Brigham and Women's Hospital

Thomas S. Thornhill, MD

John B. and Buckminster Brown Professor of Orthopaedic Surgery, Harvard Medical School
Chairman, Department of Orthopaedic Surgery, Brigham and Women's Hospital, Boston, MA

INTRODUCTION

This past academic year at the Brigham and Women's/ Faulkner Hospitals (BW/F) has been marked with continued growth and expansion clinically as well as in research and education. There has been a change in our department administrative structure and we are pleased that Mr. Mark Miller has joined our department as the administrative leader. Mark brings a strong skill set from his recent work with the BW/F neurosurgery department and, prior to that, with general surgery departments in Colorado. Under the leadership of Dr. Gary Gottlieb, president and CEO of BW/F, musculoskeletal disease has been named one of the five major core businesses in the strategic plan of our institution. This will allow us to further build upon the unique close relationship between orthopedics and rheumatology, which was started at the Robert Breck Brigham Hospital. The Departments of Orthopedic Surgery and Rheumatology continue to share administrative leadership through the Orthopedic and Arthritis Center. Moreover, part of the BW/F strategic plan is to create a Research Institute to coordinate research efforts across our expanding campus. This initiative has been lead by Dr. Michael Brenner, Chairman, Division of Rheumatology and it will allow us to integrate a robust research initiative in each department. As we all compete for precious wet and dry lab space on the BW/F campus as well as decreasing federal grant support, this association is very helpful.

Dr. Thornhill in a meeting

As part of the strategic planning process, each of the five major core hospital initiatives was featured in a brochure sent to patients and physician colleagues. In order to give you an overview of our musculoskeletal program, I have incorporated portions of that brochure in the following paragraphs and many of the photographs in the report come from this article.

BRIGHAM AND WOMEN'S ORTHOPEDIC AND ARTHRITIS CENTER

The Brigham and Women's Orthopedic and Arthritis Center, one of the largest centers of its kind in the world, provides one-stop comprehensive orthopedic and rheumatologic care for patients with orthopedic conditions, joint diseases and bone disorders such as osteoporosis.

Our world-class orthopedic services range from joint reconstruction to cartilage repair and sports medicine as well as comprehensive spine, orthopedic oncology, hand and upper extremity and foot and ankle programs.

Our Center for Arthritis and Joint Diseases is comprised of an outstanding team of rheumatologists that focus on the medical management of rheumatoid arthritis, lupus, osteoarthritis and the full range of rheumatologic conditions. Our cutting-edge research programs have helped define how diseases of bone and joints are treated worldwide.

The Center offers patients the opportunity, in one location, to consult with not only orthopedists and rheumatologists, but also with such services as podiatry, physiatry, neurology, physical therapy, specialized nursing care, nutritional support, endocrinology, radiology, and pain management, in an integrated manner that strengthens and enriches the care we provide to each patient.

DEPARTMENT OF ORTHOPEDIC SURGERY PROGRAMS AND SERVICES

Adult Reconstruction Service/Joint Replacement

The Adult Reconstruction Service provides a comprehensive approach to treatment. The Service includes a team of orthopedic surgeons with an expertise in joint replacement of the hip, knee, elbow and shoulder that work closely with rheumatologists. The Service is at the forefront of innovative research and development of new techniques within the area of joint replacement and has vast experience in joint replacements for patients with osteoarthritis and rheumatoid arthritis.

Cartilage Repair Center

A Center within the Adult Reconstruction Service, the Cartilage Repair Center offers younger patients who have significant cartilage defects – that are the result of trauma or are degenerative – an innovative approach to reconstruction of the knee. The Center specializes in an innovative new approach to treatment called autologous chondrocyte implantation (ACI). ACI involves using the patient's own cartilage cells, multiplying them in the laboratory, and then using the newly-grown cells to patch damage to the knee – eventually multiplying after implantation and filling in the damaged cartilage with new

tissue. The Center uses a variety of other innovative technologies for the management of defects around the knee and other joints.

Foot and Ankle Service

The Foot and Ankle Service provides foot and ankle care to patients age 15 and older. Surgeons with a specialty in foot and ankle surgery, along with podiatrists, physical therapists, and radiologists provide comprehensive care for a wide variety of foot and ankle disorders and treatment for all acute and chronic problems including fractures, foot deformities, tendon disorders and sports injuries.

Hand and Upper Extremity Service

Surgeons of the Hand and Upper Extremity Service treat fractures, tumors, ligament disruptions and tendinitis of the hand and upper extremities with a special expertise in arthritis, sports injuries and traumatic disorders.

Orthopedic Oncology Service

The Orthopedic Oncology Service, part of Dana-Farber/Brigham and Women's Cancer Center, specializes in the treatment of patients with bone and soft tissue cancers as well as patients with musculoskeletal complications related to the disease. Patients are diagnosed and treated by a multidisciplinary team that cares for them through each phase of their treatment.

Orthopedic Trauma Service

The Orthopedic Trauma Service is led and staffed by orthopedic trauma surgeons with a special expertise in the management of orthopedic trauma and later conditions that develop from a trauma. Our surgeons use the most advanced treatments – including minimally invasive techniques – to provide comprehensive care. Brigham and Women's Hospital is certified by the American College of Surgeons as a Level 1 trauma center – equipped to provide specialized care to the most severely injured patients and complex cases.

Shoulder Service

The Shoulder Service treats patients with the full range of common to complex shoulder problems, including shoulder instability, degenerative diseases, rotator cuff injuries, and fractures. In addition to surgical treatments, the Service also focuses on postoperative rehabilitation that emphasizes early range-of-motion and return-to-normal function.

Spine Surgery Service

The Spine Surgery Service provides adult cervical, thoracic and lumbar surgery for the treatment of degenerative and inflammatory conditions of the spine as well as spinal trauma and deformity. The Service specializes in fusion discectomy, decompression and minimally invasive microsurgical approaches, working closely with the Neurosurgery Service of Brigham and Women's Hospital to offer a comprehensive joint surgical approach when necessary.

Sports Medicine Program

The Sports Medicine Program provides care for professional, collegiate and high school teams as well as "weekend athletes." The Program has a particular expertise in women's orthopedic conditions, young athletes with arthritis or pre-arthritic conditions, and aging athletes.

CENTER FOR ARTHRITIS AND JOINT DISEASES PROGRAMS AND SERVICES

Arthritis Center

The Arthritis Center provides multidisciplinary care for patients with arthritis and other diseases of the joints as well as those with immunologic disorders. The Center is a world-class leader in research including rheumatoid arthritis, lupus and osteoarthritis. Physicians of the Center work closely with colleagues in orthopedics, physiatry, radiology, physical therapy, neurology, podiatry, dermatology and other professionals to provide comprehensive care to their patients. Clinicians at the Center offer comprehensive care – diagnosis, treatment, and management – for patients with rheumatoid arthritis and other rheumatic diseases. From its origins as the Robert B. Brigham Hospital, the first teaching hospital in this country entirely devoted to treatment of symptoms and causes of rheumatoid arthritis and related diseases, the Center has become a focus for pioneering research, innovative therapeutics, and world-class care for arthritis sufferers.

Center for Skin and Related Musculoskeletal Diseases

The Center provides coordinated care between specialists in the Department of Dermatology and Division of Rheumatology, Immunology and Allergy. This comprehensive care involves the most advanced treatments for those illnesses that require multispecialty care and quick diagnosis. The Center provides patients with access to experts in both dermatology and rheumatology who simultaneously manage care along with dermatopathology.

Center for Adults with Pediatric Rheumatic Illness (CAPRI)

The Center provides a continuum of care between pediatric and adult rheumatology and is devoted to the multidisciplinary treatment of adults with childhood-onset arthritic and inflammatory disorders. In collaboration with pediatric rheumatologists from Children's Hospital, Center staff work with physical therapists, occupational therapists and orthopedic surgeons to provide optimal care of patients as they transition from their pediatric providers and throughout their adult lives.

Lupus and Antiphospholipid Antibody Center

The Center specializes in the diagnosis and management of patients with systemic lupus erythematosus and lupus-like syndrome (antiphospholipid antibody syndrome) and other rheumatic diseases. In addition, the Center provides expertise in the management of rheumatic diseases during pregnancy.

Spine Center

The Spine Center offers comprehensive services to evaluate and manage treatment for patients with back, neck and spine problems. Working collaboratively with physical therapists, pain specialists, surgeons, radiologists and other providers at Brigham and Women's Hospital, the physicians of The Spine Center evaluate a wide range of problems. Patients who are coping with sprains and strains of the lower back, work-associated low back pain, sciatica, scoliosis, whiplash and other conditions can make an appointment at The Spine Center for evaluation and any necessary treatment. Orthopedic and neurosurgery services are readily available for innovative surgical solutions to difficult spine problems.

Women's Musculoskeletal Center

The Women's Musculoskeletal Center is dedicated to the evaluation and treatment of arthritic conditions in women. On-site laboratory, radiology and physical therapy services are available to provide comprehensive care. The rheumatologists work closely with orthopedic surgeons to develop treatment plans and to expedite surgery when necessary.

ORTHOPEDICS RESEARCH

The Department of Orthopedics at BW/F has an active research program in several areas. Moreover we are increasingly collaborating with our rheumatology colleagues, who have a robust musculoskeletal program ranging from clinical trials in inflammatory arthritis to basic mechanisms of inflammation and control of immune mechanism. I have asked each of the section heads in orthopedic research to summarize their current activities. While the list is not complete, it will give you a sense of our areas of interest. They are listed alphabetically by investigator and much of this is in their own words.

Dr. Anuj Bellare who heads the Orthopedic Nanotechnology Group, which includes Dr. Wolfgang Fitz, Dr. Andreas Gomoll, Dr. Richard Scott and me, has focused in three specific areas which include:

Bone Cements: We continue to apply principles of Nanotechnology to improve the mechanical performance of bone cement. Our previous studies had shown that bone cement based on polymethyl methacrylate utilizing radiopacifier nanoparticles have a fatigue life that is more than twice that of cements utilizing micrometer size radiopacifiers. Recently, we showed that there is an even greater increase in fatigue life when this concept is employed in bone cements based on polymethyl methacrylate-styrene copolymers. We are currently exploring the possibility of employing antibiotic nanoparticles as additives to bone cement to determine how these nanoparticles would affect the mechanical properties of bone cement, as well as kinetics of elution of antibiotics into peri-prosthetic tissue.

Bone Repair: Another project utilizing principles of Nanotechnology to improve the performance of orthopaedic biomaterials is the development of resorbable polymer-ceramic nanocomposites, such as polylactic acid filled with hydroxyapatite nanocrystals. These nanocrystals of synthetic hydroxyapatite are of the same size range as natural bone mineral and offer the possibility of increasing the fracture toughness of the nanocomposite while maintaining a high modulus, necessary for application in bone repair. We are currently investigating processing techniques to improve the dispersion of nanohydroxyapatite in the polymer matrix, which is the key to activate nanoscale toughening mechanisms in these polymer-ceramic nanocomposites.

Polyethylene: We continue to manipulate the nanostructure of polyethylene to improve the mechanical properties of radiation crosslinked polyethylene, while maintaining high wear resistance. We have recently used high-pressure crystallization to develop high crystallinity, radiation crosslinked polyethylene. This research is a collaborative effort between our laboratory and the research group of Prof Lisa Pruitt at the University of California at Berkeley. We have shown that high crystallinity, radiation crosslinked polyethylene has a higher fatigue life and identical wear resistance compared to medium crystallinity, radiation crosslinked polyethylenes, which are currently in clinical use.

Dr. Mark Brezinski is one of the leaders in optical coherence tomography (OCT) continues to be extremely productive both in obtaining grant support and in peer review publication. He has published multiple papers within the past year and has 10 additional ones in submission. Dr. Brezinski has recently been awarded 2 competing renewal NIH grants (bringing his total to 5) to investigate: 1) the mechanism and efficacy of assessing osteoarthritis by optical coherence tomography during menisectomy or microawl procedures and 2) to develop advanced techniques for assessing osteoarthritis in rats. His laboratory has advanced the use of single detector polarization sensitive OCT, which permits determination of collagen content in tissues by virtue of the protein's birefringence and overcomes the limitations found by other groups using a single detector approach. Because images obtained with this technology have resolution at the micron scale, small changes in surface extracellular matrix can readily be identified. The OCT team is acknowledged pioneers in OCT for assessing musculoskeletal disease, coronary artery disease, and technology development. In addition, recent work has focused on distinguishing motor and sensory nerves and risk stratifying pulmonary vascular disease.

Dr. Julie Glowacki is head of the Skeletal Biology section and has been our representative in the Research Institute initiative. Her work with Dr. Meryl Leboff and other has already been incorporated in our hip fracture pathways and represents a true example of bench to bedside research. Dr. Glowacki summarizes her interests in the following statement:

Major interests of the Skeletal Biology Research Laboratory are the regulation of osteoblast and chondrocyte differentiation, the effects of age on those processes, innovative cell-free and cell-based approaches for skeletal repair, clinical impact of vitamin D-deficiency on fracture incidence, fracture healing, and joint replacement, and development and validation of evidence-based care pathways for orthopedic patients. Collaborative projects among BWH orthopedic surgeons and researchers, endocrinologists, rheumatologists, and radiologists aim to apply advances in basic science for translation to improved clinical care.

Many research projects take advantage of tissues and cells that are discarded during orthopedic surgery because they provide an opportunity to test whether information learned from experimental animals applies to humans. Several recent publications concern the roles of TGF-β and Wnt signaling in the differentiation of human chondrocytes, osteoblasts, and adipocytes. An overriding hypothesis is that as aging diminishes the differentiation of osteoblasts, the differentiation of marrow adipocytes is increased, as both of those cell types originate from a common progenitor. Ways to rejuvenate the differentia-

tion pathways are being evaluated with human marrow stromal cells as the *in vitro* target. We discovered that adipocyte differentiation can be reduced by increasing anti-oxidant reserves in the cells. Understanding details of signaling pathways and how they are changed with aging may result in new targets for intervention. Recent work suggests that cells from elders respond less well to hormones because signaling pathways are down-regulated.

A new competitive grant from the Musculoskeletal Transplant Foundation concerns *in vitro* effects of demineralized bone and bone morphogenic factors on human skin fibroblasts or marrow cells. Some similar and some different signaling pathways are stimulated by these different agents, with demineralized bone being the most chondro/osteoinductive one. Demineralized bone is widely available from regional tissue banks. Performance standards have not yet been developed but regulatory agencies will be seeking them. Our thirty-year experience with clinical and experimental uses of demineralized bone is being applied to evidence-based surrogate assays, at the very least for tissue banks to use as guides for release of products.

Tissue engineering programs rest on our innovative 3D porous collagen scaffold and platform technologies for applying mechanical, metabolic, and soluble and insoluble growth factors to optimize histogenesis *in vitro*. These are being used for cartilage, bone, and meniscal tissues, as well as for bioengineered joints. Animal models of impaired distraction osteogenesis are being used to evaluate approaches for gaining superior control over skeletal regeneration with this modality.

A new NIH grant seeks to determine the impact of vitamin D-deficiency on in vitro osteoblastogenesis of marrow cells discarded during hip arthroplasty. This works builds upon our discovery that 22% of osteoarthritic women requiring hip arthroplasty for advanced osteoarthritis were vitamin D-deficient and that 25% of them had occult osteoporosis, as determined by dual energy x-ray absorptiometry. This and other projects aim to determine the effects of correcting vitamin D status on outcome of orthopedic procedures. Finally, more interdisciplinary work is needed to determine the extent of osteoporosis in patients with osteoarthritis.

Dr. Myron Spector, Director - Tissue Engineering, Dr. Spector is continuing his research and development of collagen devices for tissue engineering of musculoskeletal and other tissues. He has shown the advantage of an off-the-shelf collagen membrane as a substitute for the periosteal flap for autologous chondrocyte implantation in a sheep model, and has shown that a collagen tube can facilitate peripheral nerve regeneration in a rat model. He has also shown that treatment of chondrocyte-seeded type II collagen scaffolds accelerates chondrogenesis *in vitro*. Dr. Spector has obtained a recent grant from the Department of Defense, entitled, "Autologous Marrow-Derived Stem Cell-Seeded Gene-Supplemented Collagen Scaffolds for Spinal Cord Regeneration as a Treatment for Paralysis," that investigates collagen scaffolds with stem cells and genes for spinal cord regeneration. The total amount of this grant is $1.5million dollars. Dr. Spector has had 14 publications in the last year.

Dr. Karen Yates has published 9 peer review articles, 2 abstracts and an important review within the past year. Dr. Yates received a new NIH grant to investigate the function of Wnt signaling in articular cartilage. The Wnt family of proteins plays a key regulatory role in skeletal development. This is a "hot" area of research, and Dr. Yates was one of the first scientists in the world to recognize the potential for Wnt activity to influence cartilage function. She is collaborating with Dr. Sonya Shortkroff on a study to determine how Wnt expression and activity change with age and in osteoarthritis. Ongoing NIH-funded work in Dr. Yates' lab concerns transcriptional regulators of post-natal chondrocyte differentiation. A combination of *in silico* and *in vitro* molecular biology techniques are used to derive transcriptional networks that are activated during chondroinduction from gene expression profiling data.

The Partners Harvard Shoulder Service: As part of the research effort of the Shoulder service, Dr. Peter Millett, Dr. JP Warner, senior resident Dr. Reuben Gobezie, members of the Harvard Genomic and Proteomics group and I, are working on a fascinating project using these new techniques to identify biomarkers of osteoarthritis(OA) in the shoulder and other major diarthrodial joints. These exciting new techniques should give us useful quantitative markers for disease severity, a better understanding of the pathogenesis of OA and perhaps a good barometer to measure the disease treatment. While there are some exciting new data it is not yet in the literature and hopefully it will be out soon so that I can summarize it next year.

Dr. Chris Evans has recently received an NIH RO1 to study potential gene therapy in OA. Chris heads the Center for Orthopaedic Molecular Biology and Gene Therapy and will head this exciting new project, which includes several of us, including Dr. Jeffrey Katz, Div. of Rheumatology and Dr. Philip Lang, Head of Orthopedic Radiology at the BW/F. Additionally, Dr Keith Crawford, an expert on the function and signaling of dendritic cells has joined has the group and begun collaboration with several members of the Department

PARTNERS ORTHOPEDICS AT BW/F

As most of you know, Dr. James Herndon has retired as Partners Chief of Orthopedics and those responsibilities are now split between Dr. Harry Rubash and me. One the more exciting collaborative efforts that we are now working on is through the Partners Trauma Service in initiating a partners wide hip pathway that will be instituted at the academic medical centers and hopefully embraced throughout our network. This project is headed by Dr. Mark Vrahas, Chief of Partners Orthopedic Trauma and will integrate and coordinate efforts in the departments/divisions of Orthopaedics, Endocrinology, Radiology, Medicine and Emergency medicine at both institutions.

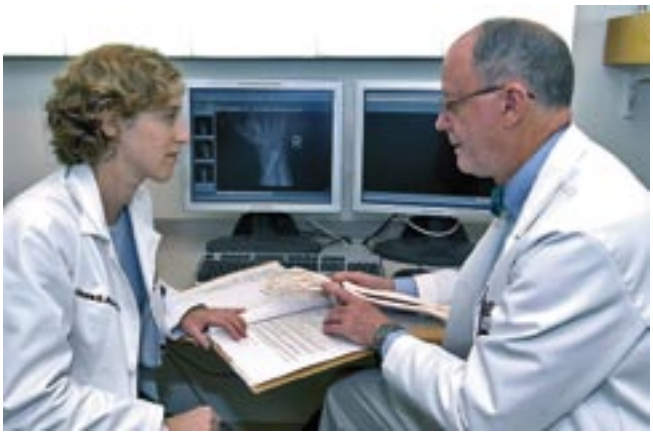
The BW/F continues to play an integral role in the Harvard Combined Residency Program as we have now moved from 10-12 residents; there will be an additional PGY1 at the BWH as well as an additional resident rotating through the BW/F.

Dr. James Herndon continues to head the residency program and works closely with the Executive Committee and the resident's council to continue to improve our educational program.

Clinical Divisions of the BW/F Orthopaedic Department: The musculoskeletal strategy material presented earlier continues small thumbnails of each of our active orthopedic divisions.

The Arthroplasty group, headed by Dr. Richard Scott, has had a very strong fellowship group. Dr. Bryan Springer from the Mayo Clinic will be joining Dr. Tom Fehring, et al in Charlotte, North Carolina. Dr. Mark Hanna from Emory will be returning to Atlanta and Dr. Timothy Williams from Ohio State will be returning to Columbus, Ohio. We continue to have an active International Program and the fellowship continues to attract excellent candidates. We have increased our revision exposure and, like many other centers, have an active program trying to evaluate the relative risks and benefits of minimally invasive and computer-assisted surgery.

The Hand/Upper Extremity Division under the leadership of Dr. Barry Simmons also is growing both at the Brigham and the Faulkner campus. The fellowship remains one of the stronger in the country and is enhanced by a strong collaboration with Dr. Peter Waters and Dr. Donald Bae at Children's Hospital and a reciprocal rotation arrangement with the Hand Fellowship at the MGH, lead by Dr. Jesse Jupiter. One of our current hand fellows, Dr. Brandon Earp, will be joining the hand and upper extremity division this fall and we are very excited that she will be joining our group.



Tamara Rozental, MD and Barry Simmons, MD

The Partners Trauma Service at BW/F has been one of the many bright spots in our department over the past 2 years. Dr. Mitchell Harris was recruited as BW/F Chief of Orthopedic Trauma and he has greatly enhanced the trauma program at the Brigham & Women's Hospital. Many of you will remember the chief residency as one of the strengths of the Harvard Program and several of you have expressed concern when you found that the chief residency was stopped a few years ago. While I was skeptical at first, I truly believe that we are a better program under our current structure. Dr. Mitchell Harris, Dr. Mark Vrahas and Dr. Timothy Bhattacharyya perform trauma at the BWH. There is an active role played by the Trauma Fellows and the senior residents get graded responsibility on the trauma service as well as the other senior rotations.

Jamie Monica, MD and Mitch Harris, MD

The Foot & Ankle Service under the direction of Michael Wilson has established its center predominately at our Faulkner Campus. The Foot & Ankle Service has had other strong fellowship year with Dr. Sam Singh from England who will be graduating the fellowship program and will return to England. The service, which includes Dr. Michael Wilson, Dr. Christopher Chiodo and Dr. James Ioli, has grown to be the largest in the area.

The Spine Center continues to evolve. Dr. Gregory Brick, Dr. Mitchel Harris and Dr. Zac Issac have been working with our neurosurgery colleagues, rheumatology, radiology and rehabilitation to facilitate patient care, teaching and research within the Spine Center.

The Sports Medicine Program, headed by Dr. Charles Brown, is located primarily at our 850 Boylston Street campus and has established relationships with many of the area college and high school teams. Moreover, the sports medicine program will be a major player in the development of the Women's Musculoskeletal Unit and will include Dr. Charles Brown, Dr. Scott Martin and Dr. Tamara Martin. Dr. Tamara Martin has also done an outstanding job in taking over as Chief of Orthopedics at the West Roxbury VA program. We are in the midst of making substantial changes with new recruitment at the Boston VA Center and currently have residents from both the Harvard and BU orthopedic programs.

With the continued realignment of the oncology programs in Boston, the Dana Farber/Brigham Oncology Service is expanding. Dr. John Ready, who divides his time between the oncology and arthroplasty service, is working with us to expand our Sarcoma Service at the DF/BWF Center.

The Partners-Harvard Shoulder Service, under the direction of J.P. Warner at MGH and Dr. Peter Millett at the BW/F, has had another outstanding clinical, academic and surgical year. The International Fellowship program is extremely popular and this service annually surpasses its goals both clinically and academically.

And finally …alumni news: Fortunately, there is nothing but good news to report from the RBBH/BWH retired surgeons. I have been in e-mail contact and occasionally speak to Dr. Clem Sledge who spends much of his time in Maine and is in good health and spirits. Dr. Dick Scott said that he saw Dr. Fred Ewald recently and Fred was looking fitter than ever. Dr. Bill Thomas continues to spend his time between Brookline, the Vineyard and Florida. He has been flying his plane and occasionally drops by for a visit. The Bill Thomas Award, which we established several years ago, is given each year to "The senior resident who best exemplifies excellence in orthopedics, devotion to patient care, collegiality and team work." This is a highly sought after award and the highlight of the resident graduation ceremony. Dr. Bob Poss continues to be active in his Deputy Editor role with Editor Dr. Jim Heckman at the JBJS. I think that you would all agree that the editorial staff at the JBJS has done an outstanding job in integrating technology with the journal, further solidifying its role as our leading periodical.

It was great seeing so many of you at the alumni reception at AAOS in Washington. I can assure you that your residency is stronger than ever. I am grateful for the opportunity to serve in this role and I look forward to seeing many of you in the near future.

Department of Orthopaedic Surgery, Brigham and Women's Hospital

Thomas S. Thornhill, MD
John B. and Buckminster Brown Professor of Orthopaedic Surgery, Harvard Medical School
Orthopaedist-in-Chief, Department of Orthopaedic Surgery, Brigham and Women's Hospital

Clinical Faculty

Philip Blazar, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

Gregory W. Brick, MD
Assistant Clinical Professor of Orthopaedic Surgery,
Harvard Medical School

Charles H. Brown, Jr., MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School
Director, Sports Medicine Service

Robert Chernack, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Christopher Chiodo, MD
Instructor in Orthopaedic Surgery,
Harvard Medical School

John A.K. Davies, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Michael Drew, MD
Clinical Instructor
Harvard Medical School

Daniel M. Estok, II., MD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Wolfgang Fitz, MD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Mitchel B. Harris, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

James H. Herndon, MD, MBA
Residency Director,
Harvard Combined Orthopaedic Residency Program
William H. and Johanna A. Harris Professor of Orthopaedic Surgery,
Harvard Medical School

James P. Ioli, MD
Instructor in Orthopaedic Surgery,
Harvard Medical School
Chief of Podiatry

Zacharia Isaac, MD
Instructor in Physical Medicine and Rehabilitation,
Harvard Medical School

Jerry L. Knirk, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Mark J. Koris, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Scott D. Martin, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

Tamara L. Martin, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

John McLoughlin, DPM
Clinical Instructor in Orthopaedic Surgery

Robert E. Miegel, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Peter Millett, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

Tom Minas, MD
Associate Professor of Orthopaedic Surgery,
Harvard Medical School

John E. Ready, MD
Instructor in Orthopaedic Surgery,
Harvard Medical School
Director, Tumor Service

Richard Scott, MD
Professor of Orthopaedic Surgery,
Harvard Medical School

Barry P. Simmons, MD
Associate Clinical Professor of Orthopaedic Surgery,
Harvard Medical School
Director, Hand and Upper Extremity Service

R. Malcolm Smith, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School
Associate Chief, Partners Orthopaedic Trauma Services

Mark E. Steiner, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School
Craig R. Stirrat, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School

Mark Vrahas, MD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School
Chief, Partners Orthopaedic Trauma Services

Jon J.P. Warner, MD
Chief, Shoulder Service
Associate Professor of Orthopaedic Surgery,
Harvard Medical School

Michael G. Wilson, MD
Assistant Professor in Orthopaedic Surgery,
Harvard Medical School
Director, Brigham Orthopaedic Department,
Faulkner Hospital
Director, Foot and Ankle Service

R. John Wright, MD
Clinical Instructor in Orthopaedic Surgery,
Harvard Medical School
Resident Coordinator, Brigham and Women's Hospital
Director, Orthopaedic Trauma Service
Clinical Faculty-Harvard Vanguard Medical Associates

Fellows

Arthroplasty
Mark Hanna, MD
Bryan Springer, MD
Timothy Williams MD

Foot & Ankle
Samrendu Singh, MD

Hand/Upper Extremity
Brandon Earp MD
Brian Fitzgerald MD
Tamara Rozental MD

International Research Fellows
Robert Sew Hoy MD
Nick Vertzyas MD

Basic Science Faculty

Myron Spector, PhD
Professor of Orthopaedic Surgery, Biomaterials
Harvard Medical School
Director, Orthopaedic Research Laboratory,
Brigham and Women's Hospital

Julie Glowacki, PhD
Professor of Orthopaedics
Professor of Oral and Maxillofacial Surgery
Harvard Medical School
Director, Skeletal Biology,
Brigham and Women's Hospital

Anuj Bellare, PhD
Assistant Professor of Orthopaedic Surgery,
Harvard Medical School

Oliver Bernd Betz, PhD
Research Fellow in Orthopaedic Surgery,
Harvard Medical School

Mark E. Brezinski, MD, PhD
Associate Professor of Orthopaedic Surgery,
Harvard Medical School

Keith D. Crawford, MD, PhD.
Instructor in Orthopedic Surgery
Harvard Medical School

Christopher H. Evans, DSC, PhD
Robert W. Lovett Professor of Orthopaedic Surgery,
Harvard Medical School

Rudolf Fluckiger, PhD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Hu-Ping Hsu, MD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Jeffrey Neil Katz, MD
Associate Professor of Orthopaedic Surgery,
Harvard Medical School

Stanislav Lechpammer, MD, PhD
Research Fellow in Orthopaedic Surgery,
Harvard Medical School

Bin Liu, PhD
Instructor of Orthopaedic Surgery,
Harvard Medical School

Shuichi Mizuno, PhD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Robert Sew-Hoy, MD
International Research Fellow in Orthopaedic Surgery,
Harvard Medical School

Sonya Shortkroff, PhD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Karen E. Yates, PhD
Instructor in Orthopaedic Surgery,
Harvard Medical School

Shuanhu Zhou, PhD
Instructor in Orthopaedic Surgery,
Harvard Medical School