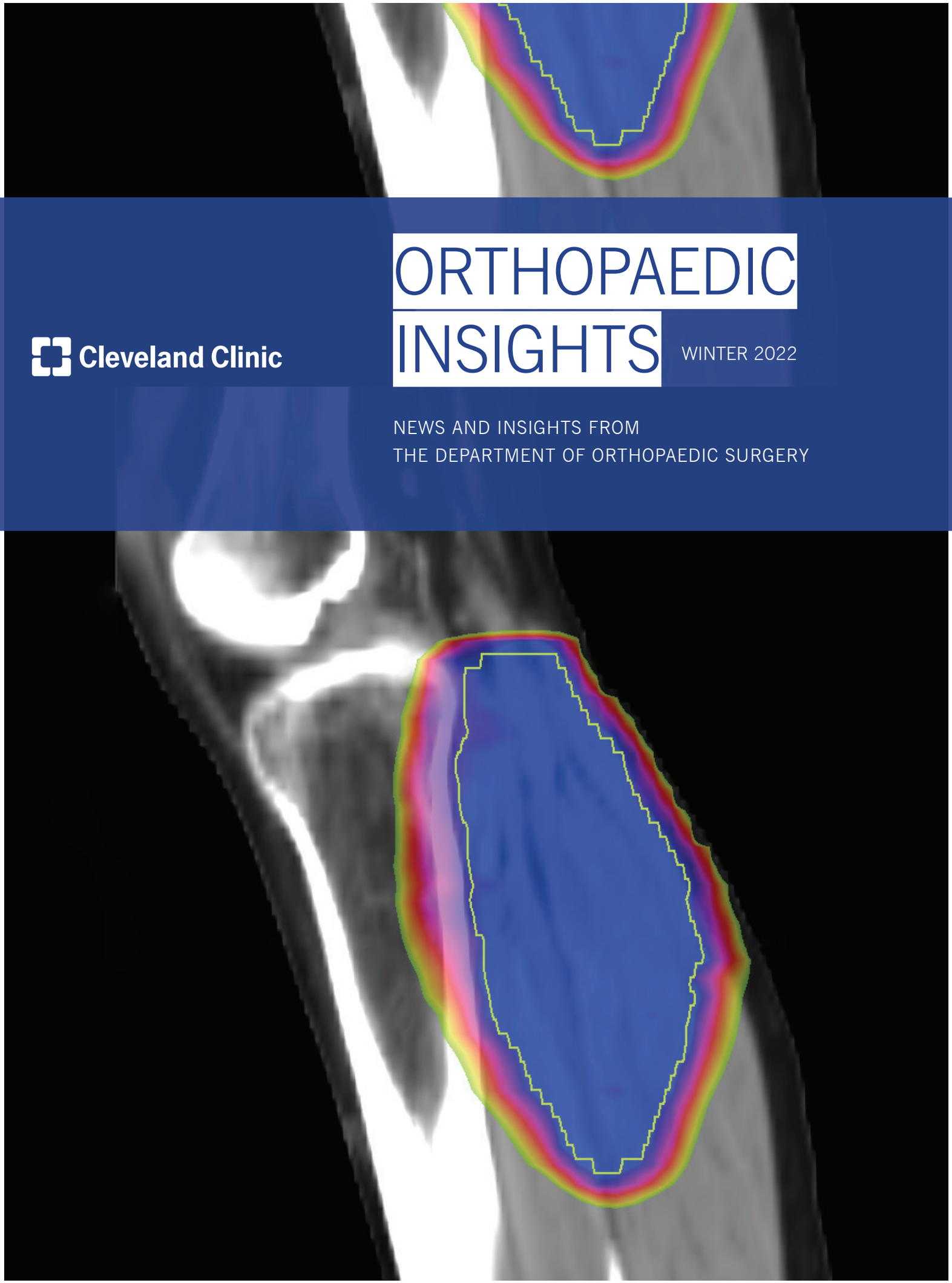


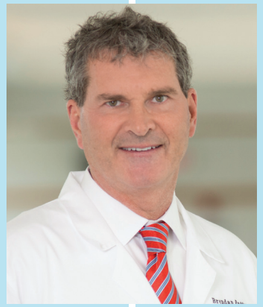
Cleveland Clinic

ORTHOPAEDIC INSIGHTS

WINTER 2022

NEWS AND INSIGHTS FROM
THE DEPARTMENT OF ORTHOPAEDIC SURGERY

DEAR COLLEAGUES



As experts in treating patients with bone and joint conditions, orthopaedic providers are a combination of caregiver, structural engineer and patient adviser. It's that third role that we focus on in this issue of *Orthopaedic Insights*.

Our staff in Cleveland Clinic's Department of Orthopaedic Surgery are regarded for their ability to educate and advise patients on the best treatment options — just as much as they are regarded for their skill in delivering treatment using innovative surgical and nonsurgical approaches. You'll read about our guidance and insight throughout these pages, in stories highlighting:

- Why to choose short-course radiation therapy instead of the conventional five weeks of radiation therapy for patients with soft tissue sarcoma (p. 3)
- The care of non-ruptured tendinopathies, including interventional orthopaedists' use of ultrasound to aid medical decision-making (p. 5)
- Limb-salvage surgery as an alternative to lower-extremity amputation in diabetic foot disease (p. 7)
- An MRI-based classification system to help guide decision-making when treating partial tears to the ulnar collateral ligament (p. 9)
- Cartilage injuries in children and how to select the most appropriate restorative surgical procedure, such as a cartilage allograft, matrix-associated autologous chondrocyte implantation or osteochondral autograft transplantation (p. 11)
- Open reduction and internal fixation (ORIF) versus revision arthroplasty for complex periprosthetic humerus fractures (p. 13)

When it comes to making the best treatment decisions for your patients, please contact us for consults or referrals. We look forward to working with you and your practice to provide the best care for your patients.

Respectfully,

BRENDAN M. PATTERSON, MD

Chairman, Orthopaedic Surgery

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ORTHOPAEDIC INSIGHTS | WINTER 2022

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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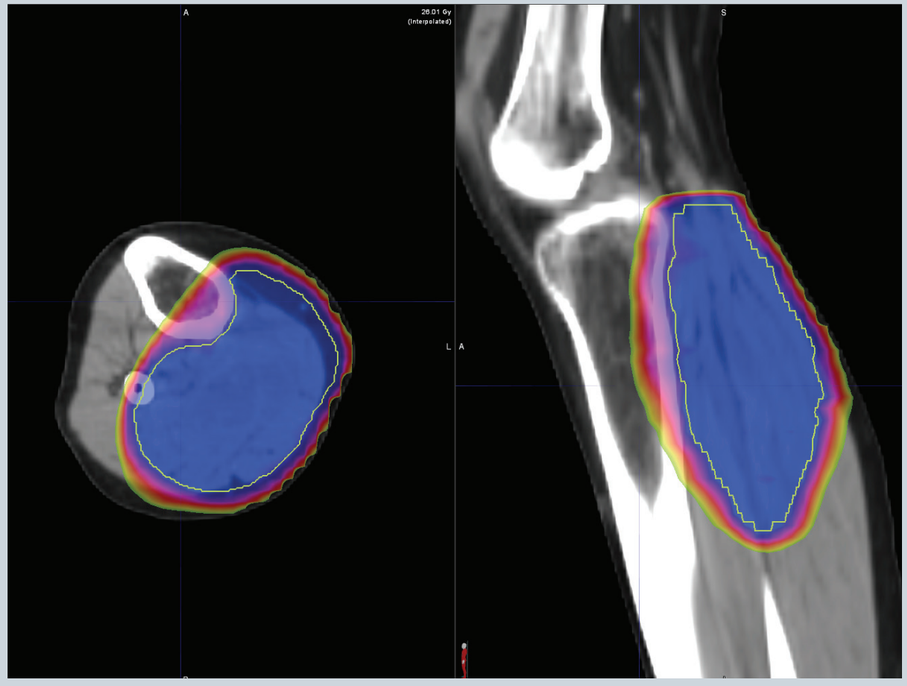
HYPOFRACTIONATED RADIATION SHORTENS TIME TO RESECTION FOR SOFT TISSUE SARCOMA

PRODUCES FAVORABLE ONCOLOGIC OUTCOMES, WOUND HEALING AND QUALITY OF LIFE



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Treatment of soft tissue sarcoma typically involves a long course of radiation followed by surgery. As a result, it can be weeks or even months before the cancer is removed and treatment is complete.

A new approach is reducing treatment time. Instead of five to six weeks of radiation therapy, patients now have the option to undergo five days of hypofractionated external beam radiation. This shorter although higher daily intensity approach has been used to treat breast, lung and colorectal cancers. Cleveland Clinic is helping lead the charge in the sarcoma space.

Early outcomes show promise

Complete surgical resection in combination with either neoadjuvant or adjuvant radiation therapy is the mainstay of treatment for soft tissue sarcomas. While there is no significant difference in survival outcomes of those who have had neoadjuvant versus adjuvant radiation therapy, preoperative radiation is shown to have fewer long-term effects.

continued next page ›

INSTEAD OF FIVE TO SIX WEEKS OF RADIATION THERAPY, PATIENTS NOW HAVE THE OPTION TO UNDERGO FIVE DAYS OF HYPOFRACTIONATED EXTERNAL BEAM RADIATION.

Conventional neoadjuvant radiation therapy regimens consist of 50 Gy in 25 fractions delivered over the course of five weeks. We then wait anywhere from four to six weeks to allow for recovery before we perform surgery. From the time a patient is diagnosed to the time the tumor is removed, it can be three months.

PATIENTS NOW HAVE AN OPTION THAT SIGNIFICANTLY DECREASES THE LENGTH OF THEIR TREATMENT, WHICH CAN IMPROVE THEIR QUALITY OF LIFE.

This can be challenging for patients, especially those who need to travel for treatment. Shifting away from this approach gives patients an option that significantly decreases the length of their treatment, which can improve their quality of life.

Short-course radiation therapy has been used for Cleveland Clinic patients with extremity sarcomas for about four years. Patients receive five fractions over the course of five days. Surgery occurs 24 to 72 hours after the last dose of radiation.

Early outcomes suggest favorable local control and wound healing. In one study published in *Advances in Radiation Oncology*, 16 patients were treated for sarcomas in their lower extremity, upper extremity or trunk.[1] Most were treated with 30 Gy in five fractions over five consecutive days, followed by resection. The median time to resection following the completion of radiation therapy was one day, and median time from initial biopsy results to the completion of primary oncologic therapy was 20 days.

Of these patients, 10 achieved R0 resection and six achieved R1 resection. Local failure was not reported in any of the 13 patients evaluated. Five patients (31%) had complications with wound healing, but only three (19%) required surgical treatment for them.

THE FIELD AS A WHOLE MUST CONTINUE TO LOOK FOR WAYS TO HELP EASE THE BURDEN OF TREATMENT, WHICH CAN IMPROVE OUR PATIENTS' LIVES EXPONENTIALLY.

Researchers continue to treat patients with hypofractionated preoperative radiation therapy, and long-term follow-up is ongoing.

Two types of short-course radiation for extremity sarcomas

Cleveland Clinic employs two types of short-course radiation for extremity sarcomas. We have traditional beam radiation, which involves five days of preoperative treatment followed by resection. The other option is brachytherapy. In this approach, we use a small radioactive source to deliver radiation in the tumor bed immediately following surgery. Brachytherapy can deliver a higher dose of radiation faster and in a more targeted way compared with standard external beam radiation therapy.

The advantage of brachytherapy is that the tumor is removed as a first step, and during the same operation, the catheters are laid in the area where the sarcoma was removed. Radiation is then delivered over five days. A few days after completion of radiation, the wound is closed or reconstructed. In less than two weeks, the entire cancer treatment for localized sarcoma is complete.

Every patient is discussed at a multidisciplinary meeting to determine which radiation treatment option is most appropriate for their diagnosis.

Investigating use in retroperitoneal sarcomas

Looking beyond extremity sarcomas, a trial is now exploring the use of short-course radiation for retroperitoneal sarcomas.

The trial, "CASE 2720: Prospective Study Evaluating Hypofractionated Radiation Therapy for Retroperitoneal Sarcomas," is currently accruing patients with histologically confirmed disease whose treatment plan includes neoadjuvant radiation followed by surgery.

Sarcoma is a life-changing diagnosis, and prolonged treatment courses only add to the stress and anxiety patients are already feeling. While we hope to see an improvement in outcomes overall, improvements in quality of life are a huge win as well. The field as a whole must continue to look for ways to help ease the burden of treatment, which can improve our patients' lives exponentially.

Dr. Mesko is Center Director, Orthopaedic Oncology, and co-Director of Sarcoma Care at Cleveland Clinic.

Dr. Campbell is a radiation oncologist at Cleveland Clinic Cancer Center.

Reference

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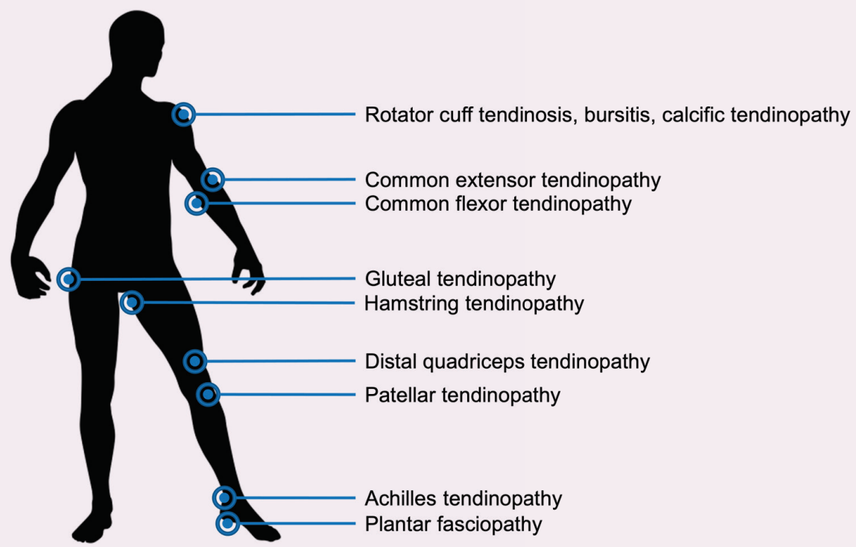
INTERVENTIONAL ORTHOPAEDICS OFFERS MINIMALLY INVASIVE CARE FOR NONRUPTURED TENDINOPATHIES

NEW CENTER WILL PROVIDE INJECTIONS AND HYDRORESECTION PROCEDURES

Cleveland Clinic's Department of Orthopaedic Surgery is staffed by a wide variety of providers who manage patients with acute and complex musculoskeletal injuries and conditions. Our orthopaedic surgeons deliver expert care through innovative and evidence-based treatments including arthroplasty. However, we also have providers who have an interest, passion and skill set in managing nonruptured tendinopathies. These are our "interventional orthopaedists."

The relationship between interventional orthopaedists and orthopaedic surgeons is similar to that between interventional cardiologists and cardiothoracic surgeons. Interventional orthopaedics is a minimally invasive approach to treating chronic tendinopathy, including with ultrasound-guided injections, platelet-rich plasma injections, and minimally invasive tenotomy and hydroresection (TenJet®) procedures.

Figure. Areas of tendinopathy (common diagnoses seen in the Tendinopathy and Interventional Orthopaedic Center).



Introducing the Tendinopathy and Interventional Orthopaedic Center

Interventional orthopaedist Jason Genin, DO, was recently named Director of the Tendinopathy and Interventional Orthopaedic Center within Cleveland Clinic's Sports Medicine Center.

This Tendinopathy and Interventional Orthopaedic Center will lead efforts in coordinating the diagnosis and management of patients with nonruptured acute and chronic tendinopathies (Figure). It will provide patients and orthopaedic colleagues with:

- **Musculoskeletal ultrasound-based tendinopathy classification.** The center recently completed research on the inter- and intrarater reliability of the musculoskeletal ultrasound-based features of tendinopathy.[1] These classification features reliably identify inflammatory, degenerative, and inflammatory on degenerative nonruptured tendinopathies of the common extensor tendon (Table).

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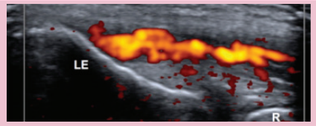
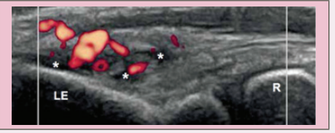
Tendinopathy Type	Tendinosis	Hyperemia	MSK-US
Type 1 Normal	Negative	Negative	
Type 2 Inflammatory	Negative	Positive	
Type 3 Degenerative	Positive	Negative	
Type 4 Inflammatory and Degenerative	Positive	Positive	

Table. Tendinopathy classification.

- **Ultrasound-guided joint and soft tissue injections.** Ultrasound has been found to be effective at ensuring the accuracy of joint and soft tissue injections.[2] The ultrasound-guided procedure allows for a diagnostic and therapeutic approach to aid medical decision-making for many providers. In addition, there is opportunity to evaluate the success of various medications based on the accuracy of injections.
- **Ultrasound-guided minimally invasive tenotomy and hydroresection.** Using an in-office, ultrasound-guided needle-based procedure, we can hydroaspirate degenerative tendinosis and calcific tendinopathies. This approach is applied to rotator cuff calcific tendinopathy, tennis elbow, golfer's elbow, hamstring and gluteal tendinopathy, quadriceps and patellar tendinopathy, Achilles tendinopathy, and plantar fasciopathy.
- **Tendon evaluation and management (TEAM) combined visits.** This multidisciplinary clinic is focused on the coordination of care for the nonsurgical patient with tendinopathy. Patients receive real-time, same-day care with both diagnosis and treatment recovery recommendations prior to leaving the office. Providers can use TEAM combined visits to structure best practices for the care of various tendon injuries that have otherwise been difficult to manage.

Next steps: Validating and expanding care guidelines

Now that a two-year TEAM pilot program has ended, a dedicated group of physicians and physical therapists has begun to develop care guidelines for many nonsurgical orthopaedic conditions. With continued collaboration, further research will help expand knowledge in the fields of orthobiologics, tendinopathy, musculoskeletal ultrasound and associated outcomes. Further research to validate these guidelines and expand the library of current guidelines is underway. We also will be adding more providers to the Tendinopathy and Interventional Orthopaedic Center, with plans to expand services throughout Cleveland Clinic's health system.

Dr. King is a sports medicine physician in the Department of Orthopaedic Surgery as well as Manager of Orthopaedic Informatics and Director of Clinical Transformation in the Orthopaedic & Rheumatologic Institute.

Dr. Genin is a sports medicine physician in the Department of Orthopaedic Surgery as well as Director of the Tendinopathy and Interventional Orthopaedic Center.

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PODIATRISTS PLAY VITAL ROLE IN SALVAGING LOWER EXTREMITY IN PATIENTS WITH DIABETIC FOOT DISEASE

MANY AMPUTATIONS CAN BE PREVENTED

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Diabetic foot disease is a leading cause of disability all over the world. Lower-extremity amputation (LEA) due to this condition greatly decreases quality of life and patient function, increases healthcare costs, and leads to increased mortality. Diabetes disproportionately accounts for the majority of LEAs, while peripheral arterial disease, infection and ulcerations are the leading underlying pathologies.[1]

Up to 1 in 4 persons with diabetes mellitus develops foot ulcers. Of these cases, up to 24% result in LEA.[2,3,4] However, many amputations can be prevented.

The multidisciplinary team within Cleveland Clinic's Foot & Ankle Center — comprising podiatric surgeons, vascular surgeons, orthopaedic surgeons, infectious disease specialists, physical therapists and orthotists — works collaboratively to address medical optimization, arterial perfusion and infection eradication in order to create a functional lower extremity. In the outpatient clinic, our team of podiatrists performs comprehensive foot evaluations for high-risk patients, screening for factors that could lead to diabetic foot complications. We endeavor to identify and curtail vascular disease early by:

- Prescribing custom-molded inserts for foot deformities
- Using customized braces and diabetic footwear to prevent the formation of foot ulcerations
- Applying amniotic tissues, living cell therapies, negative-pressure wound therapies, total contact casting and other advanced therapies to heal wounds expediently

Case study: Team helps patient avoid LEA with limb-salvage surgery

A 62-year-old man presented to the emergency department after tripping over tubing on a vacuum-assisted closure device that he had been wearing for prior lower-extremity surgery. His past medical history included Type 2 diabetes mellitus with peripheral neuropathy, mild peripheral arterial disease and stage 3 kidney disease. Several months prior, he underwent surgery for an infection in his posterior calf with subsequent latissimus dorsi muscle flap. This was complicated by a new dorsal medial foot ulceration, which was addressed with a medial column resection of his foot. Podiatry was consulted in the emergency department after he sustained a fall, which caused a subtle dorsal dislocation of his midfoot (Figures 1 and 2).

The patient insisted that he did not want to have his leg amputated as had been suggested by other surgeons. Long discussions ensued with the patient regarding the risks and benefits of a major LEA versus limb salvage, which would still involve surgical debridement of his large soft tissue defect and eradication of infection. He was approximately four months away from a major personal event, and he wanted to save as much of his lower extremity as possible and remain functional or mobile.

Noninvasive vascular testing was performed, which revealed potential satisfactory arterial circulation to heal a Chopart amputation (i.e., amputation of the forefoot and midfoot, leaving the talus and calcaneus). At this point, a staged surgical approach was decided upon. The first procedure was to debride the wound and remove the metatarsal bases, which were known to be infected. Cultures were obtained for targeted antibiotic treatment, and negative-pressure wound therapy was employed to determine flap and tissue viability (Figures 3 and 4).

After 72 hours, the first dressing change was performed, and the remaining foot appeared viable. At that point, the podiatric surgical team proceeded with the definitive amputation level. The patient's remaining

Figure 1. Clinical photo of emergency department presentation with absence of medial column of foot.

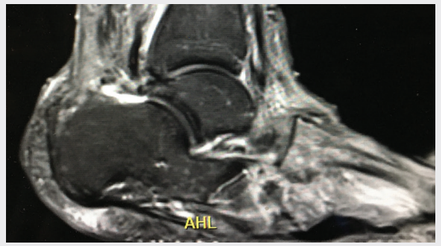

Figure 2. MRI findings compatible with osteomyelitis.

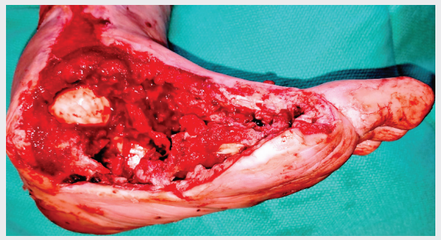

Figure 3. After first surgical foot debridement. Staging has been shown to yield better outcomes in reaching a definitive amputation level without reamputation or a higher level of amputation.

Figure 4. Negative-pressure wound therapy after first foot debridement.

Figure 5. Immediately postop Chopart amputation.

Figure 6. Status post-Chopart amputation with amniotic graft of ankle wounds.

midfoot and forefoot osseous structures were removed. Then a plantar artery flap was brought from the lateral side of the foot to the medial side and was remodeled to fit the area (Figure 5).

Tendon balancing was performed in order to prevent an equinovarus deformity. Prior to closure, antibiotic beads with gentamicin and vancomycin were inserted. A drain was left in place for 48 hours in order to prevent hematoma or seroma.

A successful outcome ensued over the course of several months, with eradication of infection and primary closure of both the foot and prior ankle wounds. Advanced amniotic biologics were employed under the negative-pressure wound device at the time of the patient's second surgical procedure. The patient is now three years postop (Figure 6).

A multidisciplinary approach to preventing reulceration

To ensure a functional, mobile extremity and to prevent future ulceration, multidisciplinary care is required.[5] Patients are referred to physical therapy for gait training, and to orthotics for a custom brace or appropriate footwear.

Patients with a history of neuropathic or neuroischemic ulcerations are patients for life for the podiatrist and vascular specialist, respectively. To reduce the risk of reulceration and the potential for subsequent infection of the affected limb or the contralateral extremity, regular preventive visits are recommended.

With the diagnosis of diabetes mellitus at epidemic proportions, a functional limb preservation team is crucial to performing all roles necessary in caring for patients at high risk of foot ulceration and amputation.

Dr. Botek is Head of Podiatry within the Foot & Ankle Center and a founding member of Cleveland Clinic's Functional Limb Preservation Council, a multidisciplinary group devoted to education, research and best practices involving the diabetic foot.

Dr. Hild is a podiatric surgeon specializing in limb salvage and general foot surgery in Cleveland Clinic's Foot & Ankle Center.

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ADVANCING THE TREATMENT OF ULNAR COLLATERAL LIGAMENT INJURIES IN THROWING ATHLETES

STUDYING ELBOW INJURIES IN BASEBALL PITCHERS LEADS TO NEW INJURY CLASSIFICATION AND SURGICAL TECHNIQUE

Ulnar collateral ligament (UCL) injuries in throwing athletes are common and related to repetitive valgus stress on the medial elbow joint during the throwing motion. It is generally accepted that complete tears or avulsion injuries often require surgery, but how partial tears should be managed has been less clear.

In 2017, our team at Cleveland Clinic looked at MRI factors that led to failure in professional baseball pitchers with partial UCL tears and found that distal, ulnar-based tears were more likely to fail compared to proximal tears.[1] To understand our results, we performed a histologic dye study to assess vascularity and found that the proximal UCL was well vascularized compared to the hypovascular distal UCL.[2,3]

PROXIMAL TEARS WERE LESS LIKELY THAN DISTAL TEARS TO FAIL NONOPERATIVE MANAGEMENT.

Next, in conjunction with the BioRobotics and Mechanical Testing Core at Cleveland Clinic's Lerner Research Institute, we demonstrated that distal tears resulted in more gapping compared to proximal tears when a simulated valgus force was applied.

An MRI-based classification system

Based on these prior studies, we developed and validated an MRI-based classification system to help guide decision-making when considering treatment of partial UCL tears. Tears are classified by location (1 = proximal, 2 = midsubstance, 3 = distal) and subcategorized by grade (A = partial, B = complete) (Figure 1).

This classification system was found to be reliable and reproducible based on studies looking at inter- and intrarater reliability.[4] We also assessed its clinical utility by retrospectively applying it to a series of consecutive patients with UCL injuries and confirmed that proximal tears were less likely than distal tears to fail nonoperative management.[5]

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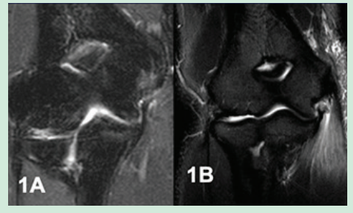
1A	Partial tear of the proximal/humeral UCL
1B	Complete tear of the proximal/humeral UCL
2A	Partial tear of the midsubstance UCL
2B	Complete tear of the midsubstance UCL
3A	Partial tear of the distal/ulnar UCL
3B	Complete tear of the distal/ulnar UCL



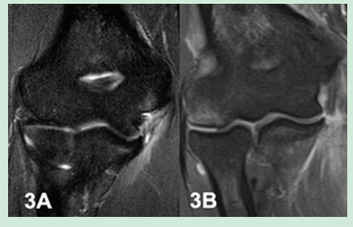


Figure 1. UCL injury classification.

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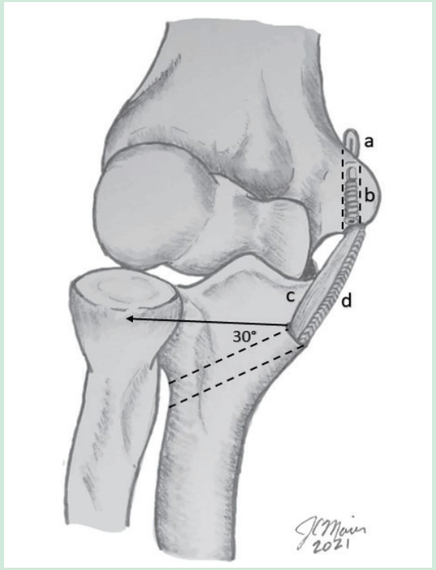

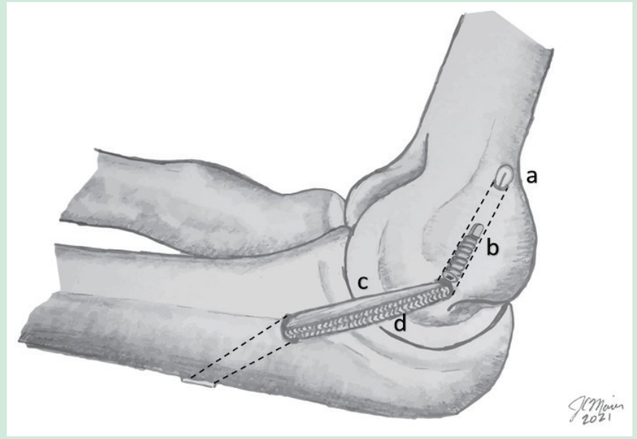

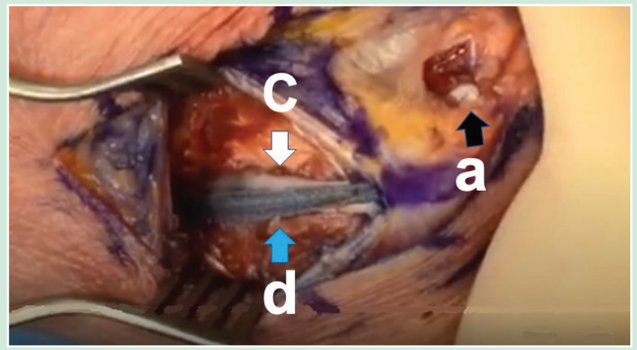

Figure 2. Novel adjustable, dual suspensory UCL reconstruction technique, demonstrating all-suture suspensory button (a), interference screw fixation (b), palmaris autograft (c) and internal brace (d).

This classification system and its associated research were presented at Major League Baseball's 2019 Winter Meetings, earning accolades for best research project.

Novel reconstruction technique reinforces medial elbow

Today we are testing a surgical technique that combines a novel UCL reconstruction method and internal bracing to reinforce the medial elbow after reconstruction (Figure 2). This technique uses dual suspensory fixation on the humerus and ulna to minimize the most common methods of failure: bone tunnel fracture and suture breakage. It also gives the surgeon better control of graft tensioning.

We hypothesize that this technique, soon to be published in the *Video Journal of Sports Medicine*, can lead to improved outcomes in UCL reconstruction and may expedite certain parts of the rehabilitation process. A comparative biomechanical study in conjunction with the BioRobotics and Mechanical Testing lab will begin in the near future.

Drs. Frangiamore and Schickendantz are orthopaedic surgeons specializing in sports medicine at Cleveland Clinic's Orthopaedic & Rheumatologic Institute. They both are team physicians for the Cleveland Guardians (formerly Cleveland Indians) Major League Baseball team, where Dr. Schickendantz is Director of Orthopaedic Services.

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CARTILAGE INJURIES IN CHILDREN: SURGICAL TREATMENT OPTIONS ABOUND

RESTORATIVE PROCEDURES PRODUCE BETTER OUTCOMES AND DURABILITY

Cartilage injuries are a common cause of pain in children and young adults. These injuries, most commonly in the knee, can be traumatic, such as through a direct impact or dislocation, or from repeated microtrauma arising from instability or pathologic biomechanics. It is essential to identify and treat these lesions, not only to relieve pain and restore function, but also to prevent the earlier development of osteoarthritis.

In evaluation of these patients, in addition to a standard knee examination — gait, range of motion, effusion, crepitus and palpation — it is important to assess the body habitus and alignment (including with full-length lower extremity radiographs), as they may be underlying mechanical contributors to the disease process (Figure 1). In addition to radiographs, MRI is essential for identification, sizing and characterization, as well as for assessment of the subchondral bone for fractures (Figure 2). Since the focal lesion is typically surrounded by degenerative or poor-quality cartilage (Figure 3), MRI actually underestimates the area required for debridement by up to 65%.

Reparative vs. restorative treatment

Initial treatment for cartilage injuries consists of activity modification, NSAIDs, bracing, physical therapy, and corticosteroid or viscosupplementation injections, but it is important to note that these interventions are only for symptom modification and do not address the underlying pathology. Patients failing conservative management or who have mechanical symptoms, loose bodies, recurrent effusions or focal lesions are indicated for surgery. Surgery must also address any ligament deficiency or malalignment present in order to optimize biomechanical conditions for healing and survival of chondrocytes.

As cartilage cannot regenerate, surgical options are either reparative or restorative. Reparative marrow-stimulation procedures, such as microfracture, introduce undifferentiated mesenchymal cells into the lesion and fill the lesion with mechanically inferior fibrocartilage. Longer-term studies also suggest microfracture may not be durable over time. Because these procedures involve an intra-articular inflammatory phase, they also lead to increased failure rates for subsequent cartilage procedures.

Restorative procedures, such as those involving cartilage allografts, matrix-associated autologous chondrocyte implantation (MACI) and osteochondral autograft transplantation (OAT), attempt to reintroduce hyaline cartilage into the lesion. Restorative options are based on the size and location of the lesion, with smaller lesions generally favoring treatment with cartilage allograft or OAT, and larger lesions requiring treatment with MACI or size-matched bulk grafts.

Cartilage allografts

Several types of cartilage allografts are commercially available. BioCartilage® (Arthrex, Inc.) is a putty containing cartilage extracellular matrix that can be used to fill defects. DeNovo® NT Graft (Zimmer Biomet) is a particulated juvenile cartilage graft that also can be used to fill defects. Cartiform® (Osiris Therapeutics, Inc.) is a sheet of allograft cartilage that is matched to the size of the lesion and then fixed in place in the defect using anchors and suture (Figure 4).

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Figure 1. Full-length lower extremity radiograph showing normal alignment, with the mechanical axis passing through the center of the knee.

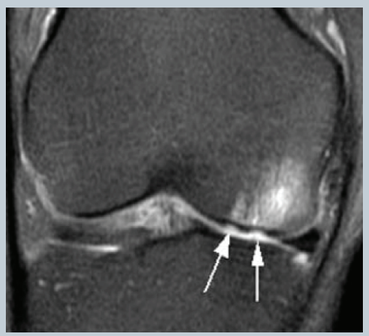

Figure 2. MRI showing cartilage lesion with associated subchondral edema.

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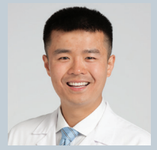

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Matrix-associated autologous chondrocyte implantation (MACI)

MACI is an effective option for lesions that are larger or located in an area of the joint difficult to match with a graft, such as the patellar trochlea. It is a two-stage procedure. First, a biopsy of healthy cartilage is obtained arthroscopically either from a non-weight-bearing area of the joint or from an area of cartilage that would otherwise be debrided. The specimen is processed to extract and culture the chondrocytes. After about four weeks, a membrane containing the expanded chondrocytes is replanted into the lesion (Figure 5).

Osteochondral autograft transplantation (OAT)

OAT procedures involve transferring plugs of cartilage along with underlying bone from a non-weight-bearing area of the joint (such as the intercondylar notch or medial side of the patellar trochlea) to the defect (Figure 6). This procedure fills the defect with native hyaline cartilage and also addresses subchondral bone problems. The osteochondral plugs also allow for direct bone-to-bone healing with the area surrounding the lesion.

OAT is ideal for smaller lesions (< 2.5 cm^2) in active patients with high physical demands. If mechanical malalignment is present, it should be corrected with a concurrent osteotomy.

Alternatively, a fresh allograft may be used as the source of the osteochondral plug. For smaller lesions, off-the-shelf osteochondral plugs are available. For larger lesions, bulk allografts matched by size and location to the lesion can be used. These grafts are processed to preserve the existing cartilage and chondrocytes while removing the cellular and immunogenic components of the bone and, therefore, do not require immunosuppression. Studies have shown a high rate of return to play in athletes after either autograft or allograft osteochondral transplant procedures.

Overall, treatment of cartilage lesions has transitioned from reparative to restorative procedures as cartilage grafts have been shown to have improved outcomes and durability, and as a wider array of biologic graft options has become available. These options allow us to help children with these injuries reduce pain, improve function, return to physical activity and reduce the risk of developing osteoarthritis.

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Dr. Zhu is a fellow in orthopaedic sports surgery.

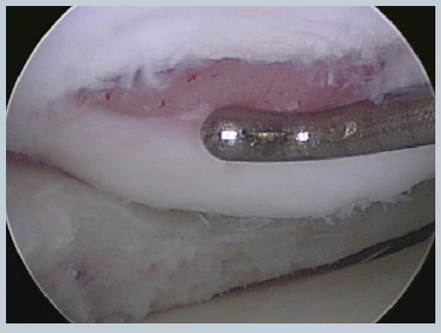

Figure 3. Arthroscopic view of a cartilage lesion of the femoral condyle.

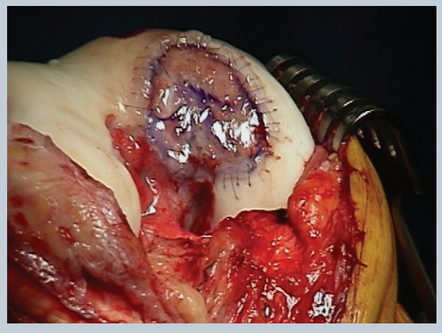

Figure 5. MACI membrane filling cartilage lesion, affixed with suture and fibrin glue.

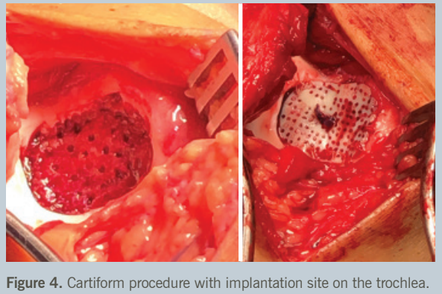

Figure 4. Cartiform procedure with implantation site on the trochlea.

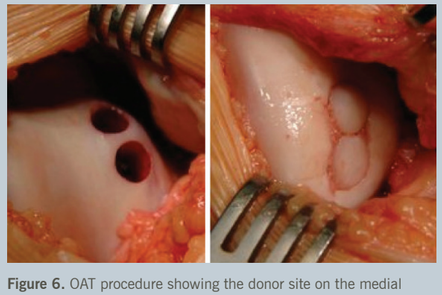

Figure 6. OAT procedure showing the donor site on the medial trochlea and implantation site on the femoral condyle.

SURGICAL MANAGEMENT OF COMPLEX PERIPROSTHETIC HUMERUS FRACTURES: REPLACE OR FIX?

TWO CASES SHOW MULTIPLE FACTORS TO CONSIDER

It is estimated that by 2025, more than 300,000 shoulder replacements will be done annually in the U.S.[1] The number of complications associated with these surgeries likely will increase as well. With the growing number of replacements in an aging and increasingly active population, falls and fractures around prosthetic implants will become more common.

Often we can treat these fractures without surgery, using a brace with simple therapy. However, there are times when the fracture and functionality of a patient make surgical management the preferred treatment. When this is the case, it becomes a complex, shared decision on whether to proceed with open reduction and internal fixation (ORIF) or revision arthroplasty based on the patient's functionality, medical risks, physiology and fracture pattern.

Case 1

An 84-year-old right-hand-dominant female fell onto her left arm from a standing height four days prior to presentation. She lived at home with her family and used a walker for ambulation. She was diagnosed with a left periprosthetic humerus fracture around a reverse total shoulder replacement done more than five years earlier. Her exam in the office showed intact motor function. Her axillary nerve and deltoid appeared to be functioning, and her prior deltopectoral incision was well healed. Surgical intervention was discussed due to the displacement and comminution of the fracture.

We discussed ORIF vs. revision reverse replacement using a megaprosthesis due to the poor bone stock and concern for a loose implant. With the patient's functional status, the preference was to perform an ORIF to preserve any tuberosity and soft-tissue attachments and prevent postoperative instability. Our concern with a revision reverse replacement was potential perioperative complication, specifically instability in the setting of a patient with frequent falls and walker use. We also discussed nonoperative management in the form of a functional brace, but due to the displacement and comminution around the implant and possible loose prosthesis, we did not feel this was a viable option, as it likely would lead to nonunion and an inability to use that arm for ambulating with a walker. After discussing these risks and benefits with the patient and her family, we elected to proceed with ORIF with a backup plan of revision using a megaprosthesis.

At the time of surgery, we used an extended deltopectoral incision to expose the fracture. Intraoperatively, the stem was noted to be well fixed to the proximal metaphyseal bone but loose at the tip of the stem. With good proximal bone fixation, it was decided to pursue an ORIF with a long proximal humeral locking plate. We pieced together the comminuted fracture from the intact distal shaft segment to the proximal bone around the prosthesis. There also appeared to be a more

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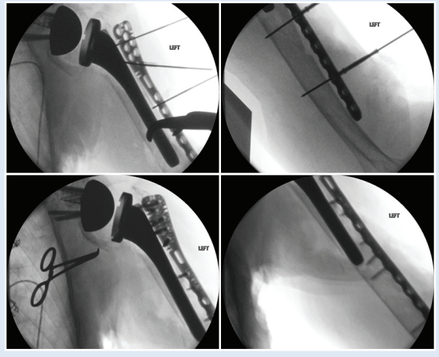

Figure 1. Intraoperative fluoroscopic views showing provisional reduction with clamps and wires from the plate, and final plate fixation prior to allograft placement.

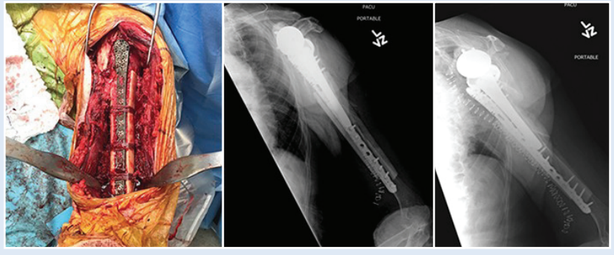

Figure 2. Intraoperative photo demonstrating the plate placement with allograft strut grafts on either side held in place by cerclage sutures, and postoperative recovery room X-rays of the construct.

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chronic fracture in the proximal humerus that was healing in addition to the acute fracture around the tip of the stem. We used a unique fracture plate that allowed for variable-angle screw placement around the implant to provide compression of the plate, and then locking caps to create fixed-angle locking screws (Figure 1).

Due to the poor bone stock, we elected to place strut grafts anterior and posterior to the plate as reinforcement of the construct. A femoral strut allograft was fashioned into two long cortical pieces measuring 16 cm posteriorly and about 12 cm anteriorly that were fixed with multiple cerclage tape sutures around strut grafts and the plate. Before final tensioning of the cerclage sutures, we placed a mixture of cancellous allograft chips with demineralized bone matrix around the fracture site and struts to help with healing of the allograft (Figure 2).

At 12 weeks postop, the patient was starting to use her arm as she did before her fall without complaint. Radiographs showed strut grafts intact, healing of the fracture and no migration of the hardware.

Case 2

A 60-year-old right-hand-dominant female pack-per-day smoker initially presented with a proximal humerus fracture nonunion that was treated with a reverse shoulder replacement with tuberosity repair in 2013.

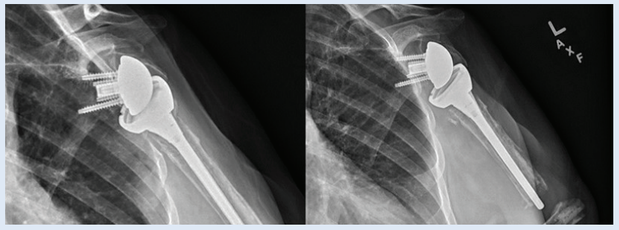

Figure 3. Postoperative X-rays at five and 6.5 years, demonstrating humeral component loosening and eventual periprosthetic fracture.

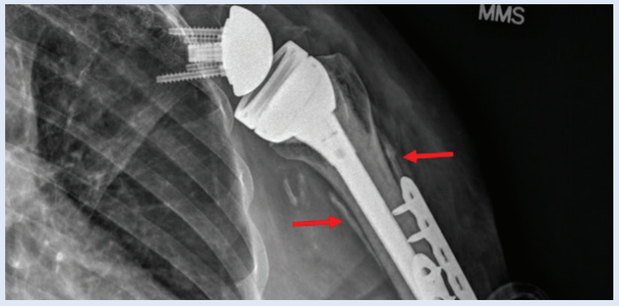

Figure 4. Early postoperative X-ray demonstrating the APC construct with red arrows indicating the clamshelled native bone around the APC construct.

She did well with excellent overhead function until presenting 6.5 years after surgery with atraumatic new-onset pain after a period of gradually worsening arm pain. Swelling and deformity of the arm with ecchymosis was seen without neurovascular compromise. X-rays showed a periprosthetic fracture at the tip of the stem with signs of humeral component loosening (Figure 3).

Because of the young age of the patient, with her previously excellent function and significant fracture displacement, surgical intervention was discussed, specifically revision arthroplasty with an allograft-prosthetic composite (APC) construct vs. ORIF based on the proximal humeral bone stock at surgery.

At the time of surgery, an ORIF was initially attempted, but the proximal bone stock was noted to be too poor for stable fixation. Revision reverse shoulder arthroplasty with APC was performed. The shell of proximal humeral bone was kept in place to preserve soft-tissue attachments for stability. The new long-stem implant was cemented into the allograft proximal humerus and native distal humeral bone. Two plates were placed to reinforce the APC-native humeral interface, and cerclage wires were used to gain additional fixation distally. The remaining rotator cuff tissue was repaired to the rotator cuff attachments of the proximal humeral allograft, and the native proximal bone was clamshelled around the APC proximally and held by cerclage sutures (Figure 4).

Cultures taken at the time of surgery were negative for infection. At the one-year follow-up visit, the patient had excellent function, with active forward elevation to 120 degrees, external rotation to 40 degrees and internal rotation to the lower thoracic spine.

Team approach produces best results

These two cases illustrate the complex decision-making required when surgically treating periprosthetic humerus fractures. A team approach, involving multiple fellowship-trained shoulder surgeons as well as other specialists throughout and outside of orthopaedic surgery, is the best way to identify optimal surgical technique.

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Reference

1. Wagner ER, Farley KX, Higgins I, Wilson JM, Daly CA, Gottschalk MB. The incidence of shoulder arthroplasty: rise and future projections compared with hip and knee arthroplasty. *J Shoulder Elbow Surg*. 2020;29(12):2601-2609.

RESIDENCY UPDATE 2021

Astute readers of this fine publication may have noticed the Winter 2020 mid-pandemic issue was notable for its lack of the Residency Update. When I inquired, post-publication, about this egregious oversight, "they" first blamed the absence on supply chain issues with paper and/or ink availability. When I pressed further, there were low and frequently unintelligible mumblings of budgetary restraints as being causative for the publication's foreshortening. Finally, and exasperatedly, when pushed further, they blurted that the readership just needed a break from my ramblings. Ouch.

Well, alas and with ego intact, we are back. We have plenty of paper, and the budget sheet looks good. Thanks also to the devoted readers who wrote letters on behalf of the return of this column. The three passionate emails were much appreciated.

But seriously, this pandemic has been a tragedy of the 11th degree. The unexpected silver linings we've all managed to find — our newfound ability to do virtual this or remote that — pale in comparison to the worldwide suffering COVID-19 has caused. The toll in all areas — emotional, physical and financial — has been great. Cleveland Clinic has successfully weathered this storm, and our department has emerged strong. We are fortunate, indeed, to reside in a country that has made the vaccines universally available, and it is that which is allowing us to dream again of normalcy.

Celebrating graduates

Absent this vaccine, the graduation festivities in June 2020 were, to say the least and understandably so, a bit bleak. Happily, this year's nine orthopaedic graduates from the main campus and South Pointe programs enjoyed end-of-academic-year festivities that bordered on the good old times.

Graduating in June were: **Deepak Ramanathan, MD**, who secured a coveted ABC medical news internship for his final two months as an orthopaedic resident, before heading to Duke for a fellowship in foot and ankle surgery. **Prem Ramkumar, MD**, who is off to an adult reconstructive fellowship at the Peter Bent Brigham Hospital in Boston, which is, of course, home to his beloved Celtics. Also seduced into the world of polished metal and cross-linked polyethylene were **Bilal Mahmood, MD**, who is at the University of Utah; **Jim Bircher, DO**, who is now a fellow at the world-famous Cleveland Clinic; and **Nicholas Arnold, MD**, who is also engaging in a joint reconstruction fellowship at Beaumont Hospital, Royal Oak in Michigan. **Inyang Udo-Inyang, MD**, is currently toiling in Louisville, Kentucky, as a hardworking fellow in spine surgery at the Leatherman Institute. (N.B. There is no time for fluff hobbies #Utahmountainbiking in that subspecialty, or so he reports.) **Sameer Oak, MD**, is in a sports medicine fellowship at that "school up north" (aka University of Michigan) as is fellow sports medicine enthusiast **P.J. Bevan, DO**, who is plying his scope at Hoag Orthopaedic Institute in Irvine, California, not all that far when you take the "5" from **Logan Worrell, DO**, who is doing an orthopaedic traumatology fellowship at UC San Diego.

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Welcoming new residents

The 2020-21 residency interview season was remarkable for its all-virtual interview format. Despite the drawbacks of screen-time interviews, we matched nine talented and truly superb future orthopaedic surgeons. They are:

- **Zach Bernard, DO**, of West Virginia School of Osteopathic Medicine
- **Alex Brewer, DO**, of Lake Erie College of Osteopathic Medicine
- **Zach Sturgill, DO**, from the Carolina Campus of the Edward Via College of Osteopathic Medicine
- **Lola Fakunle, MD**, of Emory University Medical School
- **Collin LaPorte, MD**, of Michigan State University School of Medicine
- **Mustafa Mahmood, MD**, of Southern Illinois University Medical School
- **Conner Paez, MD**, of UC San Diego School of Medicine
- **Rui Soares, MD**, of Georgetown University School of Medicine
- **Jason Teplensky, MD**, of Case Western Reserve University School of Medicine

We are delighted these men and woman have joined us for five years, or that they are about to do so. Their futures are bright, and the guild is being passed into gifted and able hands.

With luck and human perseverance, the COVID-19 pandemic soon will wind to a close, and we can look forward to routinely shaking hands, embracing and being mask-free again. That is, of course, except in the OR.

Dr. Kuivila, a pediatric orthopaedic and scoliosis surgeon, is Vice Chair of Education in the Orthopaedic & Rheumatologic Institute and Director of Cleveland Clinic's orthopaedic residency program.

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