Le Bonheur Children's Hospital
Memphis, Tennessee

PEDIATRIC ORTHOPAEDICS

Campbell Clinic® ORTHOPAEDICS

Winter 2017

Case study: Separating ischiopagus conjoined twins

A team of surgeons at Le Bonheur Children's Hospital successfully separated 12-month-old ischiopagus conjoined twins, Miracle and Testimony Ayeni, in an 18-hour procedure on Nov. 7. The girls were born in Nigeria on Nov. 16, 2015, and were connected to Le Bonheur Children's Hospital through the Linking Hands Foundation. The Ayenis spent five months at Le Bonheur prior to surgery as surgeons prepared for the separation.

Joined at the pelvis and perineal area, Miracle and Testimony shared a bladder, pelvis and lower gastrointestinal tract. William Warner, MD, Derek Kelly, MD, and James Beaty, MD, served as the girls' primary pediatric orthopaedic surgeons.

"The girls' legs were angled 90 degrees to where they should be. We had to figure out how to separate the pelvises and swing the legs back into a normal position," said Warner.

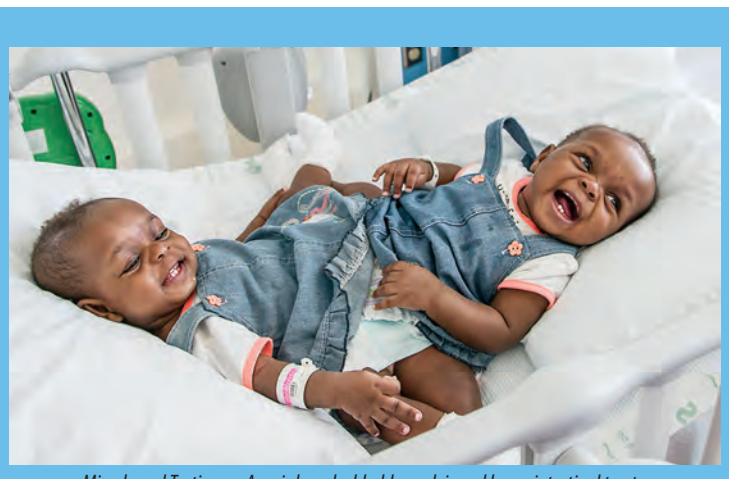
The orthopaedic team separated the girls' shared pubis bone by transecting the pubic symphysis on each side. They then reshaped the pelvis using iliac wing osteotomies and an external fixator. The fixators were removed six weeks after surgery.

William Warner, MD, describes his plan to separate and rotate the girls' pelvis. The multidisciplinary surgical team met weekly to plan for the separation.

"We expect the girls to have a normal gait, although they could need more lower extremity surgeries," said Warner.

Miracle and Testimony will also need a future orthopaedic surgery to correct a hemivertebrae.

Scan of Miracle and Testimony Ayeni, 12-month-old conjoined twins



Miracle and Testimony Ayeni shared a bladder, pelvis and lower intestinal tract. They were separated on Nov. 7.

External fixators hold the girls' pelvises in place for six weeks post-surgery.

MIRACLE AND TESTIMONY AYENI: *SURGICAL SEPARATION TIMELINE*

NOVEMBER 7-8

7:05 a.m. Anesthesia induction begins and intravenous lines are inserted.

8:45 a.m. General surgery team marks abdominal incisions.

9:06 a.m. Twins are rolled onto their stomachs; urology team places foley catheters; general surgery marks spot to create anus and rectum.

9:43 a.m. Twins are rolled onto their backs; team applies sterile drapes.

10 a.m. Pediatric surgery team divides colon and separates the conjoined bowel.

11:15 a.m. Plastic surgery and urology teams make incisions to access the ureters.

12:10 p.m. Urology team mobilizes and divides the ureters.

2 p.m. Orthopaedics team divides the two shared pubic bones.

2-3 p.m. Urology and pediatric surgery teams complete soft tissue dissection.

3:16 p.m. Girls are separated and Testimony is moved to Operating Room 6.

Miracle

3:50 p.m. Plastic surgery team removes Miracle's right tissue expander and makes incisions for osteotomies.

5 p.m. Orthopaedics team completes reshaping of Miracle's pelvic bone.

5:55 p.m. Pediatric surgery team completes creation of anus and rectum.

7 p.m. Urology team completes ureter to bladder connection.

8:30 p.m. Orthopaedics team begins pin placement and external fixator to hold pelvis in place.

9:15 p.m. Pediatric surgery team closes the perineum.

11:40 p.m. Plastic surgery team completes removal of tissue expanders, placement of patch between the pubic bones in the midline and abdominal wall reconstruction.

12:06 a.m. Orthopaedics team completes readjustment of the external fixator. Surgery is complete. Miracle is transported to the Pediatric Intensive Care Unit.

Testimony

3:15 p.m. Team begins incisions to reshape Testimony's pelvis.

5:56 p.m. Orthopaedics team completes reshaping of pelvic bone.

7:30 p.m. Urology team completes the new connection between Testimony's ureter and her other ureter.

8:15 p.m. Pediatric surgery team completes colon to small intestine connection.

9:30 p.m. Orthopaedics team completes placement of pins and an external fixator to hold pelvis in position.

12:25 a.m. Plastic surgery team closes the perineum and abdominal wall after removing tissue expanders.

12:55 a.m. Orthopaedics finishes readjusting the external fixator and surgery is complete. Testimony is moved to Pediatric Intensive Care Unit.

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Nurse practitioners present at International Pediatric Orthopaedic Symposium

Orthopaedic Nurse Practitioners Leslie Rhodes, DNP, PPCNP-BC, and Lindsey Locke, MSN, RN, CPNP-PC, presented at the 13th Annual International Pediatric Orthopaedic Symposium in Orlando. Their presentations — "Common Cast Issues" and "Commonly Missed Elbow Fractures" — were part of the breakout session, Fracture Care and Casting 101 for the Advanced Practice Providers.

Team hosts two international visitors

The Le Bonheur/Campbell Clinic Pediatric Orthopaedic team recently hosted two international visitors. Ara Aivazran, MD, is from Yerevan, Armenia, where he works as head of the Pediatric Orthopedy and Traumatology Department at the Scientific Center of Traumatology and Orthopaedics. He was in Memphis for one week as part of the American Academy of Orthopaedic Surgeons' (AAOS) International Scholars program.

Brian Billy Berton Madison, MD, came to Memphis as part of the Campbell Foundation's Footprints in Motion Education Exchange program. Since 2013, Campbell Clinic has sent four residents to under-served international countries as part of a two-week exchange. This was the first year the program brought a student here. Madison is from South Sudan and is an orthpaedic resident at the Kilimanjaro Christian Medical Clinic in Moshi, Tanzania. Upon completion of his training, Madison plans to return to South Sudan where he will be only the third orthopaedic surgeon in the country. Madison spent six weeks in Memphis, including two weeks at Le Bonheur Children's.

Brian Bill Berton Madison, MD, of Sudan (center) spent six weeks in Memphis.

Sawyer co-hosts inaugural surgical techniques lab

Two-day course maximizes hands-on time

Pediatric Orthopaedic Surgeon Jeffrey Sawyer, MD, and Todd Milbrandt, MD, of Mayo Clinic hosted the inaugural Pediatric Orthopedic Surgical Techniques Lab, a two-day intensive cadaveric lab, designed for senior residents, pediatric orthopaedic fellows and new attendings. The course, held at the Medical Education & Research Institute in Memphis, was sold out at 32 participants.

"Our goal was to develop a course with minimal lecture and maximal hands-on time in the lab. We are also using this course to test new educational techniques for adult learners," said Sawyer.

Topics covered upper extremities, spine, hip and lower extremities, including trauma, deformity and sports.

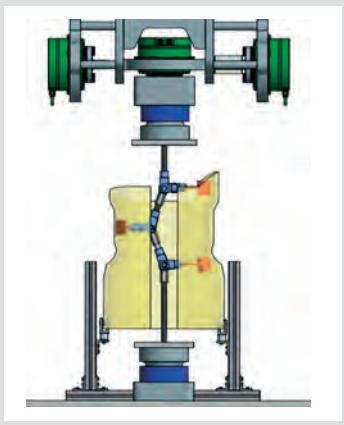
The inaugural Pediatric Orthopedic Surgical Techniques Lab provided hands-on training on new techniques for residents, fellows and new attendings.

Novel model tests biomechanics of scoliosis bracing

The Pediatric Orthopaedic team at Le Bonheur Children's/ Campbell Clinic is collaborating with the BioRobotics Laboratory at the University of Tennessee Health Science Center (UTHSC) to develop a novel mechanically equivalent analog model of the adolescent idiopathic scoliosis condition to study the biomechanics of scoliosis bracing technology.

Under the direction of Denis DiAngelo, PhD, and Chloe Chung, MS, the team developed and tested the Scoliosis Analog Model (SAM), which is a linkage-based system to simulate three-dimensional spinal correction of a single-curve scoliotic spine in order to quantify the three-dimensional forces applied to the spine by the brace. The SAM allows researchers to compare and rank the structural properties of different scoliosis braces.

UNDERSTANDING BRACE-FASTENING TECHNIQUES



The Scoliosis Analog Model uses a linkage-based system to simulate 3D spinal correction of a single-curve scoliotic spine.

The SAM was used in conjunction with a robotic testing platform (RTP) to study the biomechanical effects of strap tension on the corrective force capacity of a scoliosis brace. Two orthotists participated in the study by fitting a brace onto the SAM using their preferred strap tightening methods. The amount of vertical distractive force generated by the brace and the amount of prescribed tension in each strap were measured and were not found to significantly vary with strap tightening order. The findings showed that tightening the straps in a different order produced either an upward or downward corrective brace force response, but the net corrective brace force applied across the spine was similar.

Le Bonheur and UTHSC are collaborating to study the biomechanics of scoliosis bracing technology.

A NEW FASTENING SYSTEM

Loss of strap tension with conventional Velcro fasteners has attributed to a loss of in-brace spinal correction. Working with student Cody Bateman, MS, the team developed a novel fastening device, known as the Controlled Tension Unit (CTU), was developed for scoliosis braces and validated using the RTP and SAM. Laboratory studies showed the CTU fasteners made the brace less rigid and more flexible to wear without affecting the brace strap tension and spinal load.

CLINICAL ASSESSMENT OF CONTROLLED TENSION UNIT FASTENERS

In an ongoing clinical study, patients have reported less discomfort when wearing a brace with the CTU fasteners compared to the traditional Velcro straps and were able to more easily perform many daily tasks like taking a deep breath or bending forward. These types of movements typically increase the tension in the Velcro straps, which make the brace uncomfortable to wear. However, the novel CTU devices improved the flexibility of the brace without compromising the tension in the straps and the corrective forces applied to the spine by the brace.

Research Spotlight: 2016

The Le Bonheur/Campbell Clinic Pediatric Orthopaedic team continues to publish research and deliver podium presentations. Some of the team's latest research includes:

Evaluation of outcomes pre- and post-implementation of a standardized pathway in pediatric posterior spinal fusion patients

Standardization of care for patients undergoing a posterior spinal fusion improves outcomes and reduces length of stay, according to the team's findings. The multidisciplinary research team performed a prospective review of 64 patients pre- and post-implementation of a standardized, evidence-based care plan.

The care plan included pre-operative, intraoperative and post-operative factors, including standardized evaluation, pre-emptive analgesia and multimodal pain control – as well as post-operative pain, dietary, bowel and activity management.

Results showed that the standardized care plan (compared to individual surgeon preference) led to shorter lengths of stay, improved outcomes including less patient-controlled analgesia and narcotic use, and faster resumption of normal diet and hallway ambulation.

	Pre-standardized care plan (median)	Post-standardized care plan (median)
Length of stay	5.3 days	4.4 days
Time to hallway ambulation	Postoperative day 3	Postoperative day 2
Patient-controlled analgesia	2.3 mg/kg [IQR 1.2-2.7]	1.1 mg/kg [IQR 0.9-1.6]
Morphine equivalent	13 mg [IQR 0.0-160.5]	3 mg [IQR 0.0-16.0]
Resumption of regular diets	Postoperative day 4	Postoperative day 2
Complications	0	0
Readmissions	0	0

Occipital condyle fractures in the pediatric population

The research team conducted an analysis of occipital condyle fractures in children, reviewing medical records and computed tomography scans of the head and neck of children and adolescents. The team also collected information about the patients' demographics, associated injuries, length of stay and Glasgow Comas Score.

Results showed that occipital condyle fractures in children and adolescents are rare injuries but have a high rate of associated skull fractures, thoracic and abdominal trauma. Type I and II fractures (Anderson-Montesano classification system) predominate in children and adolescents. Operative treatment is rarely necessary, but required in patients presenting with concomitant AOD. The use of MRI to visualize the integrity of ligamentous structures at the base of the skull should be considered to rule out AOD.

Pediatric patients with spondylolysis have high rates of vitamin D deficiency

Pediatric patients presenting with spondylolysis, regardless of race or age, have high rates of 25-hydroxyvitamin D deficiency. The team enrolled 39 patients with spondylolysis in its study, designed to document the 25-hydoxyvitamin D status of patients with a confirmed diagnosis. The mean 25-hydroxyvitamin D level was 25.9 ng/ml, and of all participants, three patients were considered to have normal vitamin D levels >35 ng/ml. Per its findings, the ream recommends routine screening of 25-hydroxyvitamin D in patients presenting with spondylolysis and further studies to look at how rates of vitamin D deficiency compare to the general population, and how treatment of vitamin D deficiency affects their outcome.

Team evaluates parents' perception of discharge readiness, satisfaction after posterior spinal fusion

Le Bonheur's Pediatric Orthopaedic team is currently conducting a study to evaluate parents' perceptions of their child's readiness for discharge after a posterior spinal fusion in adolescent scoliosis patients. The goal is to assess the effectiveness of the team's current multi-phased discharge process and determine whether patient satisfaction scores with the current postoperative pathway varied in: **hospital length of stay**, **performing surgeon**, **pain score**, **number of discharge medications** and **number of days to follow-up appointment**.

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Research, Publications and Presentations

Le Bonheur Children's Hospital and Campbell Clinic's five surgeons are actively involved in research and presentations in the pediatric orthopaedic field. Highlights from their work are listed below:

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Presentations

Jim Beaty, MD

Factors that Predict Instability in Pediatric Diaphyseal Both Bone Forearm Fractures.Kutsikovich, Hopkins, Edwin W Gannon III, JHB, WCW, JRS, DDS, DMK. POSNA - April 27-30, 2016 - Indianapolis, IN. EPOS - April 6-9, 2016 - Rome, IT.

Cervical Spine Trauma Immobilization Protocols in Young Children. How Often Are These Protocols Followed? Factors that Predict Instability in Pediatric Diaphyseal Both Bone Forearm Fractures. Weldy, Beaty, Spence, Kelly, Sawyer, Warner, Jr. OTA poster. San Diego, CA. Oct. 7-10, 2015.

Factors that Predict Instability in Pediatric Diaphyseal Both Bone Forearm Fractures. Kutsikovich, Hopkins, Gannon III, Beaty, Warner, Sawyer, Spence, Kelly. ASSH eposter. Seattle, WA. Sept. 10-12, 2015; OTA podium. San Diego, CA. Oct. 7-10, 2015.

Beaty J, Bert, Biggers, Moisan, Sawyer, Warner, Kelly. Fracture of the Medial Humeral Epicondyle in Children: A Comparison of Operative and Nonoperative Management (accepted Podium). American Academy of Orthopaedic Surgeons, New Orleans, March 2014.

Beaty, Thompson, Kelly, Rush, Warner, Spence, Moisan, Sawyer. Intra and Inter-Observer Reliability and the Role of Fracture Morphology in Classifying Femoral Shaft Fractures in Children (poster). European Pediatric Orthopaedic Society, Belgium, April 2014.

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Pediatric Orthopedic Society of North America Annual Meeting 2016

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Le Bonheur/Campbell Clinic Presentations

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Child Safety Restraint Status and Age in Motor Vehicle Collisions Predict Type and Severity of Traumatic Injuries: Podium. Chris Loftis, JRS, Trey Eubanks, DMK.

Issues Affecting the Practice of Pediatric Orthopaedic Surgeons: Results of the 2014 Workforce Survey of American Academy of Pediatrics Section on Orthopaedics: Podium. Pooya Hosseinzadeh, MD*, Lawson Copley, MD**, Holly Ruch-Ross***, Richard M Schwend, MD, Jeffrey R Sawyer, MD.

Complications and Radiographic Outcomes of Posterior Spinal Fusion (PSF) and Observation (OB) in Patients Who Have Undergone Distraction-Based Treatment for Early Onset Scoliosis (EOS): Podium. Mendonça RM , Samdani A, El-Hawary R, Kishta W, Smith JT, Emans JB, St. Hilare TA, Flynn TS, Soufleris SJ, Murphy RP, Sawyer JR and CSSG.

Do Males and Females Get Different Jobs Within Pediatric Orthopedics? A Comparison from the POSNA Needs Assessment Survey: Poster. Amoli, JRS, Edmonds, Flynn, Glotzbecker, DMK.

Complications and Radiographic Outcomes of Posterior Spinal Fusion (PSF) in Patients with Spinal Muscular Atrophy (SMA) Following Growth Friendly Treatment: ePoster. Mendonça RM , Helfin JA, Sponseller PD, Thompson GH, Vitale MG, Smith JT, Flynn T, Murphy R, Flournory J, Sawyer JR and CSSG/GSSG.

POPS NP/PA Symposium: Congenital Vertical Talus: Pops Symposium. DMK.

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Evaluation of Nursing Education on the Utilization of a Pain Algorithm: POPS. Lindsey Locke.

William C. Warner Jr., MD

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Hemoglobin Levels Pre- and Post-Treatment as a Surrogate for Disease Severity in Early Onset Scoliosis Michael Glotzbecker, Joshua Pahys, Patrick Cahill, Jeffery Sawyer, Michael Vitale, Alexandra Grzywna, Patricia Miller ICEOS – November 17 & 18, 2016 - Utrecht, Holland

Development of a Risk Severity Score Predicting Surgical Site Infection in Early Onset Scoliosis Michael Vitale, Hiroko Matsumoto, Nicholas Feinberg, John Smith, Amer Samdani, Michael Glotzbecker, Jeffrey Sawyer, David Skaggs, David Roye ICEOS – November 17 & 18, 2016 - Utrecht, Holland

Comparison of Newly Implanted versus Converted Magnetically Controlled Growing Rods (MCGR) from the Post-United States Release Jeffrey R. Sawyer, Chun Wai Hung, Zachary J. Bloom, Hiroko Matsumoto, John T. Smith, Jonathan H. Phillips, Peter F. Sturm, Michael G. Vitale, Children's Spine Study Group ICEOS – November 17 & 18, 2016 - Utrecht, Holland

Complications and Radiographic Outcomes of Posterior Spinal Fusion (PSF) in Patients with Spinal Muscular Atrophy (SMA) Following Growth Friendly Treatment. Sawyer, Mendoça, Murphy, Flournory, et al. ICEOS eposter. Boston, MA. Nov. 19-20, 2015.

Cervical Spine Trauma Immobilization Protocols in Young Children. How Often Are These Protocols Followed? Factors that Predict Instability in Pediatric Diaphyseal Both Bone Forearm Fractures. Weldy, Beaty, Spence, Kelly, Sawyer, Warner, Jr. OTA poster. San Diego, CA. Oct. 7-10, 2015.

Factors that Predict Instability in Pediatric Diaphyseal Both Bone Forearm Fractures. Kutsikovich, Hopkins, Gannon III, Beaty, Warner, Sawyer, Spence, Kelly. ASSH eposter. Seattle, WA. Sept. 10-12, 2015; OTA podium. San Diego, CA. Oct. 7-10, 2015.

A Supply and Demand Analysis of the Orthopaedic Trauma Surgeon Workforce in the United States. Sielatycki, Sawyer, Mir. OTA. San Diego, CA. Oct. 7-10, 2015.

Changing Trends in Pediatric Spine Surgery in The United States: 1997-2012. Kelly, Warner, Sawyer, Copley. SRS Podium. Minneapolis, MN. Sept. 30-Oct. 3, 2015.

The Evolving State of Acute Pediatric Septic Arthritis and Osteomyelitis. Franklin, Kelly, Sawyer. POSA eposter #46. Atlanta, GA. April 29-May 2, 2015.

Early Career Experience of Pediatric Orthopaedic Fellows: What to Expect and Need for Their Services. Glotzbecker, Shore, Fletcher, Larson, Hydorn, Sawyer. POSNA Podium. Atlanta, GA. April 29, 2015.

The Evolving State of Acute Pediatric Septic Arthiritis and Osteomyelitis. Franklin, Sawyer, Kelly. EPOS Poster. Marseille, France. April 15-18, 2015.

A 10-Year Multi-Center Review of Current Trends in the Treatment of Pediatric Femoral Shaft Fracture. Roaten, Sawyer, CHOP, UCLA. EPOS eposter #644, Marseille, France. April 15-18, 2015.

Sawyer, Warner, Beaty J, Bert, Biggers, Moisan, Kelly. Fracture of the Medial Humeral Epicondyle in Children: A Comparison of Operative and Nonoperative Management (accepted Podium). American Academy of Orthopaedic Surgeons, New Orleans, March 2014.

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Spence David D. MD, Beaty James H. MD, Ryan Murphy BS, Derek M. Kelly MD, William C. Warner Jr. MD, Alice Moisan RN, Norfleet Thompson MD, Jeffrey R. Sawyer MD. Transverse Femoral Shaft Fractures are a Better Predictor of Non-Accidental Trauma than Spiral Fractures in Young Children (poster). European Pediatric Orthopaedic Society, Belgium, April 2014.

Spence David D. MD, Beaty James H. MD, Byron F. Stephens MD, Jeffrey R. Sawyer MD, William C. Warner MD, Alice A. Moisan BSN and Derek M. Kelly MD. Interleukin-6 in Pediatric Musculoskeletal Infection: A Pilot Study (Podium). European Pediatric Orthopaedic Society, Belgium, April 2014.

Spence David D, MD, Beaty James H, MD, Juan Pretell-Mazzini, MD, Vinayak Perake, MD; Derek M. Kelly, MD, Jeffrey R Sawyer, MD, Alice A Moisan, BSN, William C Warner, Jr, MD. Outcomes And Complications Of Tibial Tubercle Fractures Within The Pediatric Population. A Systematic Review Of The Literature (e-poster). European Pediatric Orthopaedic Society, Belgium, April 2014.

Spence David D. MD, Beaty James H. MD, Ryan Murphy BS, Derek M. Kelly MD, William C. Warner Jr. MD, Alice Moisan RN, Norfleet Thompson MD, Jeffrey R. Sawyer MD. Transverse Femoral Shaft Fractures are a Better Predictor of Non-Accidental Trauma than Spiral Fractures in Young Children accepted podium. POSNA, Hollywood, Ca., April-May 2014.

Spence David D., MD, Warner William C. Jr, MD, Robert F. Murphy, MD, Austin R. Davidson, BS, Derek M. Kelly, MD, and Jeffrey R. Sawyer MD. Sub-axial cervical spine injuries in children and adolescents accepted e poster. POSNA, Hollywood, Ca., April-May 2014.

Spence David D. MD, Beaty James H. MD, Byron F. Stephens MD, Jeffrey R. Sawyer MD, William C. Warner MD, Alice A. Moisan BSN and Derek M. Kelly MD. Interleukin-6 in Pediatric Musculoskeletal Infection: A Pilot Study accepted e poster. POSNA, Hollywood, Ca., April-May 2014.