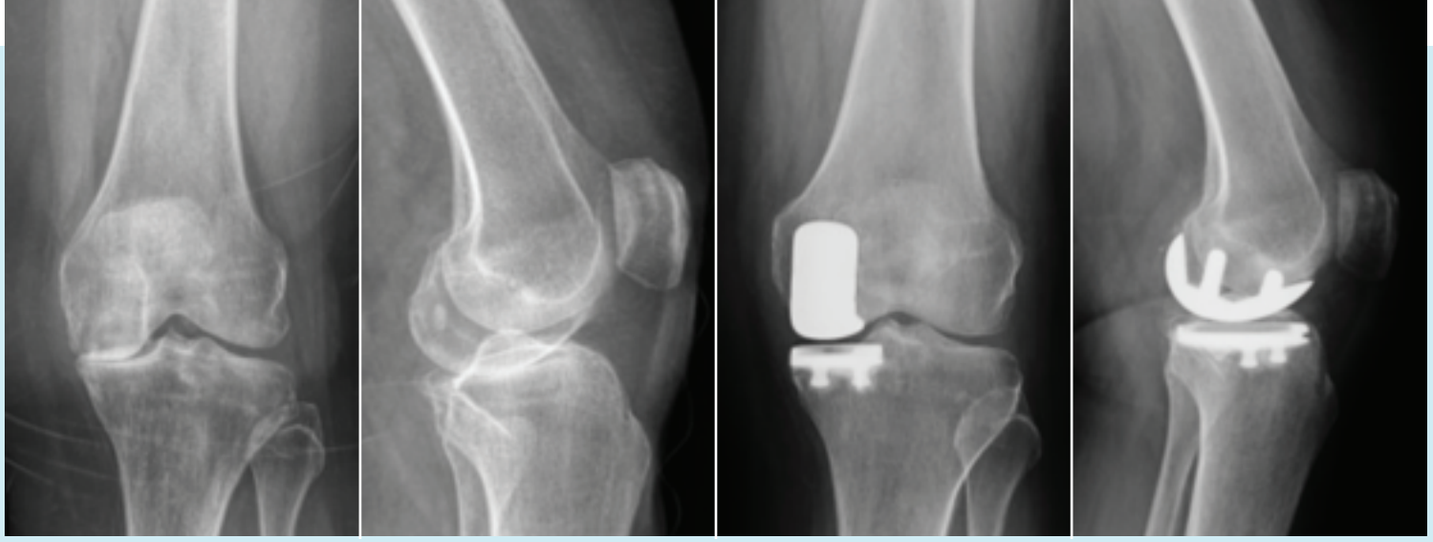

Figure 2. Radiographic evaluation of isolated medial-compartment osteoarthritis successfully treated with medial UKA.

CELEBRATING 10,000 ROBOTIC SURGERIES

Cleveland Clinic's Department of Orthopaedic Surgery recently completed its 10,000th robotic-assisted total joint replacement. Since 2016, Cleveland Clinic surgeons have been using robotic platforms to maximize precision and personalization in hip and knee arthroplasty.

"Robotics is here to stay," says Nicolas S. Piuzzi, MD, Director of Cleveland Clinic Adult Reconstruction Research. "It's not a trend or marketing tool. It's a new approach and surgical tool that allows us to do a high volume of procedures with both precision and efficient, reliable delivery."

However, these conservative criteria are poorly backed by evidence. Multiple recent studies report successful results in patients formerly considered suboptimal for UKA.[5]

Overall, UKA has become a valid option for the younger patient as an alternative to high tibial osteotomy, showing lower rates of complication and reoperation. UKA is also a valid option for older patients, who may not recover as readily from a more invasive TKA. UKA offers reduced operative time, blood loss and hospital stays and enables higher levels of activity at discharge.

Why UKA revision rates seem high

As previously noted, early registry data showed high revision rates in UKA compared with TKA — a statistic that is frequently quoted when deciding against UKA. However, these data need careful interpretation. More recent cohort studies from high-volume centers report survivability of the modern UKA as similar to TKA.[6]

There are a number of factors that may explain this difference:

1. The threshold to revise UKA is often lower than TKA, even when outcome scores are similar. Among patients with Oxford knee scores less than 20, only 12% of TKAs were revised compared with 63% of UKAs.[7]

2. UKA is more easily revised. UKA conversion to TKA is less technically challenging than TKA revision, generally requiring fewer revision components and techniques.

3. Patients conventionally considered ideal for UKA are younger and more active than TKA patients. Thus, UKA patients have a higher likelihood of lifetime revision simply due to longevity.

4. UKA revision rates are reportedly four times higher for low-volume surgeons compared with high-volume surgeons.[2] Volume is important because surgeons with UKA usage less than 5% have higher revision rates. Optimal outcomes in UKA are seen when surgeon usage is 40%-60%.

High-volume experience matters

For the appropriately indicated patient, UKA can be a more effective and less invasive surgical option than TKA. Modern implants and surgical techniques in the hands of high-volume surgeons result in outcomes comparable or superior to TKA.

Medial UKA (Figure 2) is the most commonly performed and best understood UKA procedure, but any compartment can be replaced. At Cleveland Clinic, we have performed single-stage bilateral patellofemoral UKA.

Overall, we have been able to report excellent short- and long-term outcomes, almost-universal same-day discharge, quick surgical recovery, a high level of activity at discharge, and a low rate of complications. While there is a risk of eventual conversion to TKA, our data agree with the latest cohort results, showing similar survivability between UKA and TKA.

Dr. Murray is staff in the Department of Orthopaedic Surgery and a high-volume unicompartmental knee arthroplasty surgeon. Dr. Ibaseta is a resident in the Department of Orthopaedic Surgery.

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Orthopaedic Traumatologists Rely on Limb Salvage in 3 Cases of Lower Extremity Nonunion

TRAUMA PATIENTS PRESENT WITH INFECTED PILON AND DISTAL FEMUR FRACTURES

When treating patients with a nonunion, the clinical question is whether it is best to perform a primary amputation or arthroplasty or to proceed with limb salvage. Limb salvage can involve treatment in a one- or two-stage procedure. Treatment is personalized, based on the patient's unique injury characteristics and shared decision-making between the surgeon and patient.

Here we present three cases in which the decision was made to proceed with limb salvage.

Case 1: Infected pilon nonunion

A 35-year-old female presented to our emergency department for severe left ankle pain after sustaining a left closed pilon fracture four weeks earlier. She initially had been treated at an outside hospital with external fixation followed by open reduction and internal fixation (ORIF) four days later. Her postoperative course was complicated by wound dehiscence with positive cultures for *Enterobacter*, which was treated with vacuum-assisted closure (wound vac) and intravenous antibiotics.

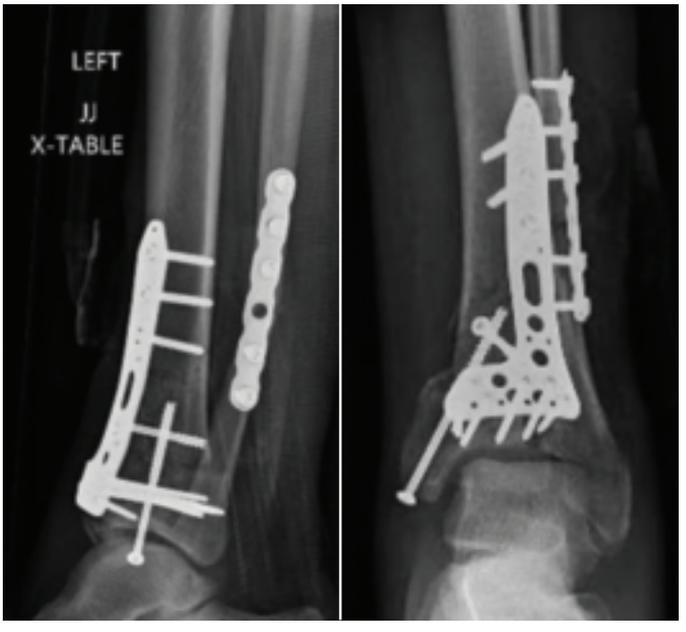

Figure 1. Radiographs demonstrate prior ORIF to the distal tibia with malreduction. Distal tibia intra-articular fracture demonstrates diastasis with medial column collapse and varus alignment of the ankle. Fibula demonstrates prior ORIF with apex posterior malreduction.

Figure 2. Clinical examination of the left ankle upon initial presentation to the emergency department. There is a 4.5 cm anterior pretibial wound with exposed anterior tibial tendon (A). Previous nylon suture is in place (B). There is a stage 1/2 pressure wound to the heel (C).

Radiographs of her ankle demonstrated malreduction and fracture gapping of the articular surface (Figure 1). Physical exam revealed a 4.5 cm anterior pretibial wound with serosanguinous drainage and exposed anterior tibial tendon and hardware (Figure 2). Additionally, the patient had a stage 1/2 pressure wound to her heel.

Reconstruction commenced with irrigation and debridement, removal of hardware, and application of a uniplanar external fixator with wound vac. She underwent serial debridements. She then had a repeat ORIF (Figure 3) and synthetic bone graft with gentamycin once the wound bed was clean, followed by an anterolateral thigh (ALT) free flap by plastic surgery to cover the pretibial wound.

Postoperatively, her fracture and free flap healed with no concern for continued infection.

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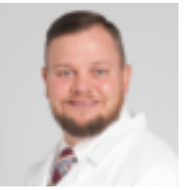

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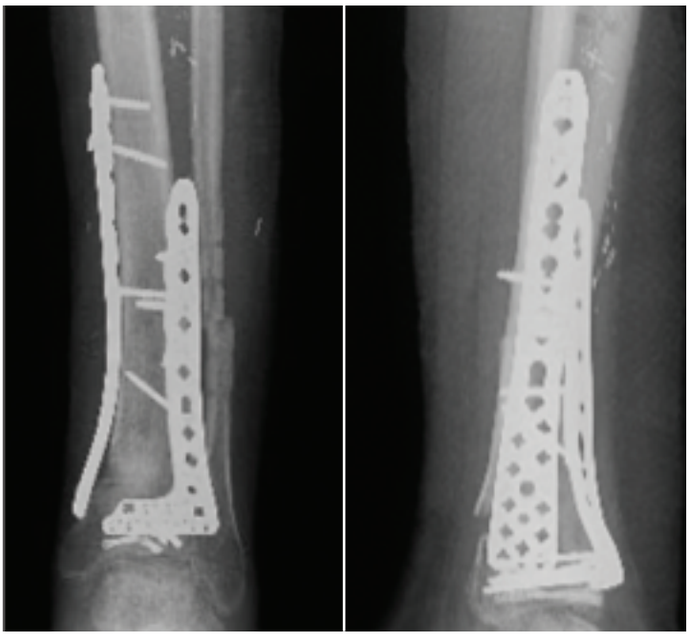

Figure 3. Three-month postoperative radiographs demonstrate callus, neutral alignment and intact hardware to the tibia. Vascular clips present.

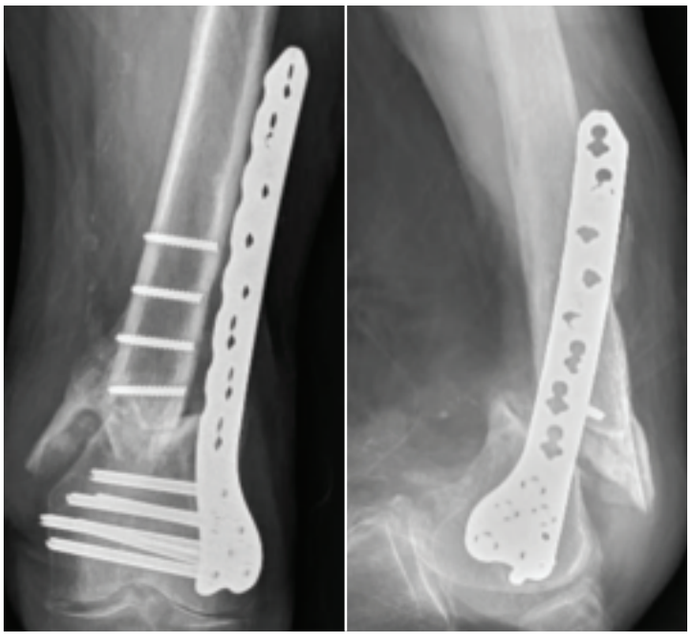

Figure 4. Preoperative radiographs of the left distal femur demonstrate a supracondylar nonunion with flexion and valgus alignment. There is failure of a lateral distal femur locking plate with multiple broken screws proximal to the fracture site. Chondrocalcinosis of the knee with joint space narrowing is evident.

Case 2: Distal femur nonunion

A 70-year-old female with a medical history of smoking, deep vein thrombosis, chronic obstructive pulmonary disease, stage 3 chronic kidney disease and rheumatoid arthritis presented to our clinic for evaluation of continued pain and ambulatory dysfunction of her left lower extremity. After a left distal femur fracture, she had been treated at an outside hospital with a distal femoral locking plate. Her postoperative course was complicated by nonunion with hardware failure (Figure 4). She was treated with a bone stimulator and knee brace.

In our office, the patient stated that she could ambulate short distances with a walker but mostly used a wheelchair. On exam, her surgical incisions were well healed. The range of motion of her knee was 0-90 degrees of flexion with gross motion at the fracture site. Surgical intervention was recommended as the fracture was unlikely to heal due to instability at the fracture site.

The patient was taken to the operating room, where the previous hardware was removed, the nonunion site was debrided, the fracture was reduced and a retrograde femoral nail was placed. Bone graft was applied to the fracture site from the left femur using a reamer-irrigator-aspirator (RIA) system.

Postoperatively, the fracture healed with maintained alignment (Figure 5). At her last clinic appointment, the patient was pain-free and ambulating with a walker.

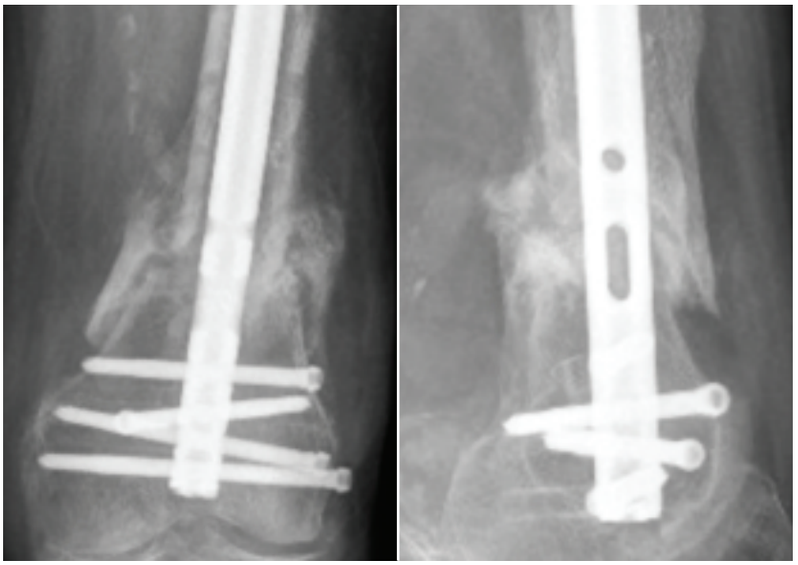

Figure 5. Postoperative radiographs of the left distal femur demonstrate abundant callus of the left distal femur fracture with near anatomic alignment. Hardware is intact, without evidence of loosening or breakage.

Case 3: Distal femur nonunion with leg length discrepancy

A 32-year-old female presented to our office with a history of polytrauma. She had been hit by a motor vehicle and had sustained a right open distal femur fracture (grade 3A), right patella fracture, left closed midshaft femur fracture and bilateral distal radius fractures. Her right femur was treated at an outside hospital with a retrograde femoral nail and a two-stage Masquelet procedure to address a large bone void.

The patient presented to our office for continued right distal thigh pain, ambulatory dysfunction and a limb length discrepancy of 3 cm. Radiographs demonstrated an 8 cm bone void with nonunion (Figure 6).

Preoperative surgical planning commenced, and it was decided that a custom synthetic graft cage would be created to add 2 cm of length to her right lower extremity.

The patient was taken to the operating room, where the previous retrograde nail was removed, an osteotomy was created, and the femur was lengthened acutely using a femoral distractor. Bone graft was harvested from the femur and ipsilateral tibia by RIA. A new retrograde nail with a side plate was implanted into the femur. The bone graft was mixed with synthetic bone graft and impacted into the custom cage, which was inserted into the femur and secured with screws.

Postoperatively, the patient had two distal interlocking screws that loosened and became prominent. As a result, she had a subsequent surgery to remove the prominent screws. The patient progressed to full weight-bearing, and her last radiographs demonstrated maintained alignment with incorporation of the bone graft with bone bridging (Figure 7).

Takeaway points

These three cases demonstrate that nonunions can cause severe dysfunction and pain.

Limb salvage is a viable option for certain patients, helping them return to function by preserving their native extremity.

Drs. Billow, Cereijo and Padubidri are orthopaedic traumatologists at Cleveland Clinic. Dr. Peirish is a trainee in Cleveland Clinic's orthopaedic residency program.

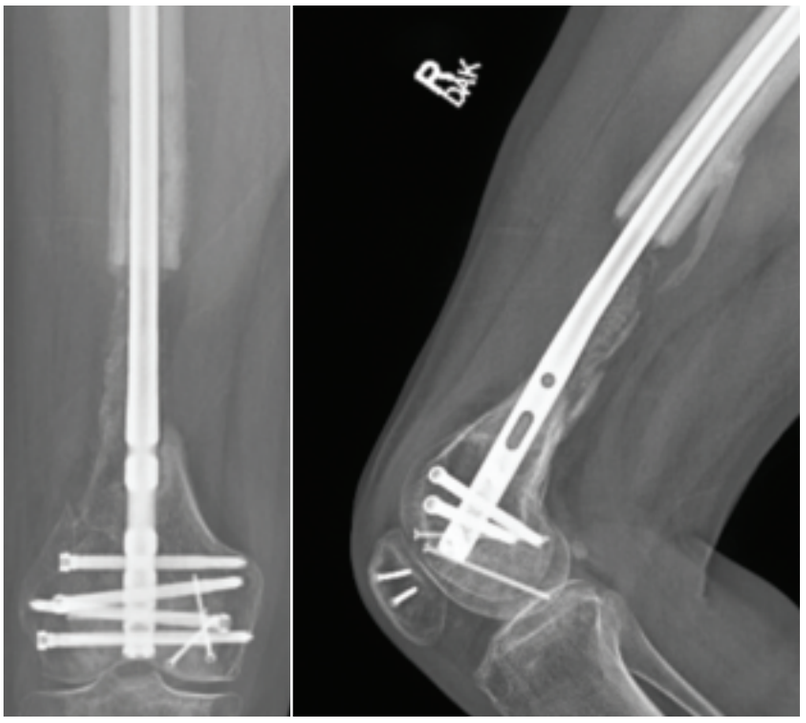

Figure 6. Preoperative radiographs of the right femur demonstrate retrograde femoral nail with 8 cm bone void and intact hardware to the patella.

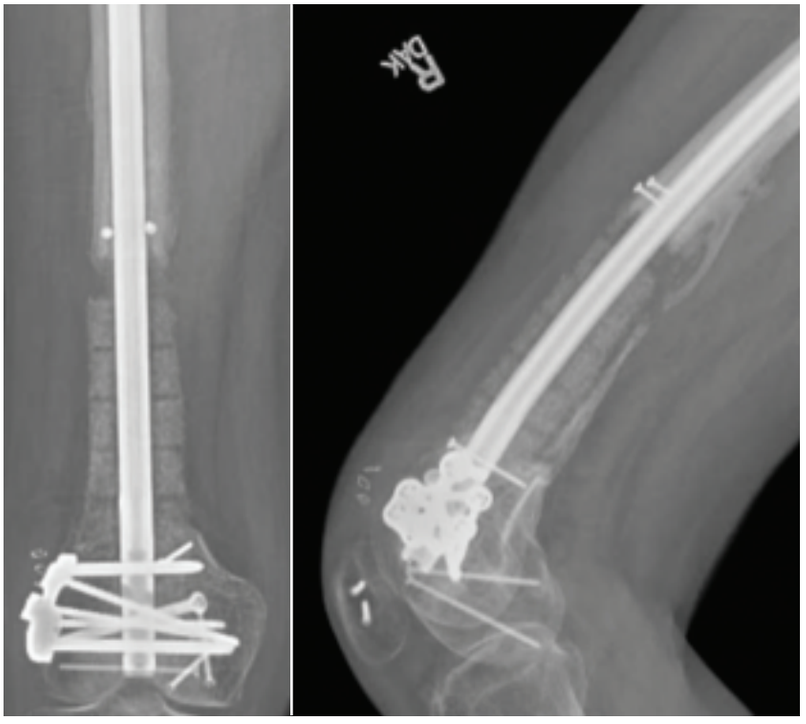

Figure 7. Postoperative radiographs of the right femur demonstrate maintained alignment with retrograde femoral nail and distal femoral side plate. Bone graft is present with bone bridging.

Tendon Retraction Indicates 'Failure With Continuity' Is Common After Rotator Cuff Repair

CT IMAGING USING RADIOPAQUE MARKERS CAN HELP ASSESS HEALING AFTER SURGERY

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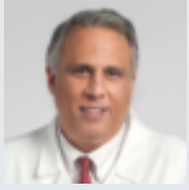

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More than half of people age 70 and older exhibit rotator cuff disease, and at least 1 in 20 Americans has rotator cuff repair (RCR) surgery by age 65. Over 250,000 RCRs are performed annually in the U.S., at an estimated $3 billion in medical costs. Reports of ultrasound- and MRI-assessed structural outcomes show that 20%-70% of RCRs fail by re-tearing, typically within six months of surgery.

Paradoxically, patients believed to have an intact repair sometimes demonstrate persistent or even progressive degenerative muscle changes and shoulder weakness. We postulate that the weak relationships between current measures of structural integrity of the repair and such clinical outcomes are due to an imprecise understanding of tendon healing. This imprecise understanding limits advances in treatment and rehabilitation strategies aimed to improve healing and outcomes.

Therefore, the objective of our research is to challenge and expand the current definition of rotator cuff healing by investigating tendon retraction — broadly defined as translation of the repaired tendon away from the bone with or without a recurrent defect — as a common and clinically predictive structural outcome following RCR.

Seeking a more precise measure of tendon healing

Currently, rotator cuff healing following RCR is defined on postoperative MRI or ultrasound as "intact," "attenuated," "partially re-torn" or "failed" based on signal abnormalities and the observation of a recurrent defect. Yet clinical imaging modalities are inadequate to discern the extent to which the repaired tendon has "failed with continuity" (undergone significant retraction in the absence of a recurrent defect).

To address the need for more objective and precise measures of tendon healing, we have developed a method using CT imaging of radiopaque markers to monitor tendon retraction in patients.[1,2] We have shown that tendon retraction of more than 5 mm can be considered meaningful above the usual range of measurement variation.[3]

Measurements of tendon retraction allow us to investigate the clinical implications of translation of the repaired tendon away from the bone with or without a recurrent defect. We hypothesize that "failure with continuity" is a common yet unrecognized structural phenomenon of rotator cuff healing that is significantly and meaningfully correlated with clinical outcomes.

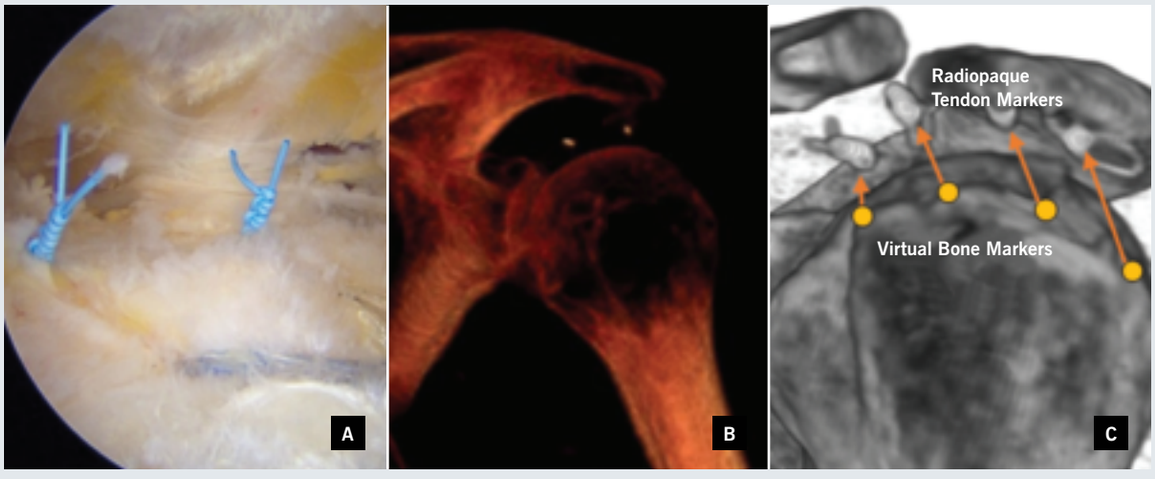

Figure 1. Intraoperatively, radiopaque tissue markers were tied to the superficial surface of the repaired tendon just medial to the repair site (A). Each patient had a low-dose CT imaging study on the day of surgery (B) to establish the baseline distance between the markers and the humeral greater tuberosity. After volumetric registration of the humerus to its position on day of surgery, tendon retraction was quantified at each postoperative time by measuring the change in distance from the radiopaque markers to virtual markers on the humeral greater tuberosity (C) and taking the mean over each patient's markers. The CT image on the right originally appeared in *JSES International* and is licensed by Creative Commons CC-BY-NC-ND.[3]

Tendon retraction in patients following rotator cuff repair

To investigate tendon retraction after RCR and its relationship with postoperative repair integrity and shoulder function, we enrolled 117 patients undergoing primary, arthroscopic double-row (or double-row equivalent) repair of the supraspinatus and/or infraspinatus tendons into a prospective cohort study. All surgeries were performed by one of seven Cleveland Clinic shoulder surgeons between 2016 and 2021.

At the time of RCR, one to four radiopaque markers were tied to the superficial surface of the repaired tendon(s) just medial to the repair site. Each patient had shoulder imaging preoperatively (MRI only), on the day of surgery (CT only), and three, six, 12 and 24 months after surgery (both). Tendon retraction was quantified at each postoperative time by measuring the change in distance from the radiopaque markers to the humeral greater tuberosity on CT images[1,2,4] and taking the mean over each patient's markers (Figure 1).

Two musculoskeletal radiologists blinded to the tendon retraction and clinical data assigned a Sugaya score of repair integrity to the MRI studies. Preoperatively and at each postoperative assessment, patients also completed patient reported outcome measures (PROMs) (Penn Shoulder Score, PSS) and were tested for isometric abduction strength (only postoperatively) and active range of motion (ROM) in the scapular plane.

Tendon retraction increased in all patients

Baseline demographics, tear characteristics and clinical assessment of the cohort are shown in Table 1. Of the 117 original patients, 113 completed two-year follow-up, at which time 19 (17%) had a full-thickness re-tear (Sugaya 4/5). Mean PSS (93 ± 10.9 points at two years), abduction strength (8 ± 4.1 lbf at six months; 12 ± 5.3 lbf at two years) and active abduction ROM (155 ± 18 degrees at two years) improved across the cohort postoperatively.

continued next page ›

Baseline demographics and tear characteristics (N = 117)	
Age	58.4 ± 8.4 years
Sex	F 44%, M 56%
BMI	30 ± 6
Race	White 86%, Black 11%
Anteroposterior tear size	2.2 ± 0.8 cm
Mediolateral tear size	1.2 ± 0.5 cm
PSS	42 ± 15.5 points
Active ROM	94 ± 43°

Table 1.

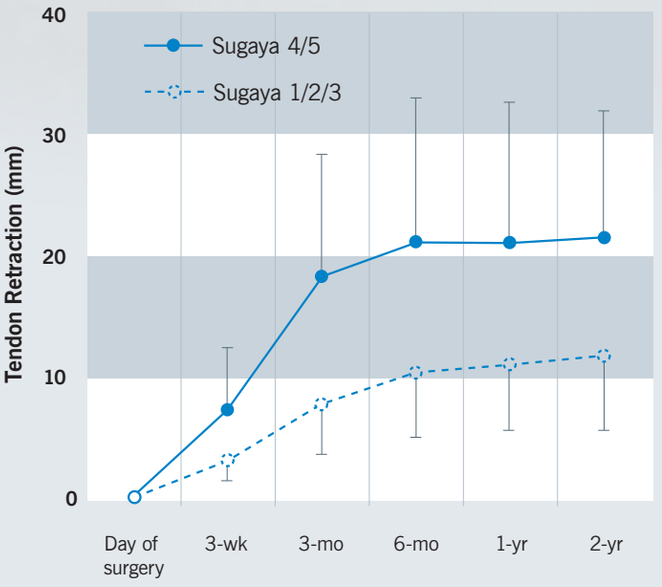

Figure 2. Mean tendon retraction in patients with Sugaya score 1/2/3 vs. 4/5 during two years after RCR.

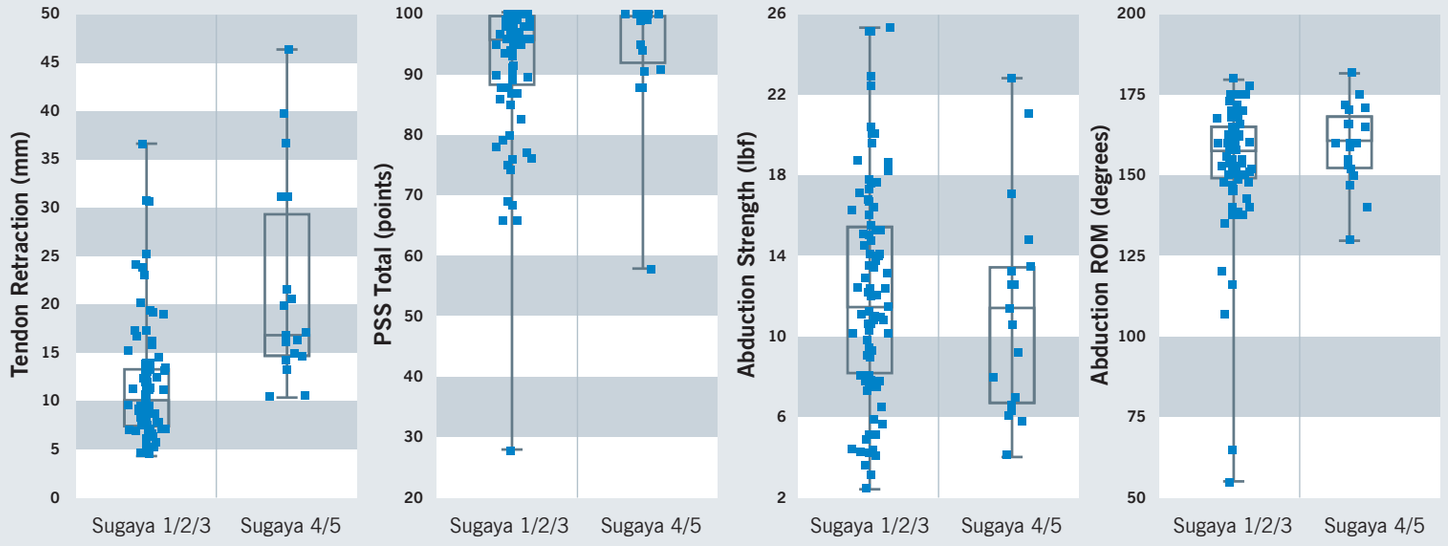

Figure 3. Individual patient tendon retraction, PSS total, shoulder abduction strength and range of motion at two years (N = 113) grouped according to Sugaya score (1/2/3: 83%; 4/5: 17%).

Tendon retraction increased in all patients after surgery, averaging 13.4 ± 7.9 mm at two years (range, 4.4-46.4 mm), with most retraction occurring by six months (Figure 2). Patients with a Sugaya 4/5 full-thickness re-tear averaged appreciably more tendon retraction at all postoperative times than those with an intact repair or partial-thickness re-tear (Sugaya 1/2/3) (Figures 2 and 3). However, 53% of patients with an intact repair or partial-thickness re-tear had mean tendon retraction greater than 10 mm at two years (Figure 3).

There was considerable overlap in PSS, abduction strength and ROM outcomes between patients with and without a full-thickness re-tear at two years (Figure 3).

More sensitive than standard clinical imaging assessments

Half of RCR patients with an intact repair or partial-thickness re-tear at two years had significant tendon retraction greater than 10 mm, suggesting that these patients have undergone some degree of "failure with continuity." At two years, patients with a full-thickness re-tear had overlapping distributions of PSS, shoulder abduction strength and ROM with patients with an intact repair or partial-thickness re-tear, but greater tendon retraction, suggesting that tendon retraction may provide more-sensitive information about repair integrity and postoperative shoulder function than do standard clinical imaging assessments.

Multivariable analysis to investigate relationships between RCR healing (by tendon retraction and/or Sugaya score) and PROMs, abduction strength and/or ROM is ongoing. We anticipate that incorporating post-operative tendon retraction as well as the integrity of the repaired tissue (via MRI) into the assessment of structural outcomes following RCR will yield an improved understanding of rotator cuff tendon healing as well as a novel quantitative metric to evaluate treatments aimed to improve healing.

Dr. Derwin is staff at Lerner Research Institute, Vice Chair of Biomedical Engineering and co-Director of the Musculoskeletal Research Center at Cleveland Clinic. Dr. Ricchetti is an orthopaedic surgeon and Center Director for Shoulder Surgery in the Department of Orthopaedic Surgery. Dr. Iannotti is an orthopaedic surgeon and Chief of Staff of Cleveland Clinic Florida. Other members of the Cleveland Clinic Shoulder Group include Mark Schickendantz, MD; Lutul Farrow, MD; Alfred Serna, MD; Vahid Entezari, MD; Jason Ho, MD; Carl Winalski, MD; Joshua Polster, MD; Sambit Sahoo, MD, PhD; Bong-Jae Jun, PhD; and Peter Imrey, PhD.

Disclosures

This work was funded by a grant from the National Institutes of Health (5R01AR0608342). Drs. Derwin, Iannotti and Sahoo are inventors with rights to royalties for the radiopaque tissue marker licensed to Viscus Biologics and used in this research.

For the full article, including complete references, see clevelandclinic.org/tendonretraction.

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Residency and Fellowship Update 2023

Mark Twain was so quotable that there are a lot of quips actually misattributed to him. My favorite apocryphal Twain is "Golf is a good walk, spoiled." But his quote on procrastination is genuine: "Never put off till tomorrow what may be done day after tomorrow just as well."

Takes one to know one.

Sometime around Memorial Day each year, the good editors of this fine publication ask if I might do a recap of the academic year. "Sure," I say cheerfully, "I can make that July 4 deadline!" As springtime blossoms into summer, so does summer ripen into autumn; Labor Day passes, and I am told my house will be egged at Halloween if I don't finish my article. Alas, now on the eve of the MLB playoffs, I am finally completing my assigned task as the printing presses are being inked.

I didn't procrastinate because it wasn't a good year. It was a great year, and our annual graduation festivities followed by dinner on a balmy June evening at the historic Union Club downtown were filled with laughter, mirth, poignant reflections, heartfelt thank-yous and teary goodbyes.

2023 graduates

Leaving the nest this year, as the graduating class of 2023, were William Zuke, MD; Andrew Swiergosz, MD; and Mike Erossy, MD, off to do adult reconstruction fellowships at Washington University, University of Louisville and New England Baptist Hospital, respectively. Anas "AJ" Minkara, MD, and Prashant Rajan, MD, chose spine surgery fellowships at Massachusetts General Hospital and Emory University, in that order; and Anton Khlopas, MD, secured a hand and upper extremity fellowship at the University of Florida.

Our orthopaedic brethren at Cleveland Clinic South Pointe Hospital enjoyed similar festivities as they bade farewell to their chief class of William Gaines Cumbie, DO, heading to an adult reconstructive surgery fellowship at Northside Hospital in Cumming, Georgia, and Bryan Demyan, DO, who is off to an orthopaedic trauma fellowship at OhioHealth Grant Medical Center. We wish them well and expect great things, as always.

Incoming residents

As these newly minted surgeons head to free agency, a new crop of rookies has arrived. Joining the show at Cleveland Clinic's main campus are Peter Delaney, MD, from the University of Michigan; Benjamin Gaal, MD, late of Case Western Reserve University; Theodore Rudic, MD, who is a product of the University of Virginia; Tariq Said, MD, a graduate of the University of Missouri-Kansas City; Karrington Seals, MD, also from Case Western Reserve University; and, from the University of Cincinnati, Yuta Umeda, MD.

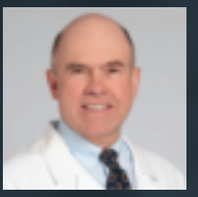
The class of 2028 at South Pointe Hospital includes Colin Baker, DO, from Kansas City University College of Osteopathic Medicine; Shaelyn O'Connor, DO, by way of Lake Erie College of Osteopathic Medicine; and Christos Zinis, DO, a graduate of the Idaho College of Osteopathic Medicine.

Fellows: Arriving and departing

I would be remiss if I left out the many fellows who spend a formative year in our department, interposed between completion of their residency and the rest of their lives. This year, we celebrated the graduation of 18 fellows as well as welcomed a new cohort of 18 across our specialty programs: adult reconstructive surgery, foot and ankle surgery, hand surgery, orthopaedic sports medicine, primary care sports medicine, and shoulder and elbow surgery.

We are justifiably proud of the many, many residents and fellows who list Cleveland Clinic on their curricula vitae as we are now in the eighth decade of training physicians in the orthopaedic arts. It is a very satisfying thing indeed. As Orthopaedic Surgery Chair Brendan Patterson, MD, said in his congratulatory remarks to our graduates this year, "Five years ago we embraced you as junior colleagues, and today we send you off as peers."

Medicine and the world continue to evolve at breakneck speed, and new technologies, materials and techniques give us the chance to help more people and do more for the conditions we encounter. Still, the surgical management of disease is not easy. So, let's call upon Mark Twain again to summarize with this maxim: "With courage you will dare to take risks, have the strength to be compassionate, and the wisdom to be humble. Courage is the foundation of integrity."



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