

# 2018 ANNUAL REPORT

*Internationally distinguished for patient care with  
compassion and advanced clinical research*

Cincinnati SportsMedicine Research & Education Foundation  
Cincinnati SportsMedicine & Orthopaedic Center — Mercy Health  
Noyes Knee Institute

# Welcome to our Foundation



I would like to provide a most enthusiastic and warm welcome to the 2018 annual report and the sponsorship organizations that contributed to one of our most successful and productive years. The Cincinnati SportsMedicine Research and Education Foundation is the parent organization to all our education and research programs with a commitment to excellence in all aspects of patient care, clinically applied research, and the education and teaching of surgeons, physical therapists, and allied health professionals in the USA and world-wide.

The Noyes Knee Institute was founded to advance these goals in the clinical treatment and long term clinical outcome registry studies for many specific knee ligament and other disorders. The physicians associated with the Foundation thrive through research and clinical practice to develop state-of-the art surgical techniques and treatment options that represent the most advanced procedures available world-wide. Our research personnel and scientists have conducted over 110 clinical research studies involving thousands of patients, published over 360 articles in peer-reviewed medical journals and orthopaedic textbooks, and trained over 155 sports medicine and arthroscopic surgeons in our fellowship program.

A Foundation program, Sportsmetrics™, has received national and international attention. Sportsmetrics™ is a scientifically proven, non-profit neuromuscular training program designed to prevent ACL injuries in female athletes and to provide the basis for the safe return to athletics in both male and female athletes after knee injury and surgery. Our Sportsmetrics™ staff teaches and certifies allied health professionals on training athletes and implementing the Sportsmetrics™ program in their communities. Sportsmetrics™ is the largest injury prevention program in the world and is described in detail later in this annual report.

In its 33rd year, our annual Advances on the Knee, Shoulder, Hip, and Sports Medicine Conference, featured in this report, has trained thousands of physicians, physical therapists, and athletic trainers world-wide.

*We appreciate the many expert faculty that support the excellence of our programs.*

*The Foundation was founded in 1985 by Frank R. Noyes, MD, President and Medical Director of the Cincinnati SportsMedicine and Orthopaedic Center.*

*The Foundation was established with the goal of bringing together surgeons, therapists, trainers, researchers and bioengineering professionals in a team approach to develop successful and innovative treatment programs to improve the lives of patients. The clinical and bioengineering research studies have received nearly every national and international award possible. These include the highest award from the American Academy of Orthopaedic Surgeons (Kappa Delta Award), the Orthopaedic Research and Education Foundation's Clinical Research Award, and the American Orthopaedic Society for Sports Medicine Clinical and Research Awards. The Foundation's studies were recently honored and ranked in bibliographic publications in the Journal of Bone and Joint Surgery and the Arthroscopy Journal as the "most-cited studies" in the world. This is unmatched by any other treatment or research facility world-wide.*

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## Our Mission

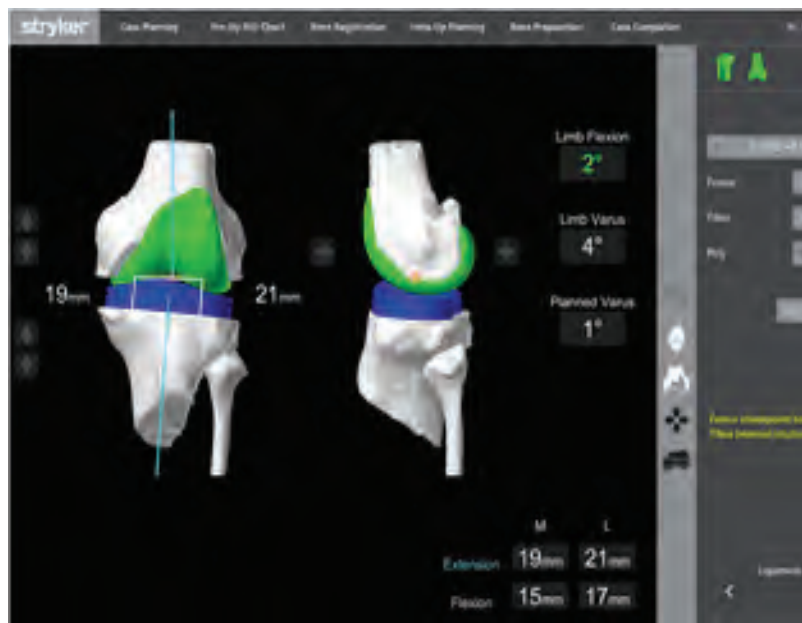
*To improve the lives of patients everywhere by offering advanced and state-of-the-art treatments for Orthopaedic and Sports Medicine disorders based on excellence and success in documented clinical outcome studies and application of basic and clinical research.*



# 2018

## Accomplishments

Research and education advances are represented by the collaboration of physicians, scientists and research staff at Mercy Health – Cincinnati SportsMedicine and Orthopaedic Center, Cincinnati SportsMedicine Research and Education Foundation, Noyes Knee Institute, and the University of Cincinnati Department of Biomedical Engineering.



- Release of the 2nd edition of two e-books, 1) Partial Knee Replacement: Everything You Need to Know to Make the Right Treatment Decision, 2) Knee Arthrofibrosis: Everything You Need to Know to Recognize, Treat, and Prevent Loss of Knee Motion After Injury or Surgery
- Development, writing and editing of chapters for a new textbook titled "Return to Sports After ACL Reconstruction and Other Knee Operations: Limiting the Risk of Re-Injury and Maximizing Athletic Performance." This textbook includes 30 chapters, 18 of which are written by Cincinnati SportsMedicine physicians, therapist and research staff. The remaining 12 chapters are written by guest contributors who are experts in the field of orthopaedics and sports medicine. The textbook will be published by Springer-Verlag
- Local, national, and international presentations by Drs. Frank Noyes, Thomas Lindenfeld, Samer Hasan, Marc Galloway, Matthew Busam, Sanjeev Bhatia and Michael Palmer.
- Series of publications in the Journal of Bone and Joint Surgery, American Journal of Sports Medicine, and Arthroscopy from the Biomechanics and Robotics Division. Research on rotational knee stability, ACL reconstruction, and extra-articular reconstructions were included in these publications.
- Hosted the 2nd annual Frank R. Noyes, MD and JoAnne Noyes Eminent Scholarship Program at the University of Cincinnati, Department of Orthopaedic Surgery. The Eminent visiting scholar award was given to Christopher D. Harner, MD, Professor and Vice Chairman of Academic Affairs and Sports Medicine Fellowship Program Director in the Department of Orthopaedic Surgery at the University of Texas Health System in Houston, Texas.



## Education

- 55 invited presentations given at international, national, regional and local meetings.
- 5 abstracts submitted for presentation at international and national meetings.
- 75 teaching conferences attended by fellows, physical therapists, athletic trainers, physical therapy students and athletic training students.
- 12 journal clubs attended by staff physicians and fellows.



## Fellowship

- Nationally acclaimed sports medicine, knee, and shoulder fellowship program.
- ACGME/RRC accreditation; recognized by the American Orthopaedic Society for Sports Medicine and the Arthroscopy Association of North America.
- 155 fellow graduates (1979-2018) practicing across the United States and Canada.



## Sportsmetrics™

- Greater than 300 athletes trained in 2018. Introduced Sportsmetrics™ training into 5 new high schools and continued formal training in 5 high schools in the Cincinnati area.
- Certification: 127 individuals certified from 32 states, as well as Australia and Hungary.
- Courses held in Cincinnati, OH; Hilton Head Island, SC; Kansas City, MO.

# Director Statements

The Foundation and patient care Center initiatives in 2018 continued on a very active and expanding pathway with major accomplishments in every Division, which are highlighted in the annual report. I am exceedingly proud of all the professional highlights in this annual report. The enthusiasm and continued excellence of our physician, rehabilitation, administrative, and research staff are a personal delight and wonderful experience as we work together so closely month-after-month in a truly wonderful teaching environment.



**Frank R. Noyes, MD**

Medical Director

The ongoing and new 2018 clinical studies, surgical approaches, and research advances are presented in this report. Select publications are described in greater detail. New research initiatives in the shoulder, knee, hip, injury prevention and performance occurred in 2018. I hope you will enjoy this summary of the many accomplishments of the Foundation and accompanying organizations represented in this report.

2018 represented the fifth year of integration of Cincinnati SportsMedicine and Orthopaedic Center and Mercy Health, which represents one of the largest healthcare organizations in the United States. We are pleased that Mercy Health and The Jewish Hospital have endorsed and supported our clinical research and educational programs through a joint operating agreement. We are highly pleased to announce the addition of Wayne Fraleigh, DPT, MBA to the Mercy Health Family. Wayne, who is a highly accomplished professional with a background in physical therapy, has directed the development of other major orthopaedic and sports medicine centers in Colorado, South Carolina, and Texas. Wayne joins Mercy Health as the Vice President of the Orthopaedic and Neuroscience service lines.

Our continued growth now numbers a total of over 100 dedicated personnel in our Center and Foundation. We offer sports medicine and specialty clinics at five Centers throughout the Cincinnati and Northern Kentucky region. Last year alone, our physicians saw more than 27,000 new and follow-up patients while our physical therapy and rehabilitation staff managed more than 60,000 patient visits. Our patients are offered the advantage to enroll in advanced treatment programs in all disciplines. We continue to operate and function at our research Centers within the Foundation and for 2019 will be increasing our collaboration with the University of Cincinnati Department of Biomedical Engineering. This relationship has spanned an amazing 40 plus years of collaboration between scientists and clinicians. Department of Biomedical Engineering highlights are shared later in this report.

Our sports medicine and arthroscopy fellowship continues to attract an excellent group of orthopedists. The achievements of our fellows in 2017-2018 and 2018-2019 are provided. Our fellows work closely with our full-time staff and have major commitments to clinical and robotic research studies. The list of publications shows their involvement in national peer reviewed publications and presentations.

We are pleased to announce the completion of the new graduate medical education building and auditorium at the Jewish Hospital. This newly constructed facility will be home for many of our educational endeavors. This 17,200-square foot facility features the latest in state-of-the art educational and teaching tools.





# Professional Staff

## 2017-2018 Fellows



Dapo Ajayi, MD



Richie Edeen, MD



Sean Kelly, DO



Mike Palmer, MD

## 2018-2019 Fellows



Andrew Crapser, MD



Oscar Noel, DO



David Parker, MD



Andrew Smith, DO

## Foundation Staff



Edward Grood, PhD  
Emeritus Professor,  
University of Cincinnati  
Department of Biomedical  
Engineering



Sue Barber-Westin, BS  
Director, Clinical  
Research,  
Noyes Knee Institute



Cassie Fleckenstein, MS  
Manager,  
Clinical Research



Jennifer Riccobene, BA  
Research Coordinator



Debbie Hartwig  
Administrative Assistant



Tommy Campbell, BA  
Director of Marketing,  
Noyes Knee Institute  
& Sportsmetrics™



Stephanie Smith, MS  
Manager,  
Sportsmetrics™ Program



Teresa Wood  
Fellowship Coordinator/  
Administrative Assistant



Lauren Huser, MEng  
Research Associate

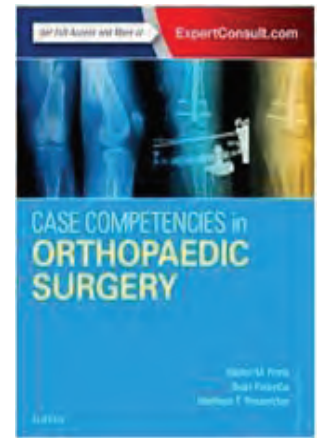
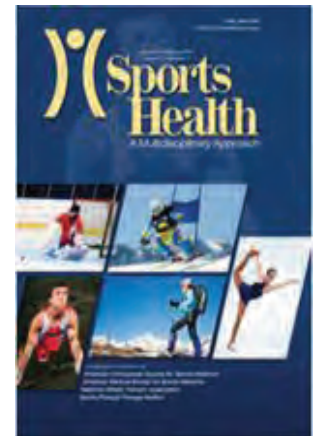
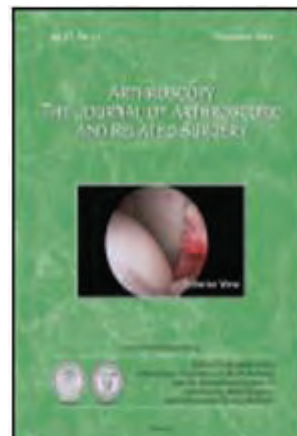


Caitlin Kirst, ATC  
Sportsmetrics™  
Athletic Trainer

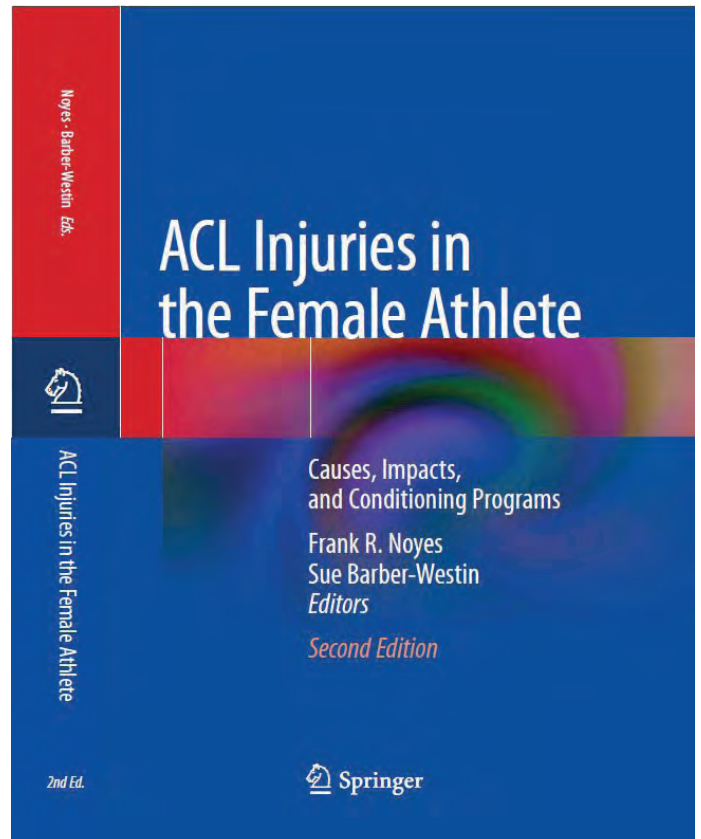
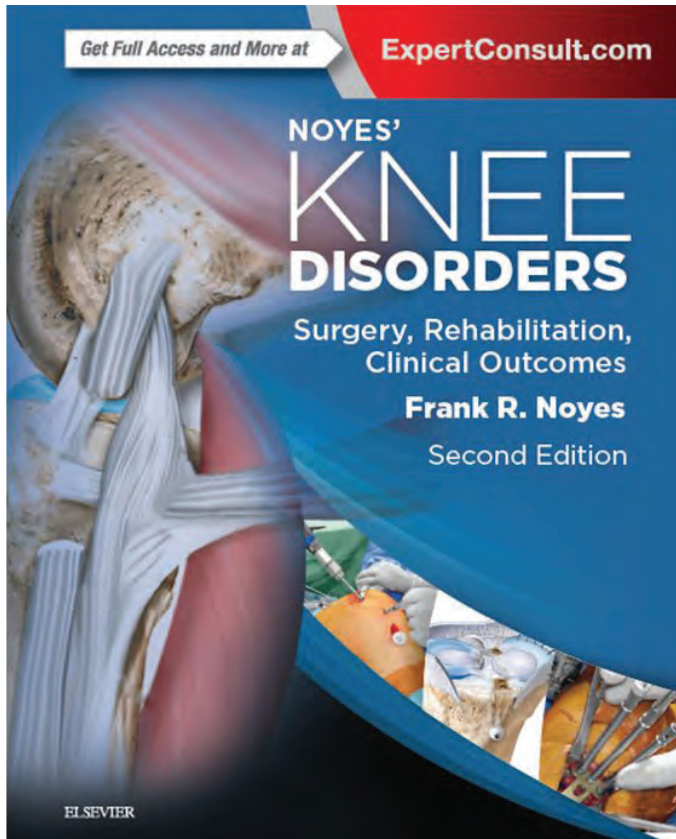


Vanessa Florian, BS  
Research Coordinator

# 2018 Journal Publications and Textbook Chapters







# Knee Division: Clinical Outcome Studies & Applied Clinical Research

- *Knee Disorders Prospective Registry*
- *Tibial and Femoral Osteotomy Realignment Studies*
- *Cartilage and Meniscus Restoration Center*
- *Robotic Patellofemoral and Tibiofemoral Joint Replacement Center*



This division is responsible for every phase of our patient-related studies under the direction of Dr. Frank Noyes. The Knee Registry is over 25 years old and numerous clinical studies have been published on all types of complex knee disorders. The publications have a 90% to 100% follow-up, which is a major credit to our research staff that follow our patients throughout the United States. Patients travel from all over the world to receive specialized care for serious knee disorders and our clinical and research team continue to provide the highest standard of care available with compassion and individualized treatment programs. The breadth of clinical outcomes studies are featured in the 2nd edition of the Noyes Knee Disorders book published in 2016.

*Personnel: Sue Barber-Westin, Cassie Fleckenstein, Jennifer Riccobene, Vanessa Florian*

## Publications

1. Barber-Westin SD, Noyes FR: Low-impact sports activities are feasible after meniscus transplantation: A systematic review. *Knee Surg, Sports Traumatol, Arthrosc* 26:1950-1958, 2018.
2. Noyes FR, Huser LE, Levy MS: The effect of an ACL reconstruction in controlling rotational knee stability in knees with intact and physiologic laxity of secondary restraints as defined by tibiofemoral compartment translations and graft forces. *J Bone Joint Surg Am* 100: 586-597, 2018.
3. Noyes FR, Huser LE, West J, Jurgensmeier D, Walsh J, Levy MS: Two different knee rotational instabilities occur with anterior cruciate ligament and anterolateral ligament injuries: A robotic study on anterior cruciate ligament and extra-articular reconstructions in restoring rotational instability. *Arthroscopy* 34: 2683-2695, 2018.
4. Noyes FR, Barber-Westin SD: Blood flow-restricted training for lower extremity muscle weakness due to knee pathology: A systematic review. *Sports Health* ePub Nov. 26, 2018.
5. Knee Arthrofibrosis: Everything You Need to Know to Recognize, Treat, and Prevent Loss of Knee Motion After Injury or Surgery. E-Book updated 2018.
6. Partial Knee Replacement: Everything You Need to Know to Make the Right Treatment Decision. E-Book updated 2018.

## Textbook chapters

Our textbook [ACL Injuries in the Female Athlete, 2nd Edition](#) was completed in 2017. This second edition was deemed necessary due to the exceptional sales of the 1st Edition that was published in 2012 and to the continuing worldwide research efforts in this area. The first edition has consistently been in the top 20% of the publisher's (Springer-Verlag) online sales, with over 40,000 chapters sold to date. This textbook provides step-by-step details of training programs of proven value in reducing the rate of noncontact ACL injuries in female athletes. Risk factors for ACL injuries in female athletes are described using data from hypothesis-driven investigations. Hundreds of

published studies are summarized, providing a clear understanding of the short- and long-term impacts of ACL injuries. The second edition was published in the summer of 2018.

[ACL Injuries in the Female Athlete. Causes, Impacts, and Conditioning Programs, 2nd Edition](#)  
Noyes FR, Barber-Westin SD (eds), Springer-Verlag, Berlin Heidelberg, 2018.

1. Noyes FR, Barber-Westin SD: Chapter 1: The ACL: Anatomy, Biomechanics, Mechanisms of Injury, and the Gender Disparity.
2. Barber-Westin SD, Noyes FR: Chapter 2: Consequences of Complete ACL Ruptures.
3. Noyes FR, Barber-Westin SD: Chapter 4: Risks of Future Joint Arthritis and Reinjury after ACL Reconstruction.
4. Barber-Westin SD, Noyes FR: Chapter 15: Effect of Fatigue and Gender on Lower Limb Neuromuscular Function.
5. Barber-Westin SD, Noyes FR: Chapter 17: Testing for Neuromuscular Problems and Athletic Performance.
6. Noyes FR, Barber-Westin SD: Chapter 18: Sportsmetrics™ ACL Intervention Training Program: Components, Results.
7. Barber-Westin SD, Noyes FR: Chapter 19: Sports-Specific Programs for Soccer, Basketball, Volleyball, and Tennis.
8. Noyes FR, Barber-Westin SD: Chapter 21: ACL Injury Prevention Warm-up Programs.
9. Barber-Westin SD, Noyes FR: Chapter 22: Effect of Intervention Programs on Reducing the Incidence of ACL Injuries, Improving Neuromuscular Deficiencies, and Enhancing Athletic Performance.
10. Heckmann TP, Noyes FR, Barber-Westin SD: Chapter 24: Rehabilitation After ACL Reconstruction.
11. Noyes FR, Barber-Westin SD: Chapter 27: Functional Assessment of Neuromuscular Function Before Return to Sports After ACL Reconstruction.
12. Barber-Westin SD, Noyes FR: Chapter 29: Promotion of ACL Intervention Training Worldwide.



## Manuscripts and Book Chapters Under Review/In Press

1. Barber-Westin SD, Noyes FR: Which anterior cruciate ligament prevention programs are effective in decreasing injury rates and improving neuromuscular indices in female athletes? A systematic review. Under review, *Sports Health*.

In 2018, we began working on a textbook that will be published by Springer in 2019, Return to Sport After ACL Reconstruction and Other Knee Operations: Limiting the Risk of Reinjury and Maximizing Athletic Performance. Nearly a million anterior cruciate ligament (ACL) injuries occur each year worldwide, most of which are sustained by young athletes. The ability to return patients back to sports safely and without subsequent problems is paramount. Return to play has become the subject of increased scrutiny as a result of high reinjury rates that have been reported, as well as disappointing percentages of athletes who returned to sports even though normal or very good knee function was restored.

This unique textbook focuses on return to play after ACL and other knee operations and discusses:

- Common barriers to return to play, including physical, psychological, psychosocial, and neurocognitive problems.
- Return to play decision-based models and the roles of the orthopaedic surgeon and team physician.
- The complete spectrum of optimal treatment for ACL injuries, including preoperative, intraoperative, and postoperative rehabilitation.
- Advanced training concepts such as neuromuscular retraining, work load intensity, external focus, and visual-motor training concepts.
- Objective testing for knee function, neurocognitive function, and cardiovascular fitness.
- Identification and management of psychological issues including fear and depression in the athlete.
- Return to play considerations after meniscus surgery, patellofemoral realignment, articular cartilage procedures, and knee arthroplasty.

The chapters we will write are:

1. Noyes FR, Barber-Westin SD: Advantages and Potential Consequences of Return to Sport: Patient Satisfaction, Reinjury Rates, Knee Osteoarthritis.
2. Barber-Westin SD, Noyes FR: Common Physical and Psychological Barriers to Return to Sport.

3. Barber-Westin SD, Noyes FR: Return to Sport After ACL Reconstruction: Where's the Scientific Evidence?
4. Heckmann TP, Noyes FR, Barber-Westin SD: Preoperative Rehabilitation: Basic Issues.
5. Noyes FR, Barber-Westin SD: Intraoperative Considerations Crucial for a Successful Outcome.
6. Noyes FR, Barber-Westin SD: Early Postoperative Rehabilitation to Avoid Complications and Prepare for Return to Sport Training.
7. Barber-Westin SD, Noyes FR: Sportsmetrics™ Neuromuscular Training: Basic and Advanced.
8. Noyes FR, Barber-Westin SD: Return to Sport for Soccer and Basketball.
9. Barber-Westin SD, Noyes FR: Return to Sport for Tennis.
10. Noyes FR, Barber-Westin SD: The Physician's Comprehensive Examination.
11. Barber-Westin SD, Noyes FR: Neuromuscular Function, Agility, and Aerobic Testing.
12. Noyes FR, Barber-Westin SD: Muscle Strength and Balance Tests.
13. Barber-Westin SD, Noyes FR: Validated Questionnaires to Measure Return to Sport and Psychological Factors.
14. Barber-Westin SD, Noyes FR: Return to Sport After ACL Revision Reconstruction.
15. Noyes FR, Barber-Westin SD: Return to Sport After Meniscus Operations: Meniscectomy, Repair, and Transplantation.
16. Noyes FR, Barber-Westin SD: Return to Sport After Patellofemoral Realignment.
17. Noyes FR, Barber-Westin SD: Return to Sport After Partial and Total Knee Arthroplasty.
18. Noyes FR, Barber-Westin SD: Current Understandings and Directions for Future Research.

## Abstracts

1. Noyes FR, Huser LE, West J, Jurgensmeier D, Walsh J, White J, Levy. Two Different Knee Rotational Instabilities Occur with Injury to the ACL and Anterolateral Structures. 2018 AAOS Annual Meeting.
2. Noyes FR, Barber-Westin SD, Smith S. Which Anterior Cruciate Ligament Prevention Programs are Effective in Decreasing Injury Rates and Improving Neuromuscular Indices in Female Athletes? 2018 AAOS Annual Meeting.





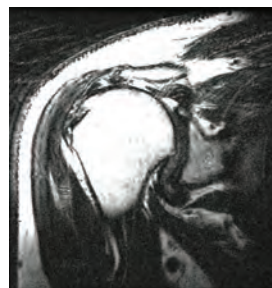
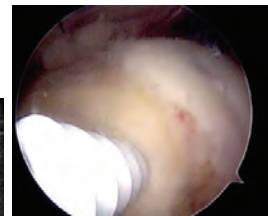
3. Noyes FR, Barber-Westin SD, Fleckenstein CM, Riccobene JV. Patellofemoral Arthroplasty in Younger Patients: Are Recreational Activities Feasible? 2018 AAOS Annual Meeting and 2018 World Arthroplasty Congress.

### Current Major Studies

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1. Long-term Clinical Outcomes Following Meniscus Transplantation.
2. High Tibial Osteotomy with TOMA Fix Locking Plate.
3. MPFL Reconstruction with Proximal Patellar Realignment.
4. ACL Revision with Tibial and/or Femoral Tunnel Bone Grafting.
5. Short and Long-term Clinical Outcomes Following MAKO Patellofemoral and Tibiofemoral Joint Replacements.
6. Cartilage Restoration of the Knee Joint.
7. Distal Femoral Osteotomy for Valgus Malalignment in Young Patients.
8. Return to Recreational Activities and Work Following Total Knee Replacement: Introduction of Advanced Conditioning and Performance Programs to Achieve Higher Success Rates.
9. Blood Flow Restriction Training for Severe Muscle Atrophy.
10. Biologics – Bone Marrow Aspirate Stem Cell Concentrate, PRP.

# Shoulder Division: Clinical Outcome Studies & Applied Clinical Research



Under the direction of Drs. Samer Hasan, Thomas Lindendorf, Marc Galloway and Matthew Busam, the Center is a destination for patients seeking quality nonoperative and operative treatment of their shoulder and elbow conditions and injuries. In addition, the Center continues to lead in various shoulder related research studies. Dr. Hasan is involved with two major, multi-center studies. The first is a five-year, post-market study of the DJO reverse shoulder prosthesis. The second is a two-year randomized, investigational device exemption study of the OrthoSpace InSpace balloon device for the treatment of massive irreparable rotator cuff tears. Dr. Lindendorf continues to evaluate a device to more accurately measure glenohumeral rotation. Full details on our other studies, submitted abstracts, publications and book chapters can be found below.

*Personnel: Cassie Fleckenstein, Jennifer Riccobene, Vanessa Florian*

## Publications

1. Ashman BD, Tewari A, Castle J, Hasan SS, Bhatia S. Intraoperative Neuromonitoring for Brachial Plexus Neurolysis During Delayed Fixation of a Clavicular Fracture Presenting as Thoracic Outlet Syndrome: A Case Report. JBJS Case Connect. 2018 Oct-Dec; 8(4):e85.
2. Hasan, S.S. Cited in "Wide Armamentarium Still Needed to Treat Massive Cuff Tears", Orthopedics Today, March, 2018.
3. Hasan, S.S. Perspective on "Long term outcomes of glenohumeral arthrodesis" by Wagner et al., Orthopedics Today, August, 2018.

## Book Chapters

1. Kawtharani, F., Hasan, S.S., Clinical Anatomy of the Clavicle. In: Clavicle Injuries: A Case Based Guide to Diagnosis and Treatment. Groh GI (ed.) Springer, New York, 2018, pp. 1-18.

## Manuscripts/Textbook chapters under review, in press

1. Hasan, S.S., Levy, J.C., Leitze, Z.R., Kumar, A.G., Krupp, R.J., Harter, D.G., "Reverse Shoulder Prosthesis with a Lateralized Glenosphere: Early Results of a Prospective Multi-Center Study Stratified by Diagnosis", J Shoulder Elbow Arthroplasty, In Press.
2. Hasan, S.S., Rolf, R.H., Simpson, A., Eten, K., Elsass, T.R. "Single Shot versus Continuous Interscalene Block for Postoperative Pain Control following Primary Shoulder Arthroplasty: A prospective randomized clinical trial", JAAOS – Global Res Rev., 2018, In Press.
3. Palmer, M., Fleckenstein, C.M., Levy, M.S., Hasan, S.S., "The Distribution of Shoulder Replacements among Surgeons and Hospitals is Changing over Time", Shoulder Elbow, 2018, Under Review.

4. Young Osteoarthritis Shoulder Study Group, "Evaluating Glenohumeral Osteoarthritis: The Relative Impact of Patient Age, Activity Level, Symptoms, and Kellgren-Lawrence Grade on Decision-making", Arch Bone Joint Surg, 2018, In Press.
5. Hasan, S.S., Schwindel L.E., Fleckenstein, C.M., "Prosthetic Shoulder Arthroplasty in Patients 40 Years Old or Less: Early Outcomes Stratified by Diagnosis and Surgery", J Shoulder Elbow Arthroplasty, Under Review.
6. Hasan, S.S. Perspective on "Nonarthroplasty surgical treatment options for massive, irreparable rotator cuff tears" by Carver et al., Orthopedics Today, Under Review.

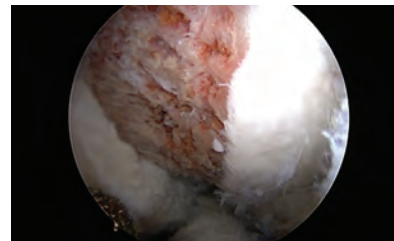
## Abstracts

1. Hasan SS, Schwindel LE, Fleckenstein CM. Prosthetic Shoulder Arthroplasty in Patients 40 Years Old or Less. Submitted for consideration at the 2018 American Academy of Orthopaedic Surgeons Annual Meeting.

## Current Studies

1. Multi-Center Study – InSpace Device for the Treatment of Full Thickness Massive Rotator Cuff Tears.
2. Multi-Center SAFE – Shoulder Arthroplasty Failure Experience – Study.
3. Continuous Passive Motion following Arthroscopic Rotator Cuff Repair: A Randomized Prospective Study.
4. Glenohumeral Shoulder Rotation and Arch of Motion in Overhead Athletes.
5. Results of Prosthetic Shoulder Arthroplasty in Patients Under Age 40.
6. Multi-Center Study – Orthofix Rotator Cuff Repair.

# Hip Division: Clinical Outcome Studies & Applied Clinical Research



The prospective clinical outcomes hip division is responsible for every phase of all patient-related studies under the direction of Dr. Sanjeev Bhatia and Dr. Michael Palmer. The Hip Arthroscopy and Joint Preservation Center aims to provide patients from the Midwest region and beyond with a cutting edge, multidisciplinary approach involving injuries of the hip. Using the latest in newly developed arthroscopic and open surgical techniques, newly developed cartilage technologies, and non-surgical rehabilitation protocols and injections, the Center aims to provide young, active individuals with the best evidence-based non-arthroplasty treatment options for relieving hip pain, delaying the progression of end stage arthritis, and returning individuals to sports and function. Additionally, the Center is actively engaged in research and education efforts to advance the understanding of hip and joint preservation, sports medicine, and orthopaedic wellness.

In 2018, the Hip Division engaged in several research efforts and achieved a number of accolades, one of which being a Podium presentation invitation to the American Academy of Orthopaedic Surgeons (AAOS) Annual Meeting for work related to Ultrasound-Guided Injection in the Office Setting.

Going forward in 2019, Dr. Michael Palmer will be the new Director of the Hip Arthroscopy & Joint Preservation Center. Dr. Bhatia will continue to serve as adjunct faculty but will be in a new role with Northwestern Medicine.

*Personnel: Cassie Fleckenstein, Jennifer Riccobene, Vanessa Florian*

## Current Studies

1. In Office Ultrasound Guided Intra-articular Hip Injection vs. Hospital and Operating Room Based Fluoroscopic Guided Intra-articular Hip Injection: A Cost Minimization Analysis.
2. Can Effective Outcomes with Hip Arthroscopy be Achieved in Obese Individuals?: A Matched Cohort Analysis

## Publications

1. Briggs KK, Soares E, Bhatia S, Philippon MJ. Postoperative alpha angle not associated with patient-centered midterm outcomes following hip arthroscopy for FAI. *Knee Surg Sports Traumatol Arthrosc.* 2018 Apr 11. doi: 10.1007/s00167-018-4933-3.
2. Bhatia S, Ellman MB, Nho SJ, Mather RC, Bedi A, Aoki SK, Larson CM, Kelly B, Griffin DR, O'Donnell J, Mei-Dan O. Letter to the Editor: Bilateral Hip Arthroscopy: Direct Comparison of Primary Acetabular Labral Repair and Primary Acetabular Labral Reconstruction. *Arthroscopy.* 2018 Jun;34(6):1748-1751. doi: 10.1016/j.arthro.2018.03.027.

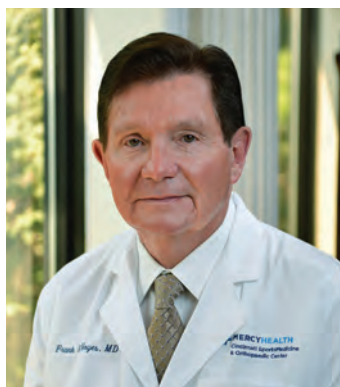
## Manuscripts/Textbook chapters under review, in press

1. Bhatia S, Chahla J, Cinque ME, Ellman MB. "Recovery of Hip Muscle Strength After ACL Injury and Reconstruction: Implications for Reducing the Risk of Re-Injury." ACL Injuries in the Female Athlete- Causes, Impacts, and Conditioning Programs. Springer-Verlag 2018. In Press.
2. Das V, Ellman MB, Bhatia S. "Emerging Concepts in Arthroscopic Hip Preservation Surgery: Labral Reconstruction and Capsular Preservation." Hip Preservation Techniques. Boca Raton, FL: CRC Press 2018. In Press.





## Local, National, and International Meeting Presentations



**Frank R. Noyes, MD**

1. Biomechanical Function of the Anterolateral Complex. Knee Consensus Meeting. United Kingdom, 2018.
2. Patellofemoral Arthroplasty in Younger Patients: Are Recreational Activities Feasible? Poster, AAOS Annual Meeting, New Orleans, March 6-10, 2018.
3. Which Anterior Cruciate Ligament Prevention Programs Are Effective in Decreasing Injury Rates and Improving Neuromuscular Indices in Female Athletes? Poster, AAOS Annual Meeting, New Orleans, March 6-10, 2018.
4. Patellofemoral Arthroplasty in Younger Patients: Are Recreational Activities Feasible? Poster, World Arthroplasty Congress, Rome, April 19-21, 2018.
5. Meniscus Repair and Transplantation: What's New in 2018. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 27, 2018.
6. Surgical Correction for Patellofemoral Malalignment. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 27, 2018.
7. Comprehensive Knee Exam: Clinical Rationale and Diagnosis. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 28, 2018.
8. Scientific Basis and Development of the Sportsmetrics™ Neuromuscular Training Programs. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 28, 2018.
9. Surgical Perspective on Avoiding and Treating Knee Arthrofibrosis. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 28, 2018.
10. Surgical Treatment of PCL and Posterolateral Ligament Injuries. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 29, 2018.
11. High Tibial Osteotomy: Techniques and Surgical Results. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 29, 2018.
12. Partial Joint Replacement: Unicompartamental and Patellofemoral. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 29, 2018.
13. Patellofemoral MAKO Arthroplasty in Younger Patients. University of Cincinnati Department of Orthopaedic Surgery and Sports Medicine. The Frank R. Noyes, MD and JoAnne Noyes, BS, RN Endowed Eminent Visiting Scholar in Sports Medicine and Bioengineering. Cincinnati, OH. August 18, 2018.



**Thomas N. Lindenfeld, MD**

1. Shoulder Anatomy Review – What You Need to Know. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 26, 2018.
2. Elbow Anatomy and Basic Arthroscopy. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 27, 2018.

## Local, National, and International Meeting Presentations



**Samer S. Hasan, MD, PhD**

1. Invited Faculty, TSA Bioskills Demo and Lab, Speaker on “Computer Aided Preoperative Planning”, “DJO Workshop – TSA”, “Debate: Baseplate Design – Screw-in/Threaded Post”, and “Posterior Shoulder Instability and Scope Rx”, Current Solutions in Shoulder and Elbow Surgery, Tampa, Florida, February 1-3, 2018.
2. Co-Chairman, Size Matters: Innovations in Shoulder and Elbow Arthroplasty, Las Vegas, Nevada, February 16-17, 2018.
3. Faculty, 24th Annual Sports Medicine Symposium for the Health Care Profession, Speaker on “Diagnosis and Treatment of Shoulder Instability”, Cincinnati, Ohio, February 22-24, 2018.
4. Faculty, 7th Annual Fellows Course in Shoulder Arthroplasty, Dr. A Green, Course Director. Indianapolis, Indiana, April 12-14, 2018.
5. International Faculty, 1st Shoulder Live Surgery Course in Jordan, Specialty Hospital. Amman, Jordan, April 20-21, 2018.
6. Faculty and Moderator, 33rd Advances on the Knee and Shoulder, Talks on: “Complications of SLAP and Biceps Surgeries”, “Anatomic Shoulder Replacement Surgery”, Moderator: “Treatment of the Overhead Athlete: Case Based Symposium”, “Treatment of Shoulder Instability: Case Based Symposium”, Panelist: “Treatment of Massive Rotator Cuff Tears: Case Based Symposium”, Faculty: “Physical Examination of the Shoulder – Breakout Session”, “The Stiff Shoulder – Breakout Session”, “Complex Case Presentations – Breakout Session”, Hilton Head, South Carolina, May 26-29, 2018.
7. Faculty, North Sports Health and KORT Sports Medicine Symposium, “Point-counterpoint: I Don’t Want to Fail: Collision Athlete with First Time Dislocation – Do a Scope with Remplissage”, “Management of Posterior Instability”, Louisville, Kentucky, June 8-9, 2018.
8. Faculty, 2018 San Diego Shoulder Course, San Diego, California, June 20-23, 2018.
9. Invited Speaker, “Arthroscopic Treatment Options for the Massive and Irreparable Rotator Cuff Tear” and “Glenoid and Humeral Bone

Loss in Anterior Shoulder Instability”, Orthopaedic Grand Rounds, American University of Beirut, Beirut, Lebanon, July 5, 2018.

10. Delegate, Second International Consensus on Musculoskeletal Infection, Philadelphia, Pennsylvania, July 25-27, 2018.
11. Guest Speaker, “2018 Update on Arthroscopic Treatment of Anterior Shoulder Instability”, “2018 Update on Superior Capsule Reconstruction”, OhioHealth/Grant Medical Center Residency (Arthrex Sponsored), Columbus Ohio, September 26, 2018.
12. Guest Speaker, “Shoulder Replacement Surgery: Past, Present, and Future”, Association of Surgical Assistants Annual Meeting, Cincinnati, Ohio, September 29, 2018.
13. Panelist and Moderator – Case Presentation, “Symposium I: Indications – How Much Does Age Matter?” ASES 2018 Open Symposium, Shoulder Arthroplasty: Past, Present, and Future, Chicago, Illinois, October 11, 2018.
14. Presenter, “Matsen’s Red and Yellow Protocol”, “Symposium III: Update on Infection: Prophylaxis and Treatment”, ASES 2018 Annual Meeting, Chicago, Illinois, October 12, 2018.
15. Speaker, “Treatment of Partial Thickness Rotator Cuff Tears”, Shoulder Conference, University of Cincinnati, Department of Orthopaedic Surgery, November 9, 2018.



**Matthew L. Busam, MD**

1. Distal Biceps Injuries. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, SC, May 27, 2018.
2. Sports Medicine Review: Keeping Athletes in the Game. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, SC, May 27, 2018.
3. Avoiding Complications in ACL Surgery. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, SC, May 28, 2018.

# Local, National, and International Meeting Presentations



**Sanjeev Bhatia, MD**

1. Femoroacetabular Impingement: Current Concepts in Diagnosis and Treatment. Current Concepts in Hip Arthroscopy: Decision-Making and Treatment of Acetabular Labral Tears Live National Webinar. AAOS Webinar Series. Course Director Michael Ellman MD. September 25, 2018.
2. Hip Arthroscopy in 2018: What Works and What Doesn't. Podium Presentation at 2018 Frank R Noyes, MD and JoAnne Noyes, BS, RN Endowed Eminent Visiting Scholar Lectureship. Department of Orthopaedic Surgery, University of Cincinnati. Cincinnati, OH. August 18, 2018.
3. Ultrasound Guided Hip Injections: Incorporating into Practice. Podium Presentation at 2018 Inaugural Fellows Course. Arthroscopy Association of North America. Rosemont, IL. June 22, 2018.
4. Labral Reconstruction: Tips and Tricks for Labral Refixation. Podium Presentation at 2018 Inaugural Fellows Course. Arthroscopy Association of North America. Rosemont, IL. June 23, 2018.
5. Interportal Capsulotomy: Tips and Tricks for Repair. Podium Presentation at 2018 Inaugural Fellows Course. Arthroscopy Association of North America. Rosemont, IL. June 23, 2018.
6. Hip Arthroscopy: What Works and What Doesn't. Podium Presentation at 2018 Cincinnati SportsMedicine Annual Meeting. Hilton Head Island, SC. May 27, 2018.
7. Hip Arthroscopy: Case Presentations. Podium Presentation at 2018 Cincinnati SportsMedicine Annual Meeting. Hilton Head Island, SC. May 27, 2018.
8. Orthopaedic Innovation: From Idea to the Patient - A Surgeon's Guide. Podium Presentation at 2018 Vail International Shoulder Summit. Vail, CO. April 6, 2018.



**Michael P. Palmer, MD**

1. Abnormal Lachman & Pivot-Shift Translations after ACL Graft Reconstruction are Affected by Graft Conditioning Protocols: A Robotic Study of Three ACL Graft Constructs. Society of Military Orthopaedic Surgeons Annual Meeting in Keystone, CO. December 12, 2018.

## Fellows

### Adedapo Ajayi, MD

1. The Key to the Knee: Medial and Anterior Knee Anatomy. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 28, 2018.

### Richie Edeen, MD

1. The Key to the Knee: Lateral and Posterolateral Knee Anatomy. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 28, 2018.
2. Use of Blood Flow Restriction Training in the Treatment of Severe Muscle Atrophy. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 29, 2018.

### Sean Kelly, DO

1. Advances in Total Knee Replacement for the Young, Active Patient. 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. Hilton Head Island, South Carolina, May 29, 2018.



# Biomechanics and Robotics Division

Under the direction of Edward S. Grood, PhD (Professor Emeritus, University of Cincinnati Department of Biomedical Engineering) and Frank R. Noyes, MD, the Biomechanics and Robotics Division conducts in-vitro studies on cadaveric knees using a custom-designed robot based on the Grood-Suntay coordinate system. The robot has the ability to apply precise motions and loads simulating clinical tests, such as the Lachman and pivot-shift, for the purpose of better understanding knee ligament function and replacement. This is achieved through the robot's measurement of tibial translations and rotations in 6 degrees-of-freedom.

Our Foundation, in conjunction with the Biomechanics and Robotics Division, hosted the 2nd Annual Frank R and JoAnne Noyes Eminent Scholarship Lecture program in August 2018 at the University of Cincinnati. Endowed Eminent Visiting Scholar, Christopher Harner, MD was honored. Dr. Harner is Professor and Vice Chair of Academic Affairs and Sports Medicine Fellowship Program Director in the Department of Orthopaedic Surgery at the University of Texas Health Science Center in Houston, Texas. Dr. Harner presented on the following topics.

- PCL Injuries: Science to Surgery
- Return to Play After ACL Reconstruction. Biological and Biomechanical Considerations

*Personnel: Edward S. Grood, PhD, Lauren Huser, Clinical Fellows*

## Studies Completed and Published

1. Noyes FR, Huser LE, Levy MS. The Effect of an ACL Reconstruction in Controlling Rotational Knee Stability in Knees with Physiologically Lax Secondary Restraints as Defined by Tibiofemoral Compartment Translations and Graft Forces. *J Bone Joint Surg Am* 2018;100-A(7):586-597.
2. Noyes FR, Huser LE, West J, Jurgensmeier D, Walsh J, Levy MS. Two Different Knee Rotational Instabilities Occur with ACL and Anterolateral Ligament Injuries. A Robotic Study on ACL and Extra-Articular Reconstructions in Restoring Rotational Stability. *Arthroscopy*. 2018; 34(9): 2683-2695.

## Manuscripts Under Review/In Press

1. Noyes FR, Huser LE, Ashman B, Palmer M. ACL Graft Conditioning Required to Prevent an Abnormal Lachman and Pivot-Shift After ACL Reconstruction. A Robotic Study of Three ACL Graft Constructs. *Am J Sports Med* 2018 under review.

## Accepted Abstracts

1. Huser LE, Noyes FR, West J, Jurgensmeier D, Walsh J, Levy MS. Two Different Knee Rotational Instabilities Occur with Injury to the ACL and Anterolateral Structures. Presented by Lauren Huser, MEng at the 2018 AAOS Annual Meeting in New Orleans, LA.

## Current Studies

1. How do you properly condition a B-PT-B and STG ACL graft in order to avoid detrimental elongation after implantation?
2. Does a properly conditioned B-PT-B and STG ACL graft restore rotational instability?
3. Correlative function of a BPTB ACL reconstruction in restoring normal anterior tibia translation and normal lateral tibio-femoral compartment translations in a pivot shift test.
4. ACL graft forces in resisting the Lachman and Pivot Shift knee subluxations measure by a "smart" instrumented ligament reconstruction for real time analysis.

## Upcoming Studies

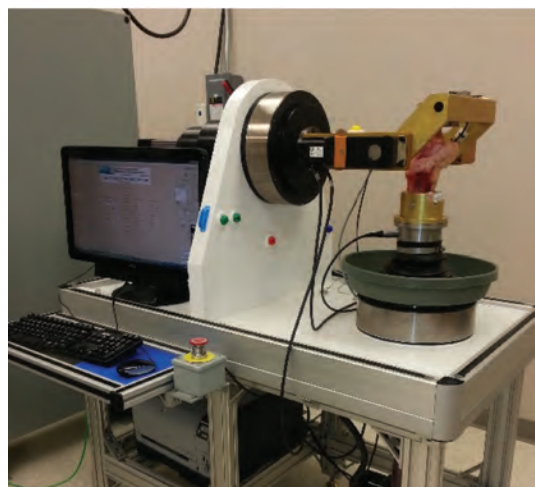
1. Biomechanics of posterior cruciate ligament (PCL) sectioning and reconstruction.
2. Three-dimensional function of the ACL characterized by 3-D maps.

Lauren Huser, MEng, presents at the 2018 AAOS meeting.

Presentation topic: Two Different Knee Rotational Instabilities Occur with Injury to the ACL and Anterolateral Structures



# Biomechanics and Robotics Division



Our research is performed on a custom 6 degree-of-freedom robotic simulator that was developed and built by Edward S. Grood, PhD. Measurements of translations, rotations, and loads on all 3 axes are displayed and recorded in real-time. This one-of-a-kind system, along with Dr. Grood's expertise in biomechanics, has been instrumental to our success in 2018.

This year has seen the completion of a major project launched in 2014 on the anterolateral complex of the knee. This project and its many facets have benefitted from the work of multiple fellows over the years, including John West, MD (2013-2014), Darin Jurgensmeier, MD (2014-2015), James Walsh, DO (2014-2015), Jared

White, DO (2014-2015), and Matthew Beck, MD (2015-2016). Their efforts resulted in 4 manuscripts: 3 already published and 1 in review.

The series of manuscripts started with a report on the biomechanical role of the anterolateral ligament (ALL) and iliotibial band (ITB) in an ACL-intact knee, published in *Arthroscopy*<sup>1</sup>. The major finding of this study was that there was little to no increase in pivot-shift subluxations with ALL and ITB injury. (Figure 1). Another major finding of this study was an increase in internal rotation with anterolateral injury that was not controlled by the ACL. This was a consistent finding throughout our series of studies and has been validated in the literature.

The second manuscript reported on the biomechanical role of the ALL and ITB in an ACL-deficient knee, published in *The Journal of Bone and Joint Surgery*<sup>2</sup>. The same testing was performed on these specimens, but the ACL was sectioned prior to the anterolateral structures. The major finding of this study was that the ALL and ITB are not primary restraints for limiting pivot-shift

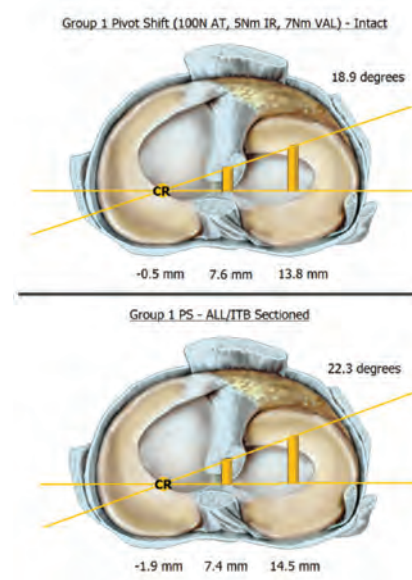


Figure 1

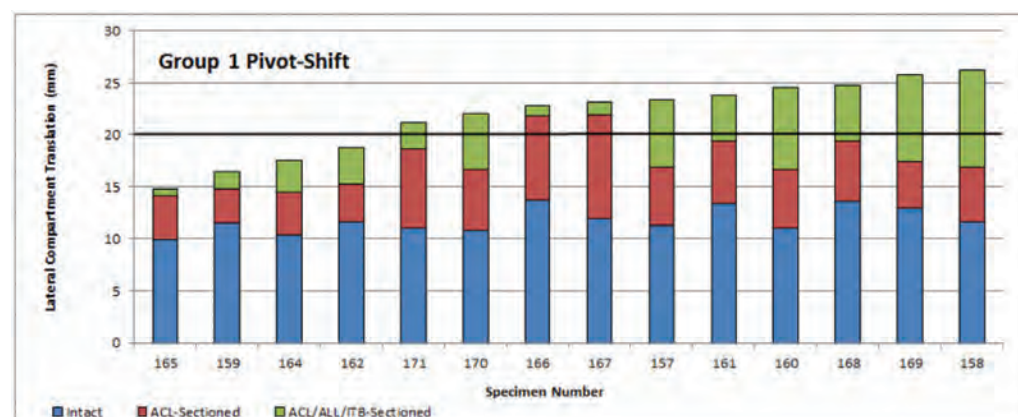


Figure 2

subluxations, but with combined ACL-ALL-ITB injury most knees resulted in a Grade III pivot-shift (Figure 2). Finally, we showed that there was great variability in the restraining action of these structures under internal rotation loading, and this became the basis of a subsequent study.

## Biomechanics and Robotics Division

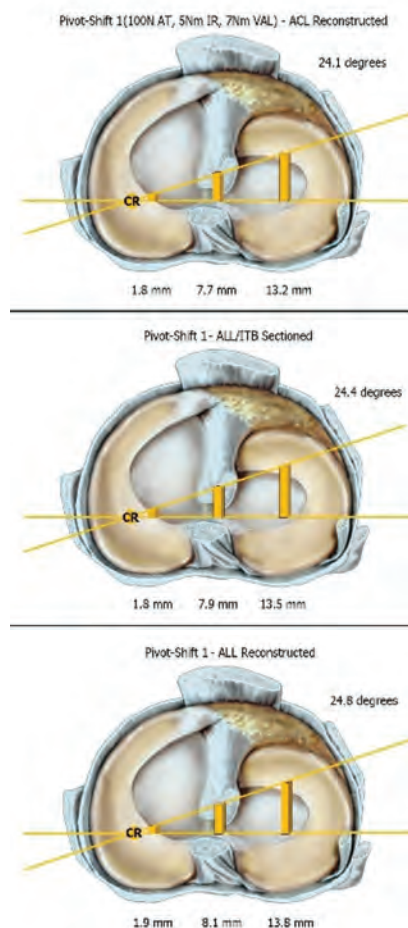


Figure 3

Our series on the anterolateral complex continued with a third manuscript that reported on the ability of an ACL reconstruction to restore knee rotational stability with ALL/ITB injury alone, and the effect of further addition of an ALL reconstruction. This was published in the *American Journal of Sports Medicine*<sup>3</sup>. We concluded that an ACL reconstruction alone will restore the pivot-shift to normal even with anterolateral injury, and thus an added ALL reconstruction had no effect on limiting pivot-shift subluxations (Figure 3). The ALL reconstruction was beneficial in restoring the internal rotation motion limit that was not controlled by the ACL reconstruction alone.

The final manuscript in our series, currently under review<sup>4</sup>, reported on the addition of an ITB tenodesis to knees with anterolateral injury. Two different tenodeses were performed: one that simulated standard clinical practice of fixing under high manual tension and a second that was fixed under a measured low tension. We concluded that a manually-tensioned ITB tenodesis will provide some restraint in the pivot-shift but will majorly over-constrain internal rotation to a degree that is not clinically acceptable.

The low-tension ITB tenodesis will restore the increases in internal rotation due to ALL/ITB injury without major over-constraint but in turn has no effect on the pivot-shift (Figure 4). The findings of this study were presented at the 2018 AAOS Annual Meeting.

A fourth manuscript, published in the *Journal of Bone and Joint Surgery*<sup>5</sup>, defined knees with and without physiologic laxity of the anterolateral restraints based on pivot-shift subluxations, Lachman translations, and internal rotation limits. The major finding of this study was that, regardless of physiologic laxity, an ACL reconstruction was able to restore knee rotational stability.

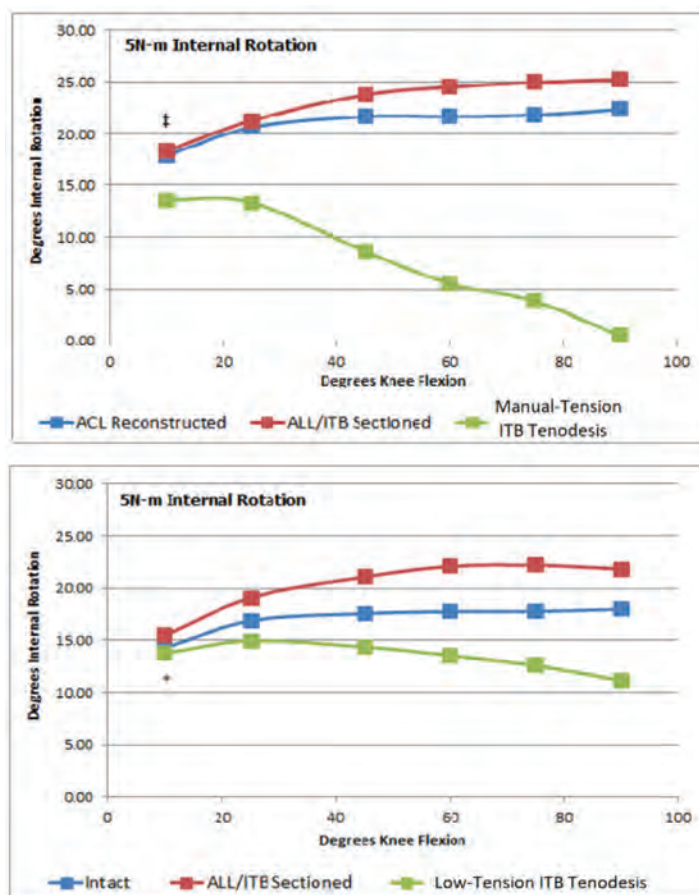


Figure 4



## Biomechanics and Robotics Division

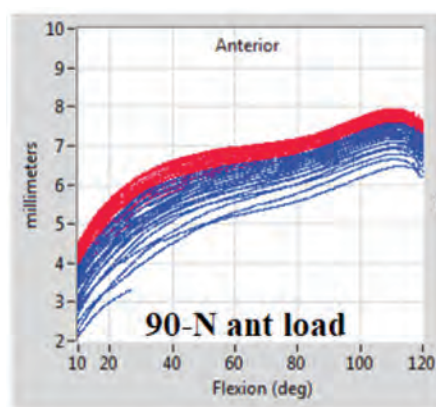


Figure 5

After completion of the series on the anterolateral complex, we started a study on ACL graft conditioning with fellows Brad Ashman, MD (2016-2017) and Michael Palmer, MD (2017-2018) that is currently ongoing. We sought to determine a practical conditioning protocol for two common ACL graft constructs: semitendinosus-gracilis and bone-patellar tendon-bone. A major finding of this study is that graft-board tensioning prior to implantation is not effective in minimizing post-operative graft elongation, as significant increases in anterior translation occur after implantation and cycling (Figure 5). Additionally, we found that cyclic loading of the knee after graft implantation produced a steady-state graft that restored rotational knee stability at time-zero. A manuscript describing this study and its results will be forthcoming.

We have plans for an important study on the posterior cruciate ligament (PCL) to begin in 2018 that explores biomechanics of the PCL and its reconstruction. This will be the first time that the PCL has been studied on our custom 6 degree-of-freedom robotics system.

1. Huser LE, Noyes FR, Jurgensmeier D, Levy MS. Anterolateral Ligament and Iliotibial Band Control of Rotational Stability in the Anterior Cruciate Ligament-Intact Knee: Defined by Tibiofemoral Compartment Translations and Rotations. *Arthroscopy* 2017;33(3):595-604.
2. Noyes FR, Huser LE, Levy MS. Rotational Knee Instability in ACL-Deficient Knees: Role of the Anterolateral Ligament and Iliotibial Band as Defined by Tibiofemoral Compartment Translations and Rotations. *J Bone Joint Surg Am* 2017;99:305-314.
3. Noyes FR, Huser LE, Jurgensmeier D, Walsh J, Levy MS. Is an Anterolateral Ligament Reconstruction Required in ACL Reconstructed Knees with Associated Injury to the Anterolateral Structures? A Robotic Analysis of Rotational Knee Stability. *Am J Sports Med* 2017;45(5):1018-1027.
4. Noyes FR, Huser LE, West J, Jurgensmeier D, Walsh J, Levy MS. Two Different Knee Rotational Instabilities Occur with ACL and Anterolateral Ligament Injuries. A Robotic Study on ACL and Extra-Articular Reconstructions in Restoring Rotational Stability. Submitted to *Arthroscopy* in January 2018. Pending Review.
5. Noyes FR, Huser LE, Levy MS. The Effect of an ACL Reconstruction in Controlling Rotational Knee Stability in Knees with Physiologically Lax Secondary Restraints as Defined by Tibiofemoral Compartment Translations and Graft Forces. *J Bone Joint Surg Am* 2018;100-A(7):586-597.

## Advances on the Knee, Shoulder, Hip and Sports Medicine Conference

This three and one-half day course provides presentations on the latest controversies and clinical, surgical, and rehabilitation recommendations for knee, shoulder, hip, and sports medicine problems. Cincinnati SportsMedicine has long recognized the collaborative efforts of orthopaedists, physical therapists, athletic trainers and many other health professionals to successfully diagnose and treat musculoskeletal problems.



In 1986, in conjunction with the American Academy of Orthopaedic Surgeons, Cincinnati SportsMedicine Research & Education Foundation co-sponsored a continuing medical education program for orthopaedic medical specialists with the emphasis on the diagnosis and treatment of knee, shoulder, and sports medicine problems. Sponsored by Cincinnati SportsMedicine, this program has evolved into one of the premier continuing education programs in the country, with an internationally recognized guest faculty.

The Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference is one of the few comprehensive continuing education courses that includes clinical, surgical, and rehabilitation techniques for knee, shoulder, elbow, hip, and

sports medicine pathology. Our internationally recognized, multi-disciplinary faculty share their experiences, research, and clinical outcomes to stimulate medical professionals to rethink their approach to many musculoskeletal challenges.





The 2018 meeting was our 33rd Annual Advances on the Knee, Shoulder, Hip and Sports Medicine Conference. We welcomed over 200 orthopaedic surgeons, physician assistants, physical therapists, physical therapy assistants, and athletic trainers to this conference. In addition to over 200 course participants, we welcomed 12 exhibitors. Course participants enjoyed listening to over 32 hours of presentations, breakouts, and panel discussions on the treatment of disorders of the knee, shoulder, elbow, hip, and sports medicine.

### 2018 Course Faculty:

Frank R. Noyes, MD  
 Sanjeev Bhatia, MD  
 Matthew L. Busam, MD  
 Samer S. Hasan, MD, PhD  
 Thomas N. Lindenfeld, MD  
 Anthony A. Romeo, MD  
 Edward M. Wojtys, MD  
 Charles A. Bush-Joseph, MD  
 Matthew J. Matava, MD  
 Adedapo Ajayi, MD  
 Richie Edeen, MD,  
 Sean Kelly, DO  
 Timothy P. Heckmann, PT, ATC  
 George J. Davies, DPT, PT  
 Julie Jasontek, PT, MHS  
 Russell M. Paine, PT  
 Kevin E. Wilk, DPT, PT  
 Stephanie L. Smith, MS





## Neuromuscular Studies, Sportsmetrics™ Training Division

The current major goal of the Neuromuscular Studies and Sportsmetrics™ Training Division is to develop and implement neuromuscular training programs that are effective in both preventing noncontact ACL injuries and improving athletic performance indicators. In addition, we provide WIPP (Warm Up for Injury Prevention and Performance) training to all Mercy Health schools.



We train and educate Mercy Health physical therapists and athletic trainers in order to provide the program in rehab and at the schools. The formal Sportsmetrics™ program, used as end-stage rehabilitation after ACL reconstruction, is evaluated for its effectiveness in reducing the high incidence of re-injury as athletes return to high-risk sports such as soccer and basketball. The targeted groups for training are high school female athletes involved in a variety of sports such as soccer, basketball, volleyball, and lacrosse.

*Personnel: Stephanie Smith, Thomas Campbell, Sue Barber-Westin, Caitlin Kirst*

### Current Studies

1. Effect of Sportsmetrics™ Training After ACL Reconstruction in Preventing Re-Injuries Upon Return to Sport.
2. Effect of Sportsmetrics™ Training in Local Female High School Athletes in Preventing Noncontact ACL Injuries.
3. Effect of an Advanced Sportsmetrics™ Training Program in Local Female High School Athletes in Preventing Noncontact ACL Injuries and Improving Sports Performance.

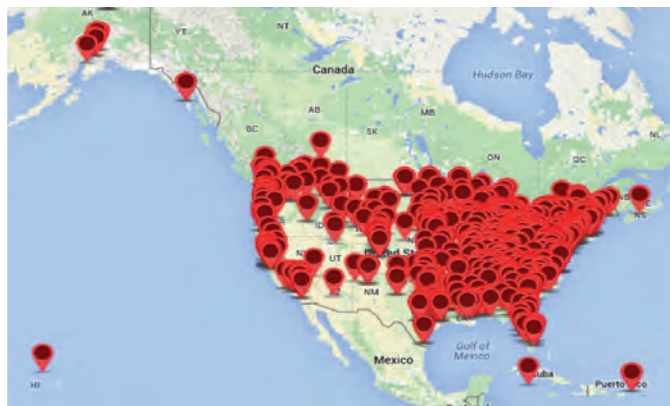
### Number of Athletes Trained

- Over 4,000 athletes trained in the Cincinnati area since 2001 with overall significant improvements in neuromuscular indices, strength and conditioning levels.
- 334 athletes in 2018

### Sportsmetrics™ Certification Program

Our Sportsmetrics™ certification program allows physical therapists, athletic trainers, and other healthcare professionals the opportunity to be part of the largest injury prevention program in the country. Our certified instructors use the scientifically-proven Sportsmetrics™ program as part of their rehabilitation program or in a group training scenario with high school and college athletes. Since 2002, we have certified over 2,200 individuals from 1,311 sites. We have certified trainers in all 50 states and 12 countries.

In 2018, 127 individuals from 32 states as well as Australia and Hungary were certified to offer the Sportsmetrics™ program in their communities. Certifications were held in Cincinnati, OH; Kansas City, MO and Hilton Head Island, SC.





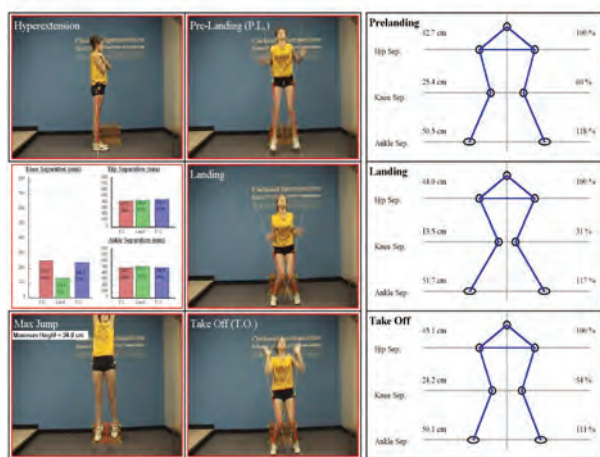
### International Sites

*Austria, Australia, Brazil, Canada, Finland, Hungary, Iceland, United Kingdom, Japan, Qatar, The Netherlands, Singapore*



### On-Site Host Sites since 2002 and number certified

1. Premier Bone & Joint Centers (16): Laramie, WY
2. SERC Physical Therapy (34): Kansas City, MO
3. Dayton Children's Hospital (18): Dayton, OH
4. University of Louisiana- Lafayette (10): Lafayette, LA
5. Emeryville Sports Physical Therapy (10): Emeryville, CA
6. Therapeutic Associates (46): Portland, OR
7. Carolinas Rehabilitation (34): Charlotte, NC
8. Community Rehab (17): Fremont, NE
9. McLeod Sports Medicine (25): Florence, SC
10. Ivy Rehab (23): Hoboken, NJ
11. Victory Sports Medicine (20): Skaneateles, NY
12. North Dakota State University (12): Fargo, ND
13. Apex Physical Therapy (10): San Mateo, CA
14. Georgia Sports Medicine (21): Atlanta, GA
15. The Jackson Clinics (30): Reston, VA
16. Hurley SportsCare (13): Flint, MI
17. SportsCare Memorial Medical Center (32): Springfield, IL
18. Physiotherapy Associates (18): Denver, CO
19. Physiotherapy Associates (15): Dover, DE
20. Northern Michigan Sports Medicine Center (16): Indian River, MI
21. Kitsap Physical Therapy & Sports Clinics (14): Silverdale, WA
22. St. Alphonsus Sports Medicine (20): Boise, ID





## Sports Medicine Fellowship Program



The fellowship program at Cincinnati SportsMedicine and Orthopaedic Center – Mercy Health is nationally acclaimed as one of the finest post-residency, sports medicine specialty training experiences. Fellows who train at our Center receive extensive experience in surgery, clinic, academics, and research. The training is accomplished through busy surgical and clinical practices, bio skills laboratories, rehabilitation exposure, on-the-field team coverage, formal weekly teaching conferences, monthly journal clubs, and research projects. The highly structured program includes didactic lectures on sports medicine, indications and complications, rehabilitation, anatomy, and biomechanics. All of the physicians at Cincinnati SportsMedicine & Orthopaedic Center are very dedicated to the educational program and the fellows every year express their gratitude for the surgical and clinical experience. The rehabilitation and athletic trainer faculty, as well, dedicated to the program and provide a unique educational experience.

*Personnel: Frank R. Noyes, Fellowship Director, Cassie Fleckenstein, Teresa Wood*

### Studies Completed

1. Anterolateral Ligament and Iliotibial Band Control of Rotational Stability in the ACL-Intact Knee: Defined by Tibiofemoral Compartment Translations and Rotations.
2. Rotational Knee Instability in ACL-Deficient Knees: Role of the Anterolateral Ligament and Iliotibial Band as Defined by Tibiofemoral Compartment Translations and Rotations.
3. Is an Anterolateral Ligament Reconstruction Required in ACL-Reconstructed Knees with Associated Injury to the Anterolateral Structures? A Robotic Analysis of Rotational Knee Stability.
4. Results of prosthetic shoulder arthroplasty in patients under age 40.
5. Distribution of Shoulder Replacements Among Surgeons and Hospitals.

*The fellowship program continues to be enriched with Dr. Marc Galloway as the Cincinnati Bengals team physician. Accompanied by the athletic coverage at local high schools, our fellowship provides for a robust sports medicine experience.*

### Manuscripts Under Review/In Press

1. Palmer M, Fleckenstein C, Hasan S. The Distribution of Shoulder Replacements is Changing.
2. Taylor ML, Palmer MP, Noyes FR. The Missed Lateral Meniscus Tear: Arthroscopic Repair of Tears at the Popliteal Hiatus.

### Current Studies

1. Comparison of iliotibial band tenodesis to an anterolateral ligament reconstruction in ACL-intact and ACL-reconstructed knees.
2. Ability of an STG ACL reconstruction using the Arthrex TightRope device to restore rotational knee stability.
3. Determination of the preconditioning protocol required at time-of-surgery to produce a sufficiently pre-tensioned, steady-state graft that will not undergo detrimental elongation following implantation. This will be evaluated in both STG and B-PT-B grafts.
4. Blood flow restriction training for severe muscle atrophy following knee injury and surgery.
5. Massive rotator cuff tear augmentation.





# University of Cincinnati Department of Biomedical Engineering

Collaboration with the University of Cincinnati Department of Biomedical Engineering continued into its 43rd year. This department was co-founded in 1975 by Drs. Frank R. Noyes and Edward S. Grood as one of the first bioengineering departments in the United States. The collaborative efforts of engineers and orthopaedic surgeons has resulted in the highest honors and awards in orthopaedic research. Awards received by the scientists and orthopaedic surgeons in the Department of Biomedical Engineering include the Orthopaedic Research and Education Foundation (OREF) Clinical Research Award for Outstanding Orthopaedic Clinical Research, and three Kappa Delta Awards from the American Academy of Orthopaedic Surgeons (AAOS). Prestigious awards have also been received from the American Orthopaedic Society for Sports Medicine (AOSSM) and the Orthopaedic Research Society (ORS).



*Jason Shearn, PhD  
Interim Chair, Department  
of Biomedical Engineering*

In 2016, the Dean of the College of Engineering announced the formation of a Department of Biomedical Engineering with a new Director and added financial resources for additional programs and faculty. Under the direction of interim chair, Jason Shearn, PhD, this department has grown to include 7 primary faculty members, 3 joint faculty members, and 30 secondary faculty members. In addition, there are 348 undergraduate students, 30 graduate students and 20 PhD students in the various programs offered by the Department of Biomedical Engineering. We would like to congratulate Dr. Shearn, former PhD student

who worked under the tutelage of Drs. Grood and Noyes, on the success of the department and his continued accomplishments in education.

We are pleased to continue our collaboration with the Department of Biomedical Engineering, allowing our Foundation's faculty to enter into new, highly innovative, and ground breaking research. These programs have a translational application to the treatment of orthopaedic and sports medicine disorders.

# Presented at the 2018 annual meeting of the American Academy of Orthopaedic Surgeons

## Patellofemoral Arthroplasty in Younger Patients: Are Recreational Activities Feasible?

Frank Noyes, MD, Sue Barber-Westin, BS, Cassie Fleckenstein, MS, Jennifer Riccobene, BS

Study conducted at the Cincinnati SportsMedicine and Orthopaedic Center-Mercy Health and the Noyes Knee Institute, Cincinnati, Ohio. This study received funding from Stryker, the Jewish Hospital, and the Noyes Knee Institute. Clinical trials gov ID #: NCT0273846.

### BACKGROUND

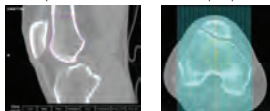
Treatment of isolated severe patellofemoral osteoarthritis in younger active patients is challenging

Patellofemoral arthroplasty (PFA) is a viable option for symptomatic patients in whom severe joint damage and loss of joint space is isolated to the patellofemoral compartment

#### PFA indications

- Painful patellofemoral arthritis
- Chronic joint dislocation or subluxation
- Trochlear dysplasia
- Trauma

Few studies have determined if patients who undergo PFA can return to recreational sports and work activities without subsequent problems.



### STUDY PURPOSE

Prospective investigation on early results of 33 consecutive third-generation PFA procedures. Determine sports and work activity levels in younger active patients.

### METHODS

33 Consecutive PFAs in 29 patients (4 bilateral)  
Mean age 40 (range, 22-68); 26 patients < 50 yrs

#### 96 Prior Operative Procedures (27 knees)

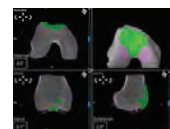
- 16 PF realignment (10 knees)
- 9 articular cartilage restorative procedures (7 knees)

#### Indications

- DJD: 18 knees
- Osteoarthritis secondary to malalignment: 11 knees
- Osteoarthritis secondary to trauma: 4 knees

#### PFA Procedure

- Cemented implant (RESTORIS MCK PF Implant System, Stryker)
- 3-D modeling, computer-assisted robotic surgical navigation (RIO, MAKOplasty Partial Knee Resurfacing, Stryker).



Preoperative planning  
Allows precise reshaping of abnormal trochlea geometry with minimal bone resection

### METHODS (Continued)

Concurrent Procedures  
5 PF realignment 11 Z-plasty lateral release

#### Comorbidities 13 patients

- 6 Obesity, 2 tobacco, 2 diabetes, 1 obesity & tobacco, 1 Ehlers-Danlos syndrome, 1 tobacco & deficiency anemia

Comprehensive clinical evaluation, Cincinnati Knee Rating System, IKDC objective rating

Radiographs (standing AP, lateral, weight-bearing PA, PF axial)  
- Trochlear dysplasia (Dejour) - Patellar height (Lindau)  
- Kellgren-Lawrence and IKDC (medial & lateral tibiofemoral)

### RESULTS

31 knees (mean age 40; 22-68)  
followed mean 4 years (range, 2-7 yrs) postop  
**Cincinnati Knee Rating System**  
**SYMPTOMS, FUNCTION**

FACTOR	POINTS	PREOP (no.)	F.U. (no.)	P
Pain*	0-10	1.9 ± 0.9	5.6 ± 1.5	< 0.0001
Swelling	0-10	2.7 ± 1.5	5.5 ± 1.9	< 0.0001
Patient perception	1-10	3.0 ± 1.2	7.6 ± 2.4	< 0.0001
Walking	0-40	26 ± 8	39 ± 3	< 0.0001
Stair-climbing	0-40	9 ± 12	34 ± 8	< 0.0001
Squatting, kneeling	0-40	4 ± 8	19 ± 15	< 0.001

\*2/31 (6%) pain ADL

#### SPORTS Before and After PFA

TYPE OF SPORT	FREQUENCY	PREOP* (no.)	FU (no.)
Low impact (swimming, cycling, aerobics)	1-3 days/mo	0	5
	1-3 days/wk	3	10
	4-7 days/wk	3	11
High-impact (jumping, pivoting, cutting)	1-3 days/wk	1	1
	Did not return because of knee condition	24	4

Change in sports activity level at follow-up

Increased, no knee problems	20
Same, no knee problems	4
Playing with knee symptoms	3
Did not return because of knee condition	3
Did not return non-knee related reasons	1

\*All were participating with symptoms and functional limitations.

#### No effect outcomes

- Concomitant patellofemoral realignment procedure
- Pre-existing comorbidity

No symptomatic subluxations or dislocations

### RESULTS (Continued)

#### OCCUPATIONS Before and After PFA

WORK LEVEL	PREOP* (no.)	FU (no.)
Very light - light	10	15
Moderate - heavy	5	2
Disabled due to knee condition	8	3
Not working due to reasons not related to knee condition	8	11

\*All patients except one who were working had knee-related symptoms and/or functional limitations.

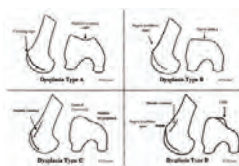
Change in occupational level at follow-up

Increased, no knee problems	5
Same, no knee problems	10
Decreased, no knee problems	1
Working with knee symptoms	1

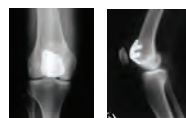
Conclusion: high 85% return to work activities in employed subgroup

#### RADIOGRAPHIC FINDINGS

Preop Patella Alta - 3 knees, Intra - 2 knees  
Dejour: A - 19 knees, B - 7 knees, C - 5 knees  
39% severe dysplasia (B, C)



Follow-up Normal position PFA prosthesis all knees  
IKDC rated A-B and K-L rated 0-1 in 97% knees  
Patella Alta - 2 knees, Intra - 3 knees



#### SUBSEQUENT OPERATIVE PROCEDURES

- 2 TKA
- 1 MPFL recon
- 1 Lateral unicondylar replacement
- 3 Arthroscopic scar tissue releases

#### COMPLICATIONS - FAILURES

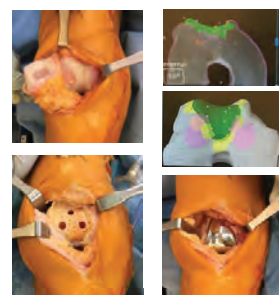
- 1 Infection
- 2/33 (6%) conversion TKA

### DISCUSSION

1. High patient perception rating: mean 3.1 pre, 7.6 post (1-10 scale)
2. High participation light sports: pre 22%, post 87%
3. High return work employed subgroup: 85%
4. CRPS preoperative in 6 (18%)  
Treat before PFA, recognize return CRPS symptoms postop, knee symptoms improve with PFA
5. Articular cartilage restoration failed, requiring PFA  
7 (21%) knees, mean age 32.7 (23-47)  
6/7 improved, returned light sports/work; 1 CRPS symptoms f.u.

#### Operative Procedure Advantages:

- Trochlear dysplasia corrected via PFA implant
- No tibial tubercle correction required for patella alta
- Correct soft tissue (MPFL) deficiency when required
- PF malalignment, z-plasty lateral release commonly required



#### Potential future problem:

- Knee flexion > 90 deg, patella prosthesis contacts femoral condyles, may produce alterations in cartilage
- Avoid high knee flexion activities postoperatively

### CONCLUSIONS

- Robotic PFA is a successful treatment option younger active patients isolated PF arthritis
- Allows return to low-impact recreational activities and occupations in the majority

### REFERENCES

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# Presented at the 2018 annual meeting of the American Academy of Orthopaedic Surgeons

## Which Anterior Cruciate Ligament Prevention Programs Are Effective in Decreasing Injury Rates and Improving Neuromuscular Indices in Female Athletes?

Frank R. Noyes, MD, Sue Barber-Westin, BS, Stephanie Smith, MS

Investigation performed at the Noyes Knee Institute and Cincinnati Sportsmedicine & Orthopaedic Center-Mercy Health. Funding received from the Noyes Knee Institute.

### BACKGROUND

2/3 ACL tears noncontact (cutting, pivoting, accelerating, decelerating, landing from a jump)

ACL reconstruction does not always restore normal knee kinematics

After reconstruction, 5-30% will tear either ACL graft or contralateral ACL upon return to sports activities

Female athletes 4-10 times increased risk noncontact ACL injuries compared with males in sports and military training

Only a few ACL prevention training programs have significantly decreased noncontact injury rates in female athletes when athlete-exposures were used to calculate injury rates

The ability of prevention programs to change dangerous movement patterns, improve muscle strength, reduce muscular imbalances, decrease landing forces is paramount to reduce noncontact injuries



### STUDY PURPOSE AND OBJECTIVE

- (1) Identify ACL prevention training programs that significantly improved neuromuscular factors believed to increase risk ACL injury
- (2) Determine if any of these training programs also significantly decreased noncontact ACL injury rates in female athletes.

### METHODS

Systematic Search PubMed, Cochrane, Google Search engine Jan 1995 - May 2017

PRISMA guidelines, studies rated MINORS or PEDro scales

**Inclusion Criteria Purpose #1** (1) all levels of evidence, (2) original studies females aged  $\geq 12$ , (3) English, (4) studies that trained female athletes to improve neuromuscular risk factors, (5) data on ground reaction forces, kinematic/kinetic factors, muscle strength/activation patterns after ACL intervention training.

**Inclusion Criteria Purpose #2** (1) same as #1-3 above, (2) ACL noncontact injury rates in female athletes calculated by athlete-exposures.

### METHODS (Continued)

**Exclusionary Criteria Purpose #1** (1) male subjects, (2) data males & females combined, (3) children <12 years, (4) studies on effects of a single training session, and (5) studies in female athletes who did not undergo training.

**Exclusionary Criteria Purpose #2** (1) same as #1-3 above (2) data contact & noncontact ACL injuries combined, (3) athlete-exposures not used in calculations.

### RESULTS

#### Study Purpose #1: Change Neuromuscular Indices

52 studies, 36 different ACL intervention programs

1,060 female athletes trained

6 programs replaced traditional team warm-up; remaining programs used separate training sessions

Direct supervision of training in 40 of 52 investigations



#### VERTICAL GROUND REACTION FORCES

- No consistent effect of training
- 5 studies significant reductions, 5 studies no change

#### KNEE JOINT ANGLES

- No consistent findings flexion drop-jump, tuck jump, vertical jump
- No significant increase flexion cutting, single-leg squatting, side-stepping
- Abduction relatively unchanged

#### Effects of Training on Knee Joint Angles



### RESULTS (Continued)

#### HIP AND KNEE MOMENTS

Knee abduction & flexion - no change most studies  
Hip abduction & flexion - relatively unchanged

#### HAMSTRINGS, QUADRICEPS MUSCLE STRENGTH

15 studies, varying results

#### Effects of Training on Muscle Strength



#### Conclusion Purpose #1

3 programs significant impact in improving multiple neuromuscular indices: Sportsmetrics, PEP, and Myer



#### Study Purpose #2: ACL Injury Reduction

- 16 studies excluded
- 7 no significant reduction noncontact ACL injury rates
- 6 combined contact & noncontact injury rates
- 3 no athlete-exposure data
- 4 studies included (3 programs)

#### ACL Noncontact Injury Rates Control vs Trained Athletes\*

Program	IR Controls	IR Trained	P
Sportsmetrics	0.21	0.03	0.03
PEP	0.49	0.09	< 0.001
KIPP	0.48	0.10	0.04

\*per 1000 athlete-exposures; IR injury rate

#### Conclusion Purpose #2: Only 3 programs effective

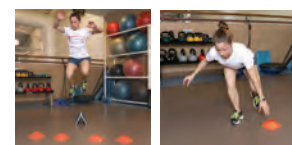
### DISCUSSION

Over 35 ACL intervention programs published to date

Only 2 (Sportsmetrics, PEP) have significantly impacted both the noncontact ACL injury rate and dangerous neuromuscular movement patterns in female athletes.

Failure other studies may be caused by:

- Short training sessions (10 mins)
- Unsupervised training
- Poor compliance
- No increase in challenge of exercises
- Failure to include plyometrics with body positioning instruction
- Lack of comprehensive strength training



### FINAL CONCLUSION

Only 2 programs (Sportsmetrics and PEP) had a significant impact in improving multiple neuromuscular indices and in significantly reducing noncontact ACL injury rates in female athletes.

#### Successful training concepts:

- Dynamic warm-up
- Supervised plyometrics
- Strength training hamstrings/hip/core/trunk
- Supervised agility training for cutting and pivoting motions
- Minimum 6 weeks of training required

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## Event Photos





# Event Photos





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