Steadman◆Hawkins Research Foundation
A 501(c)(3) nonprofit organization

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Steadman◆Hawkins

Research Foundation

Annual Report 2006

An International Center for Research and Education — Keeping People Active

Mission

The Steadman◆Hawkins Research Foundation is dedicated to keeping people of all ages physically active through orthopaedic research and education in the areas of arthritis, healing, rehabilitation, and injury.

History

Founded in 1988 by orthopaedic surgeon Dr. J. Richard Steadman, the Foundation is an independent, tax-exempt (IRS code 501(c)(3)) charitable organization. Known throughout the world for its research into the causes, prevention, and treatment of orthopaedic disorders, the Steadman◆Hawkins Research Foundation is committed to solving orthopaedic problems that limit an individual's ability to maintain an active life. In 1990, Dr. Steadman was joined by renowned shoulder surgeon Dr. Richard J. Hawkins. Together, they brought the Foundation's research production in knee and shoulder studies to a new level.

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Cover: Dr. Marc J. Philippon, one of the world's leading experts on hip arthroscopy.

The Steadman◆Hawkins Research Foundation wishes to express deep appreciation to John P. Kelly, who donated many of the stock photos in this year's Annual Report and contributed his time to photograph the many Foundation and operating room subjects.

Kelly is a renowned sports and stock photographer who approaches every photo shoot like a commando. His sense of motion combines with his obvious love of natural light to produce vibrant graphic images. He shoots extensively for a variety of prominent manufacturers in the sports and recreation industry; and his experience includes numerous assignments at the Olympics, Wimbledon, U.S. Open Golf, and World Cup Skiing. When Robert Redford needed a poster that reflected the spirit of his movie "A River Runs Through It," he called Kelly. More recently, Redford employed Kelly's photographic talents during the making of "The Horse Whisperer." Whether covering the Olympics or trekking in the Himalayas, Kelly is always ready for his next photographic adventure.

NOTE 3: CONTRIBUTIONS RECEIVABLE

Contributions receivable at December 31 are due as follows:

	2006	2005
Due in less than one year	**$ 192,750**	$ 160,750
Due in one to five years	**113,198**	150,000
	305,948	310,750
Less: unamortized discount	**(25,305)**	(13,946)
Due from related parties	**(750)**	(5,750)
	$ 279,893	$ 291,054

Discounts were 8% for 2006.

Approximately 98% of total contributions receivable at December 31, 2006 and 2005, are from two donors and one donor, respectively. The Foundation receives support and pledges from members of the Board of Directors and employees. These pledges receivable are included in contributions receivable, related party.

NOTE 4: PROPERTY AND EQUIPMENT

Property and equipment at December 31 consists of the following:

	2006	2005
Equipment	**$ 1,019,504**	$ 774,923
Furniture and fixtures	**1,379**	22,326
Leasehold improvements	**10,107**	263,793
	1,030,990	1,061,042
Less accumulated depreciation	**702,407**	846,465
	$ 328,583	$ 214,577

NOTE 5: TEMPORARILY RESTRICTED NET ASSETS

Temporarily restricted net assets at December 31 are available for the following purposes:

	2006	2005
Education	$ 495,325	$ 196,359
Biomechanics research	136,054	286,054
Time restricted contributions and pledges	—	105,000
Administration	141,838	—
	$ 773,217	$ 587,413

NOTE 6: RELEASE OF TEMPORARILY RESTRICTED NET ASSETS

Net assets were released from donor restrictions by incurring expenses satisfying the restricted purposes or by occurrence of other events specified by donors as follows:

	2006	2005
Purpose restrictions accomplished		
Education	**$ 266,317**	$ 438,099
Biomechanics research	**359,144**	285,969
Information systems	**—**	25,000
Basic science programs	**10,465**	9,504
Administration	**4,029**	4,483
Bioskills	**4,692**	—
Clinical Research	**145,464**	—
	790,111	763,055
Time restrictions expired		
Collection of contributions receivable	**105,000**	1,900
Total restrictions released	**$ 895,111**	$ 764,955

NOTE 7: OPERATING LEASES

Noncancellable operating leases for property and equipment expire in various years through 2010. Two of the property leases require the Foundation to pay all executory costs (property taxes, maintenance and insurance).

Future minimum lease payments at December 31, 2006, are:

2007	$ 83,120
2008	83,120
2009	83,044
2010	75,803
	$ 325,087

Rental expense of $62,295 and $72,768 for the years ended December 31, 2006 and 2005, respectively, is recorded in the statements of activities.

NOTE 8: PENSION PLAN

The Foundation has a defined contribution retirement plan under IRS Section 401(k). The plan is open to all employees after one year of employment. The Foundation's contributions to the plan are determined annually. The Foundation elected to match 50% of participants' contributions up to 6% during 2006 and 2005. Under this formula, the Foundation made contributions of $20,323 and $19,510 for the years ended December 31, 2006 and 2005, respectively.

NOTE 9: RELATED PARTY TRANSACTIONS

During 2006 and 2005, the Foundation received approximately $363,000 and $244,000, respectively, in contributions from related parties, including various board members as well as the Steadman Hawkins Clinic.

NOTE 10: SIGNIFICANT ESTIMATES AND CONCENTRATIONS

Accounting principles generally accepted in the United States of America require disclosure of certain significant estimates and current vulnerabilities due to certain concentrations. During 2005, approximately 28% of all contributed support was received from two donors.

Founded in 1988 by orthopaedic surgeon Dr. J. Richard Steadman, the Foundation is an independent, tax-exempt (IRS code 501(c)(3)) charitable organization. Known throughout the world for its research into the causes, prevention, and treatment of orthopaedic disorders, the Steadman◆Hawkins Research Foundation is committed to solving orthopaedic problems that limit an individual's ability to maintain an active life. In 1990, Dr. Steadman was joined by renowned shoulder surgeon Dr. Richard J. Hawkins. Together, they established an organization that today has brought research in knee, hip, shoulder, spine and foot studies to a new level.

The Foundation has influenced the practice of orthopaedics—from diagnosis to rehabilitation. Recognizing that the body's innate healing powers can be harnessed and manipulated to improve the healing process has led to exciting advances in surgical techniques that are used today by orthopaedists in many practices. The microfracture technique, for example, is now accepted as a treatment that may make it possible to postpone or even eliminate the need for knee replacement surgery.

One of the largest independent orthopaedic research institutes in the world, the Steadman◆Hawkins Research Foundation has become the most published and one of the most innovative foundations in orthopaedic research and education. Philanthropic gifts are used to advance scientific research and to support scholarly academic programs that train physicians for the future. Through its Fellowship Program, the Foundation has now built a network of 160 Fellows and associates worldwide who share the advanced ideas and communicate the concepts they learned in Vail.

THE FOUNDATION'S PRIMARY AREAS OF RESEARCH AND EDUCATION ARE:

- **Basic Science Research** – Undertakes studies to investigate the mysteries of degenerative arthritis, cartilage regeneration, and arthritic changes in the knee and shoulder.
- **Clinical Research** – Conducts "process" and "outcomes" orthopaedic research that aids both physicians and patients in making better-informed treatment decisions.
- **Biomechanics Research Laboratory** – Performs knee and shoulder computer modeling and related studies in an effort to reduce the need for surgical repair.
- **Education and Fellowship Program** – Administers and coordinates the physicians-in-residence Fellowship Program, hosts conferences and international medical meetings, and produces and distributes publications and videotapes.

SINCE ITS INCEPTION, THE FOUNDATION HAS HELPED PEOPLE OF ALL AGES REMAIN PHYSICALLY ACTIVE THROUGH ORTHOPAEDIC RESEARCH AND EDUCATION. IT CONTINUES TO PURSUE ITS GOALS OF:

- Understanding and enlisting the body's innate ability to heal.
- Designing and validating surgical and rehabilitation techniques, as well as non-operative treatments for arthritis.
- Producing and publishing scientifically validated research in leading medical and scientific journals.

The Year in Review

Dear Friends,

It is with great pride and appreciation that we present to you the 2006 Annual Report for the Steadman◆Hawkins Research Foundation. In this report you will find a review of our research and educational accomplishments for the year, and our vision for the future.

We gratefully recognize the generosity of loyal friends and patients. Your continued support has enabled us to achieve tremendous research and education initiatives—thank you. Our research directors, their teams, and the Foundation staff continue to grow our worldwide reputation through their excellent work. We are most appreciative of their efforts.

For 18 years, the Foundation has applied your philanthropic, scientific, and industry support to become one of the world's leading orthopaedic research foundations. As a result, the Foundation is the most published clinical research institute for sports medicine in the world. In 2006 alone, our scientists made 189 presentations at scientific meetings around the world and published 47 papers in scientific and medical journals. The published results of our research have enabled us to become a leader in the prevention and treatment of injuries and arthritis, leading to improved patient care.

From the beginning in 1988, we have focused on improving rehabilitation techniques after surgery. Our research has proven that aggressive rehabilitation ensures an excellent overall result. Conversely, an excellent surgical result without good rehab would produce a poor outcome. Following this breakthrough, the Foundation developed and validated the microfracture technique, which has now become the gold standard in repairing cartilage defects in the knee, and is being perfected for use in other joints. Today, more than one million patients around the world have benefited from microfracture and are leading active lives.

Initially, our objective was to create the best clinical research group (page 29) in the world for sports medicine and evidence-based medicine. This is something that has been practiced ever since. Evidence-based medicine will continue to shape changes in this country's health care system and become a topic in the 2008 political election debate.

Our achievements in 2006 would not be possible without the contributions of more than 800 individuals, foundations, and corporations whose combined support has amounted to more than $2.9 million. With overhead costs less than half of university research programs, our donors will be pleased to know that more of their support is going directly to research and education.

As the Foundation's contributions to science and medicine are documented, it is important to celebrate and recognize the achievements made by our senior research directors and their teams.

Karen Briggs, M.P.H., M.B.A., heads the Clinical Research department and oversees the most widely published clinical research organization of its kind in the world. Managing patient expectations following hip arthroscopic surgery continues to be an important research topic. Our research has expanded to include the hip joint, and already the Foundation is becoming a leader in hip-related research. Karen reports that initial findings show that the progression of arthritis in the hip may be prevented or delayed with early intervention.

William G. Rodkey, D.V.M., recognized worldwide for his research, heads the Basic Science department. Regenerative cartilage research is a major area for optimism. Dr. Rodkey has continued to focus on regeneration of cartilage tissue that is used to treat defects on the joint surface. A new topic for future research (shockwave therapy) is reviewed on page 26. Shockwave therapy is a new and exciting concept to stimulate tissues to heal more rapidly.

Michael Torry, Ph.D., is the director of the Biomechanics Research Laboratory, which is becoming a world leader in the development of biplane fluoroscopy and computer joint modeling. Dr. Torry and his team of scientists dedicated the year to building a one-of-a-kind, biplane fluoroscopy system. One of two institutes in the world to design and house such equipment for

research, the sophisticated x-ray system will create movies or videos of bones and joints in motion. This equipment will help Foundation researchers gain a better understanding of the development and progression of arthritis, resulting in more effective treatments—perhaps prevention—and reduced healthcare costs.

Advising our research departments is the Scientific Advisory Committee, an integral resource for the past 18 years. These preeminent, world-renowned scientists have shaped our research. Please read the articles, *C. Wayne McIlwraith: A View from the Top,* page 6, and *Bone and Joint Research: The Human-Horse Connection*, on page 27.

Our Fellowship and education programs continue to be very successful. We graduated six Fellows in 2006 and welcomed seven new Fellowship surgeons for 2007. We now have more than 160 former Fellows worldwide at leading universities and private practices performing excellent sports medicine and keeping people active. Sports medicine continues to improve through our education initiatives.

In this report, you will meet Adele and Roy Igersheim (page 21) and learn how "The Package" treatment for Adele's knee arthritis reduced pain, restored function, and resulted in a significant gift to the Foundation. You will also read accounts from the Ghent Family, Kim Gustafson, and Mr. and Mrs. O.B. Shelburne—all friends who have benefited significantly from the Foundation's research, providing them with help and hope.

During the past 18 years, our donors have contributed more than $35 million dollars in support of orthopaedic research. The results of that research have changed the way physicians look at arthritis, joint disease, healing, and treatments for injured joints. From this base, our board members, management team, scientists, and physicians are committed to building the number one orthopaedic sports medicine research institute in the world. Our state-of-the art facilities and equipment will continue to be updated. The fundraising goal to support the research efforts of the Foundation is expected to triple. The Foundation's research will have a dramatic and positive impact on the acceptance of hip arthroscopy worldwide.

The only way to achieve these ambitious goals is with the continued generous support of the people who have received treatment, benefited from Steadman-Hawkins research, or have been made aware of our programs.

On behalf of our dedicated board members, researchers, and staff, we wish to thank you, our donors, corporate sponsors, and foundations for your commitment in 2006. We look forward to your continued support and to updating you on exciting advances from the Steadman◆Hawkins Research Foundation.

Respectfully yours,

J. Richard Steadman, M.D.
Chairman of the Board

J. Michael Egan, Jr.
President and Chief Executive Officer

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Steadman-Hawkins Clinic
Steadman◆Hawkins Research Foundation
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The Colorado Council was established as an auxiliary board of prominent Colorado citizens who serve as ambassadors for the Foundation within the state.

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Scientific Advisory Committee

The Scientific Advisory Committee consists of distinguished research scientists who represent the Foundation and serve as advisors in our research and education efforts, in our Fellowship Program, and to our professional staff.

Steven P. Arnoczky, D.V.M.
Director
Laboratory for Comparative Orthopaedic Research
Michigan State University
East Lansing, Mich.

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Boston, Mass.

C. Wayne McIlwraith, D.V.M., Ph.D.
Director of the Orthopaedic Research Laboratory
Colorado State University
Fort Collins, Colo.

Peter J. Millett, M.D.
Steadman-Hawkins Clinic
Steadman◆Hawkins Research Foundation
Vail, Colo.

Marcus Pandy, Ph.D.
Associate Professor
Biomedical Engineering
University of Texas/Austin
Austin, Texas

Marc J. Philippon, M.D.
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Steadman◆Hawkins Research Foundation
Vail, Colo.

William G. Rodkey, D.V.M.
Director of Basic Science Research
Steadman◆Hawkins Research Foundation
Vail, Colo.

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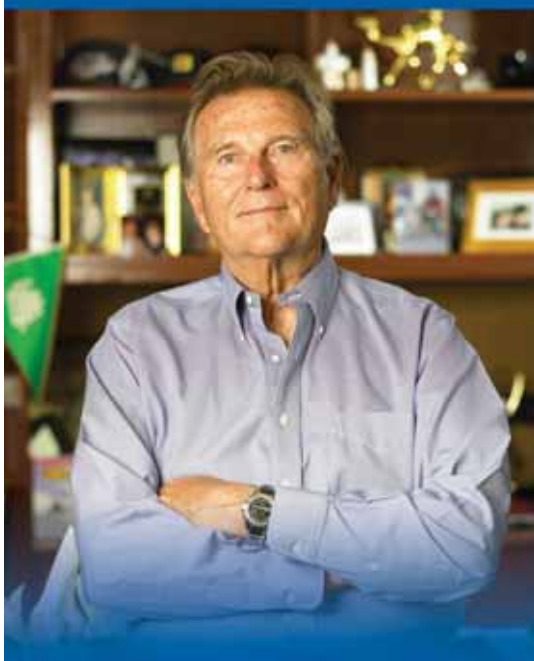
Steadman-Hawkins Clinic
Vail, Colo.

Savio Lau-Yuen Woo, Ph.D., D. Sc. (Hon.)
Ferguson Professor and Director Musculoskeletal Research Center
University of Pittsburgh
Pittsburgh, Pa.

Bay Area Knee Society Honors Dr. Steadman with Lifetime Achievement Award



The Bay Area Knee Society, a San Francisco-based organization, presented its annual "Lifetime Achievement Award," on November 16, to Dr. Richard Steadman.

"Every year we present our Lifetime Achievement Award to that individual who we believe has made a substantial contribution to advancing the art and science of knee surgery," commented Dr. Scott Dye, president of the Bay Area Knee Society. "We see it as equivalent to the Nobel Prize of the knee." Past recipients have included Jack Hughston, Werner Muller, John Feagin, John Insall, Dale Daniel, and Mark Coventry, among others.

The Bay Area Knee Society is composed of more than 100 orthopaedic surgeons who have an academic and clinical interest in the knee.

C. Wayne McIlwraith: A View From the Top

By Jim Brown, Ph.D.

The first question was a simple one: How did you get from New Zealand to Fort Collins, Colorado? But when his answer began with, "I left New Zealand to lead an alpine mountain climbing expedition in Peru," it was clear this was not going to be an ordinary interview.

In fact, there is very little that is ordinary about C. Wayne McIlwraith, D.V.M., Ph.D., Director of the Equine Orthopaedic Research Center at Colorado State University, and a lot that is extraordinary. He holds three doctoral degrees from universities in his native New Zealand and the United States and three honorary degrees from prestigious schools in Austria, New Zealand, and Italy. He was awarded a Diploma of Fellowship at the Royal College of Veterinary Surgeons in London for Meritorious Contributions to Learning and a Diploma of Surgery at the University of Guelph in Canada, where he began to specialize in equine surgery. He has operated on more than 10,000 horses around the world, including a former Kentucky Derby favorite (Indian Charlie) and winner (Spend A Buck). Type his name into Google and you'll get more than 900 entries. In short, Dr. McIlwraith is arguably the foremost equine orthopaedic surgeon in the world.

Fortunately for the Steadman◆ Hawkins Research Foundation, he has collaborated with the staff on groundbreaking research projects and he serves as a member of the Foundation's Scientific Advisory Committee. And fortunately for Dr. McIlwraith, he has been a beneficiary of Foundation research and the patient-first approach of the Steadman-Hawkins Clinic. On August 9, 2005, he underwent total hip replacement. The osteoarthritis in his hip may have started with a mountain-climbing accident 30 years ago. The surgery took 55 minutes ("skin to skin," as he calls it) and was performed by Steadman-Hawkins orthopaedic surgeon and hip specialist Dr. Marc Philippon. "I didn't select my surgeon overnight and I was confident I was in the best hands. He is a whole new revelation as far as treatment is concerned for hip osteoarthritis. If I had run into him when I first had symptoms, then maybe I wouldn't have needed surgery."

Dr. McIlwraith is also quick to acknowledge the connection between the Foundation and the treatment he received. "I couldn't have gotten the care, and others wouldn't benefit from the advances Dr. Philippon will continue to make, without research. And research could not be done without support from the Foundation." The entire process has affected his perspective both as a surgeon and as patient. "I've seen surgery from the other side and it has enhanced my experience.

"The research at the Foundation and the application of that research in the Clinic (and in other clinics around the world) removes many of the limitations on what you can do," says McIlwraith. "Twenty or 30 years ago, doctors wouldn't have repaired a cruciate ligament on an older person. Now Steadman-Hawkins physicians are working on 60- and 70-year-old patients so they can go skiing again. They ask you what you want to do and then do their best to help get you there. I'm doing so well, I plan to rock-climb and ski again. I'll still be able to have fun."

Earlier in the journey that led him to Fort Collins, Dr. McIlwraith got a master of science degree at Purdue University as part of a Ph.D. program. "It gave me an opportunity to do something for the horse." He later went to Michigan State University to study human arthroscopy in the knee. He was the only veterinarian among 120 orthopaedic surgeons, and he eventually started doing diagnostic arthroscopic surgery on the horse. "My relationship with Dr. Steadman began when Steadman-Hawkins moved to Vail. Bill Rodkey (William G. Rodkey, D.V.M., Director of Basic Science Research at Steadman-Hawkins) got me together with Dr. Steadman and we started doing research on the horse as a model for human orthopaedics."

What would Dr. McIlwraith like the public to know about the Foundation? "Without basic research, we wouldn't have had the advances in improving cartilage repair, getting rid of calcified cartilage during microfracture, or studying ways to use gene therapy on top of the microfracture procedure. The results of Foundation research are fed right back into finding better ways to help people. We're continually finding a better mousetrap."

C. Wayne McIlwraith has seen the top of world as a mountain climber and he is at the top of his professional world as an equine orthopaedic surgeon and scientist. His contributions as a Scientific Advisory Committee member and his experience as a recipient of Steadman-Hawkins research has given him a unique perspective. He is more than a "Patient in the News." He is a former patient who makes news that is benefiting both humans and horses.

The Steadman-Hawkins Difference: A Conversation with Mike Egan, CEO

By Jim Brown, Ph.D., Executive Editor, Steadman◆Hawkins Research Foundation News

For the past two decades the Steadman◆Hawkins Research Foundation has quietly positioned itself as one of the largest, most productive and innovative independent orthopaedic research organizations in the world. Well known within the medical community for its excellence, the rest of the world is now recognizing that Steadman-Hawkins has become, simply put, one of the world's leading orthopaedic research foundations.

The person best qualified to make that claim is J. Michael Egan, who joined the Foundation as Chief Executive Officer late last year. Egan has an extensive background that includes strategic planning, marketing, financing, and operating 14 companies in the medical device industry. Dr. Richard Steadman, founder of the Steadman◆Hawkins Research Foundation, says, "Mike Egan brings a wealth of business knowledge and experience to our organization, and he has a proven record as an innovative, forward-thinking and qualified leader."

Dr. Steadman established the Foundation in 1988. In 1990, he was joined by renowned shoulder surgeon Dr. Richard J. Hawkins. Together, they brought the Foundation's research production in knee and shoulder studies to a new level.

We asked Egan to explain why the Steadman◆Hawkins Research Foundation is different from all the others. He gave us 10 answers.

DIFFERENCE #1 – The Steadman Legacy

"I came here for three reasons," explains Egan. "Number one, I wanted to be a part of continuing Richard Steadman's legacy. I have watched his vision, which started with the belief that the body has the ability to heal itself, unfold. He was convinced that an average surgical result could become an excellent one with the correct rehabilitation. Early in his career he focused strongly on improving rehabilitation techniques after surgery. Conversely, an excellent surgical result without good rehab would produce a poor outcome.

"Within a few years, Dr. Steadman developed the microfracture technique, which was at first widely criticized by the orthopaedic establishment. Once the success of his outcomes became irrefutable, the orthopaedic community accepted him as a leader in his field. The second reason I joined the Foundation was to ensure an appropriate succession. When I met Dr. Steadman in 1984, he was performing 600 surgical procedures a year. With the addition of world-renowned surgeons, surgical procedures have doubled during the past three years to nearly 4,000. Though Dr. Steadman shows no signs of easing off, he is very determined to take the steps necessary to carry on the Foundation's work indefinitely. The third reason I'm here is to continue building the number one orthopaedic sports medicine research facility in the world."

DIFFERENCE #2 – Surgeons, Scientists and Management

The relationship between the Foundation and the Clinic is unique. The Clinic doctors receive no economic benefit from the Foundation. As a matter of fact, every Clinic doctor contributes financially to the Foundation. However, the Foundation benefits from the innovative thinking of the Clinic doctors and their patients' data is used in the Foundation's clinical research. The Foundation and Clinic have each successfully recruited some of the best surgeons, researchers, and management from countries around the world, including Canada, Japan, Holland, China, and Germany. "They know," says Egan, "that this place is different from institutions associated with universities.

The doctors and scientists have the freedom to practice clinical medicine and to pursue research based on their goals, instead of those dictated by a university.

The succession plan is well underway with extraordinary, young doctors joining the Clinic. They are the reason for the significant increase in surgical cases. Very talented individuals have joined the Foundation as well. Some of the gifted experts are:

- *Dr. William Sterett, 46,* a Steadman-Hawkins Fellow, trained in Switzerland and Germany in trauma and joint preservation before joining the team in Vail.
- *Dr. Marc Philippon, 41,* came from the University of Pittsburgh and is one of the world's leading experts on hip arthroscopy.
- *Dr. Peter Millett, 39,* also a Steadman-Hawkins Fellow, left Harvard to practice medicine and conduct research at Steadman-Hawkins.
- *Dr. Thomas Hackett, 40,* came from the famous Kerlan-Jobe Orthopaedic Clinic in Los Angeles.
- *Dr. Randy Viola, 41,* is a hand and upper-extremity specialist who trained in Vail as a Steadman-Hawkins Fellow. He also completed a hand fellowship at Indiana Hand Center.
- *Dr. David Karli, 36,* specializes in the non-operative treatment of spinal disorders and is trained in physical medicine and rehabilitation.

- *Dr. Donald Corenman* is an orthopaedic surgeon with a doctorate in chiropractic specializing in the treatment of the spine.
- *Lyon Steadman* is the CEO of the Clinic. Under his stewardship, the number of physicians and surgeries has doubled.
- *Charles Ho, M.D., Ph.D.*, is a world-renowned authority in musculoskeletal imaging, specializing in MRI of sports and orthopaedic injuries. Dr. Ho's Ph.D. is in electrical engineering.
- *Karen Briggs, M.B.A., M.P.H.*, heads the Clinical Research department and oversees the most widely published clinical research organization of its kind in the world.
- *Marilee Horan, B.S.*, coordinates all shoulder-related clinical research. She has also managed the quality control of the clinical database to ensure that all data collected is of the highest quality.
- *William G. Rodkey, D.V.M.,* recognized worldwide for his research, heads the Basic Science department, which collaborates through his relationships with universities such as Colorado State University, Michigan State University, Cornell, Columbia, and the University of Pittsburgh.
- *Michael Torry, Ph.D.,* director of the Biomechanics department, has been recruited by several prestigious universities, but chooses to stay in Colorado with the Foundation to pursue significant research initiatives in the field of biomechanics.
- *Kevin Shelburne, Ph.D.,* Senior Staff Scientist, is one of the Foundation's most productive and published researchers.
- *Erik Giphart, Ph.D.*, a native of Holland, is developing the dual-plane fluoroscopy system.

In addition, the management team has grown to meet the increasing demands of the Foundation's research teams and future direction. Two noteworthy additions include:

- *Marc Prisant, Executive Vice President and CFO,* who brings extensive experience as a chief financial officer in venture capital, including work at several portfolio companies, in the fields of biotechnology and proprietary medical devices.
- *Paige Prill, development and communications officer,* who has a broad background in communications and fundraising, managing all aspects of corporate communications for corporations that include Vulcan, Inc., Microsoft, and Turner Broadcasting Systems, Inc.

DIFFERENCE #3 – Low Overhead, Easy Access, and Good Communication

"Donors need to know that more of their money is going directly into research. Our overhead costs are less than half of that of other institutions," says Egan. "A dollar here goes farther than it does in other places.

"Other research organizations have not been created around one person's vision," says Egan. "They have different entities, including deans, faculty members, departments, and colleges, competing for funds. Communication is difficult or sometimes nonexistent. At Steadman-Hawkins, there is a closeness and team approach that does not exist in other places. Everything — doctors' offices, Foundation offices, the Clinic, rehabilitation facilities, research laboratories — is in one building. The Clinic/Foundation connection is our greatest asset."

The Clinic/Foundation relationship, the low overhead, and the communication that exists among departments allow the Foundation a degree of flexibility that others cannot duplicate. Decisions regarding research efforts can be made quickly, and resources can be redirected as new opportunities develop.

DIFFERENCE #4 – Evidence-Based Medicine

The records of every patient seen at the Clinic have been entered into a massive database at the Foundation since 1993. Approximately 450 pieces of information, objective and subjective, exist on every patient. Egan says there are now 15,000 knees (meaning surgical procedures on knees), 5,000 shoulders, and almost 1,000 hips in the database. Patient outcomes are tracked 5-10 years after surgery. The goal is to monitor progress over a number of years to determine how long patients experience continued improvement and whether they require additional surgery. The evidence-based information related to patient outcomes is made available to physicians around the world through presentations, consultations, and publications, contributing to their continuing medical education.

Egan gives us an example of how the Foundation's database has changed surgical procedures. "By looking at retrospective cases of knee surgery, Clinic physicians learned that portals (openings) traditionally used during knee surgery lead to unacceptable levels of scar tissue. Moving the location of one of those portals by a few millimeters produces significantly less scar tissue."

DIFFERENCE #5 - The Fellowship Program

Every year, about 650 orthopaedic surgery residents graduate from medical schools. Between 130 and 150 of them seek to continue their higher education in sports medicine orthopaedics. Last year, 163 applications for the Steadman-Hawkins Fellowship Program were received from young surgeons in the United States and abroad. After interviews and presentations, six were selected to be Steadman-Hawkins Fellows. "Most — six out of eight last year — chosen by our screening committee accept," says Egan.

"A majority of them have already been published by the time they arrive in Vail for their year of clinical practice and research — all sponsored by the Foundation."

The fellowship and education programs are coordinated by John Feagin, M.D. Dr. Feagin is another world-class authority in orthopaedics who has chosen to live in Vail. He is an associate professor emeritus of orthopaedic surgery at Duke University and is considered by many to be one of the fathers of sports medicine.

More than 160 former Steadman-Hawkins fellows practice all over the world, and many are on faculties at leading universities such as Harvard, Stanford, and Michigan. Many of them return to Vail twice a year to continue their education and to share their experiences with Steadman-Hawkins physicians and researchers.

DIFFERENCE #6 – Presentations and Publications

"We are already the most published clinical research institute for sports medicine in the world," states Egan. "In 2005 alone, Steadman◆Hawkins Research Foundation made 175 presentations at scientific meetings. At the American Academy of Orthopaedic Surgeons meeting in San Diego earlier this year, seven studies on hip arthroscopy were accepted for presentation. The Foundation produced five of those seven studies.

The three major medical journals in orthopaedic sports medicine are the *Journal of Bone and Joint Surgery*, the *American Journal of Sports Medicine*, and *Arthroscopy*. The Steadman◆Hawkins Research Foundation tracked its number of publications in these three journals during a recent three-year period and compared the results to four other top academic sports medicine programs. Steadman-Hawkins ranked first in the number of publications, ahead of Cleveland Clinic, Hospital for Special Surgery in New York City, University of Pittsburgh, and Methodist Sports Medicine in Indianapolis.

DIFFERENCE #7 – The Patients

Some of the world's greatest athletes have come to Steadman-Hawkins Clinic for treatment. They come because their agents or team management understand that evidence-based sports medicine can get their people back into competition and performing at the highest level.

That kind of recognition might give the mistaken impression that the Clinic is just a place where athletes, entertainers, and world leaders come for treatment. But the vast majority of patients are not-so-famous everyday citizens. Dr. Steadman says that his greatest source of satisfaction is making it possible for all of his patients to be as active as they want to be throughout their lives.

How has the research conducted filtered down to the neighborhood jogger? "It means that that person, in any city worldwide, might have had a procedure that was developed here and allows him or her to continue exercising," answers Egan.

DIFFERENCE #8 - The Scientific Advisory Committee

Thirteen of the world's preeminent scientists make up the Foundation's Scientific Advisory Committee (SAC) — possibly the most accomplished group of surgeons and scientists ever assembled as an advisory group. Their role is to provide scientific guidance to the Foundation, to help give its work direction, and to provide mid-course corrections when needed. These world-class scientists not only add to the ability of the Foundation to make changes when necessary, they also provide ongoing counsel to the Foundation's doctors and researchers. The ultimate goal of the SAC is to ensure that the research process leads to improved patient care.

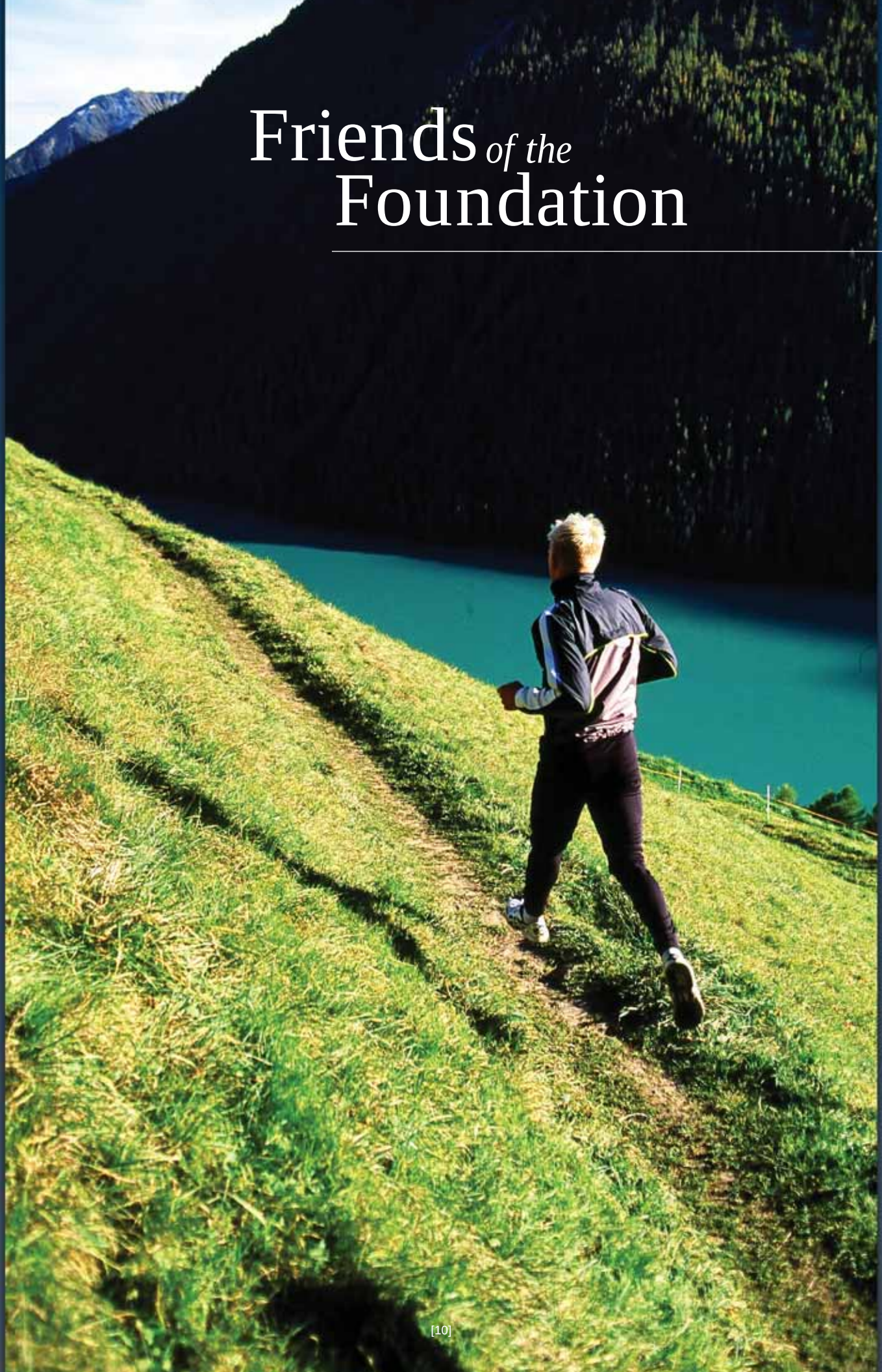
DIFFERENCE #9 – Breakthrough Procedures

Although Dr. Steadman's innovative microfracture technique, validated through the Foundation's research, has received the most attention (more than a million procedures have now been conducted worldwide), other new or improved medical procedures are equally important and have gained international acclaim. Among them are the healing response, surgery and rehabilitation that reduces the incidence of scar tissue; "The Package" approach to treat arthritis in the knees; early arthroscopic intervention of the hip (which may delay or eliminate the need for joint replacement); and identifying the biochemical factors that trigger arthritis. And most recently, a new and exciting Foundation innovation is the use of dual-plane fluoroscopy, which combines x-rays, high-speed cameras, and sophisticated software to provide amazingly accurate and comprehensive views of real-time motion within the shoulder, hip and knee joints. This has never been achieved until now. "The technology is being tested and should be up and running by the end of the year. We will be synchronizing the system with magnetic resonance imaging for accurate information about soft tissue, within and surrounding the joints, during motion," says Egan.

DIFFERENCE #10 – Growing to Become the Number One Sports Medicine Research Facility in the World

There was one more question for Mike Egan. Where do you want the Steadman◆Hawkins Research Foundation to be in five years? "We want the Foundation to be the number one sports medicine research facility in the world. The Clinic expects to have 15-20 doctors on board, each specializing in an orthopaedic area of expertise, and we will continue to update our state-of-the-art facilities and equipment. Our budget to support the research efforts of the Foundation is expected to triple. The Foundation's research will have a dramatic positive impact on the acceptance of hip arthroscopy worldwide. The only way to achieve these ambitious goals is with the continued generous support of the people who have received treatment, benefited from Steadman-Hawkins research, or have been made aware of our programs."

Friends *of the* Foundation



In 2006, we received contributions and grants from 800 individuals, foundations and corporations. This combined support, including special events, amounted to more than $2,950,574.

The Steadman◆Hawkins Research Foundation is grateful for this support and to those who have entrusted us with their charitable giving.

We are especially pleased to honor the following individuals, foundations, and corporations who have provided this support. Their gifts and partnership demonstrate a commitment to keep people active through innovative programs in medical research and education. Without this support, our work could not take place.

Lifetime Giving

1988 SOCIETY

On November 9, 1988, the Steadman◆Hawkins Research Foundation was incorporated as a not-for-profit educational and research organization dedicated to advancing modern medical science and the education of young physicians. The Foundation is deeply grateful to the following members of the distinguished 1988 Society, whose cumulative giving totals $1 million or more.

Mr. Herb Allen

Mr. and Mrs. George N. Gillett, Jr.

Vail Valley Medical Center

Dr. and Mrs. J. Richard Steadman

The Founders' Legacy Society

Over the years, the Steadman◆Hawkins Research Foundation has been privileged to receive generous and thoughtful gifts from friends and supporters who remembered the Foundation in their estate plans. In fact, many of our friends—strong believers and supporters of our work today—want to continue their support after their lifetimes.

Through the creation of bequests, charitable trusts and other creative gifts that benefit both our donors and the Foundation, our supporters have become visible partners with us in our mission to keep people physically active through orthopaedic research and education in arthritis, healing, rehabilitation, and injury prevention.

To honor and thank these friends, the Founders' Legacy Society was created to recognize those individuals who have invested not only in our tomorrow but also in the health and vitality of tomorrow's generations.

Our future in accomplishing great strides—from understanding degenerative joint disease, joint biomechanics, and osteoarthritis, to providing education and training programs—is ensured by the vision and forethought of friends and supporters who include us in their estate plans. The Foundation's planned giving program was established to help donors explore a variety of ways to remember the Foundation. We are most grateful to these individuals for their support in becoming founding members of the Founders' Legacy Society:

Mr. and Mrs. Robert M. Fisher

Ms. Margo Garms

Mr. Albert Hartnagle

Mr. and Mrs. John McMurtry

Mr. and Mrs. Edward J. Osmers

Mr. Al Perkins

Mr. Robert E. Repp

HALL OF FAME

The Steadman◆Hawkins Research Foundation is grateful to the following individuals, corporations, and foundations for their support of the Foundation in 2006 at a level of $50,000 or more. Their vision ensures the advancement of medical research, science, and care, as well as the education of physicians for the future. We extend our gratitude to these individuals for their generous support:

Mr. Herb Allen – Allen & Company

Mr. and Mrs. Earl G. Graves

Mr. Kenneth C. Griffin

Mr. and Mrs. William H. Harlan

Stavros S. Niarchos Foundation

Ossur North America

Pepsi Cola

Mr. Alan W. Perkins

Smith & Nephew Endoscopy

Mr. and Mrs. Stewart Turley

Vail Valley Medical Center

Mrs. Alice Walton

Zimmer

GOLD MEDAL CONTRIBUTORS

We are grateful to the following individuals, foundations, and corporations that contributed $20,000-$49,999 to the Foundation in 2006. Their continued generosity and commitment helps fund research such as enhancing cartilage healing. This potentially innovative treatment will help preserve the body's own joints and tissues by leading to improved quality and quantity of "repair" cartilage produced by the microfracture technique, a procedure impacting multitudes worldwide.

Aetna Foundation

American Express

Mr. and Mrs. Harold Anderson

Mr. and Mrs. Howard Berkowitz

Mr. and Mrs. Michael C. Brooks

Arie and Ida Crown Memorial

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Mr. and Mrs. Erich Spangenberg

Dr. William I. Sterett

The Liniger Family Foundation

US Bank

SILVER MEDAL CONTRIBUTORS

Silver Medal donors contribute $5,000-$19,999 annually to the Foundation. Their support makes it possible to fund research to determine the effectiveness of training programs to prevent arthritis, identify those who are most at risk for arthritis, and provide a basic foundation to improve post-surgical rehabilitation programs, thus improving the long-term success of surgical procedures. We extend our deep appreciation to these following individuals for their generous support in 2006:

Mr. and Mrs. John Alfond
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Mr. and Mrs. Paul Baker
Mr. and Mrs. Herbert Bank
Mr. and Mrs. Erik Borgen
Butterfield & Robinson
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Mr. and Mrs. Brad Seaman
Mr. and Mrs. O.B. Shelburne
Steadman-Hawkins Clinic
Steadman-Hawkins Clinic Denver
Steadman◆Hawkins Research Foundation
Dr. and Mrs. J. Richard Steadman
Mr. and Mrs. Richard Strong
Mr. and Mrs. Vernon Taylor, Jr.
T-Bird Restaurant Group, Inc.
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Vail Resorts
Dr. Randy Viola
Mr. Norm Waite and Mrs. Jackie Hurlbutt
Ms. Karen Watkins
Mr. Mark E. Watson, Jr.
Mr. and Mrs. Patrick Welsh
Dr. and Mrs. Wayne Wenzel
The Williams Family Foundation

Chairs Support Foundation Work

The education of orthopaedic surgeons is a critically important mission of the Steadman◆ Hawkins Research Foundation. Academic Chairs provide the continuity of funding necessary to train physicians for the future, thus ensuring the continued advancement of medical research. Currently, more than 160 Steadman-Hawkins Fellows practice around the world. We wish to express our gratitude and appreciation to the following individuals and foundations that have made a five-year $125,000 commitment to the Fellowship Program to support medical research and education. In 2006, five chairs provided important funding for the Foundation's research and educational mission. We are most grateful for the support from the following:

Mr. and Mrs. Harold Anderson
Mr. and Mrs. Lawrence Flinn
The Gustafson Foundation
Mr. and Mrs. Roy Igersheim
Mr. and Mrs. Jay Jordan
Mr. and Mrs. Peter Kellogg
Mr. and Mrs. Steven Read

Fellowship Benefactor

Fellowship Benefactors fund the research of one Fellow for one year at a level of $10,000. This is a fully tax-deductible contribution that provides an opportunity for the benefactor to participate in a philanthropic endeavor by not only making a financial contribution to the educational and research year but also to get to know the designated Fellow. Each benefactor is assigned a Fellow, who provides written reports and updates of his or her work. We extend our gratitude to the following individuals for their generous support:

Mr. J. Michael Egan
Mr. and Mrs. Mitch Hart
The Fred and Elli Iselin Foundation
Mr. and Mrs. John W. Jordan
Mr. and Mrs. S. Robert Levine
Mr. and Mrs. Kent Logan
Mr. Tim McAdam
Mr. and Mrs. Jay Precourt
Mr. and Mrs. Stewart Turley

BRONZE MEDAL CONTRIBUTORS

Medical research and education programs are supported by gifts to the Steadman◆Hawkins Research Foundation's annual fund. The Bronze Medal level was created to recognize those patients and their families, trustees, staff, and foundations who contribute $10 -$4,999 annually to the Foundation. Donors at this level support many programs, including the Foundation's research to validate the success of new treatments for degenerative arthritis and identify factors that influence success. We thank the following for their support in 2006:

Anonymous (3)
Ms. Opal D. Abbink
Mr. and Mrs. Don Ackerman
Mr. Joseph Adeeb III
A/E Betteridge
Mr. and Mrs. Ronald Ager
Mr. and Mrs. Ricardo A. Aguilar
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Mr. Claude Gerard
Mr. Egon Gerson
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Mr. Dennis J. Giannangeli

Special Recognition and Thank You

The Steadman◆Hawkins Research Foundation organizes special fundraising events. Proceeds from these activities support the research and educational programs of the Foundation. We are indebted and grateful to individuals and corporations for supporting our special events.

Since 2003, Pepsi Cola has been a proud supporter of the Foundation's efforts to find solutions—through research and education—to help people keep active and mobile by reducing or eliminating the disability and pain associated with arthritis and other joint diseases and injuries.

Earlier in 2006, WestStar and US Bank and the Foundation formed a partnership through common interest and civic duty. Through community fundraisers, WestStar and US Bank and the Foundation are generating funds for more orthopaedic research and development to better the lives of locals in Colorado and beyond.

Mr. and Mrs. H. William Harlan, founders of Harlan Estate, have generously supported the Foundation's special events as the featured vintners for our Winter Winemaker Evening in February, have donated Meadowood Napa Valley vacation packages for our auctions, and have made a special gift of an exclusive Napa Valley Reserve membership.

We also wish to express appreciation to American Express, Vail Valley Medical Center, RE/MAX International, and Vail Resorts for sponsorship of the Foundation's special events.

This support has played a major role in our ability to conduct critical research, develop leading-edge procedures, and document our procedures and findings for the benefit of the entire medical community. By making our research available to physicians worldwide, the Steadman◆Hawkins Research Foundation is helping to change the way patients are treated.

Winter Winemaker Festival

Vintner William H. Harlan Presents His Highly Acclaimed Wines at 2006 Winter Wine Festival

Saturday, Feb. 25, 2006, marked the third-annual First Light, First Tracks, and Winter Wine Festival, hosted by The Steadman◆Hawkins Research Foundation. Both events drew crowds to enjoy wine, food and early skiing to raise money for the Foundation.

The 2006 Winter Wine Festival featured vintner William Harlan who served three of his highly acclaimed wines: The Napa Valley Reserve 2000, BOND "St. Eden" 2001, and Harlan Estate 1997. Harlan's wines were coupled with the fine cuisine of Thomas Salamunovich of Larkspur.

Food and wine were followed by an auction to raise money to support the Foundation's research and educational programs. Auctioned items included three, three-day vacation packages to Meadowood, a Relais and Chateaux lodging estate in the Napa Valley; a Grand Teton Golf retreat; wines from the Wagner Family of Caymus; and more.

Without the kindness and generosity of those involved in this and other events, the Steadman◆Hawkins Research Foundation would not be able to provide research and education to fight the effects of arthritis for millions of people worldwide.

We wish to extend our thanks and appreciation to the following individuals for their help in making this a special evening:

Grand Teton Lodge Company
Mr. and Mrs. William Harlan and Harlan Estate
Mr. Robert Trent Jones, Jr.
Mr. and Mrs. Dave Liniger
Mr. and Mrs. Philip Norfleet
Mr. and Mrs. Steven Read
Mr. and Mrs. Larry Ruvo
Mr. Jim Salestrom
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Steadman-Hawkins Sanctuary Golf Tournament, August 17

The Steadman◆Hawkins Research Foundation was selected by RE/MAX International, a global real estate firm, to hold the third Steadman-Hawkins Golf Classic at the Sanctuary, a premier golf resort located south of Denver. Proceeds from the tournament support the development of new procedures and methodology to battle degenerative arthritis. The tournament was open to the public and included grateful patients and corporate supporters.

The Foundation thanks Dave and Gail Liniger, owners and co-founders of RE/MAX International, who created this unique opportunity for the Foundation to develop and enhance relationships with those who support our mission. In addition, we wish to express our sincere appreciation to the following sponsors and participants:

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Foundation Celebrates Colorado Evening, Presented by WestStar and US Bank.

The Steadman◆Hawkins Research Foundation's orthopaedic research and education programs were the beneficiaries of the Colorado Evening, as the Vail Valley's finest restaurants paired their culinary wares with award-winning vintner BR Cohn to create a culinary extravaganza at Falling Creek restaurant in the Vail Valley.

We wish to express our sincere appreciation to the following sponsors and participants:

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The Beaver Creek Snowshoe Adventure Series, Presented by Pepsi-Cola

This family-oriented snowshoe event attracts everyone from the first-time snowshoer to the world's premier snowshoe athletes. The series is the largest of its kind in North America and consisted of three events throughout the 2006-07 winter season — December 10, 2006; January 7, 2007; and February 11, 2007. The adventure series features 5- and 10-K races, walks and runs, slopeside sponsor expos, and post-event plaza parties.

Since 2003, Pepsi Cola has been an active supporter of the Foundation's special efforts to find solutions — through research and education — to help people keep active and mobile by reducing or eliminating the disability and pain associated with arthritis and other joint diseases and injuries.

The North American Snowshoe Championships, the final event in the Series, wraps up the season with the highest profile event in the sport.

Aetna Foundation Funds Hall of Champions

As patients step out of the elevator on the third floor of the Vail Valley Medical Center, they walk down a long hallway that leads to the Steadman-Hawkins Clinic. Photos, posters, and jerseys of famous patients hang on the walls leading to the Clinic reception area. Inspired by Foundation Trustee Earl G. Graves, the *Aetna Hall of Champions*, will display memorabilia of famous Clinic patients who have benefited from the research of the Foundation. Mr. Graves presented a proposal to Aetna that resulted in the $200,000 grant to fund the *Aetna Hall of Champions*. The hallway will be completed by the fall of 2007.

NFL Charities Awards $125,000 Grant for Orthopaedic Shoulder Research

For the 13th year, NFL Charities, the charitable foundation of the National Football League, has awarded a substantial research grant to the Steadman◆Hawkins Research Foundation for new and continuing work on the causes, treatments, and prevention of shoulder injuries.

The research project, *Understanding Three-Dimensional Motion of the Shoulder Complex*, will provide the scientific knowledge to develop more effective approaches to shoulder rehabilitation and strengthening. The new information will offer significant change in the health care provided to the shoulder patient, allowing for better outcomes, as well as increasing quality of life in these patients.

Support from the NFL Charities is vital to the Foundation's overall shoulder research program. This motion data is very important, and numerous research centers around the world are anxiously awaiting the results. The data will be instrumental in helping advance and validate the Foundation's computer model of the shoulder. "This validation process is no small task, as it is computationally very tedious. I have no doubt that this model will revolutionize our basic understanding of how the shoulder really moves, and what muscles and ligaments are involved," stated Dr. Michael R. Torry, director of the Biomechanics Research Laboratory.

The principal investigators are Dr. Torry; Kevin Shelburne, Ph.D.; assistant director Marcus Pandy, Ph.D., University of Melbourne, Australia; and staff scientists Takashi Yanagawa, M.A.; and Erik Giphart, Ph.D.

NFL Charities is the cornerstone of the National Football League's commitment to community service. It awards sports-related medical research grants that advance the body of knowledge of sports medicine for professional and recreational athletes.

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Adele Igersheim: The Knee, The Package, and The Gift

By Jim Brown, Ph.D.

Six years ago, Adele Igersheim was moving full speed ahead — a living blueprint for the busy, talented, successful American woman. Born, raised, and educated in Pennsylvania, she graduated from the University of Pittsburgh, where she met her future husband Roy on a blind date. Now married 37 years, they raised three sons, a telecommunications executive (Daniel) in Virginia, a marine biologist (Brian) in Hawaii, and the youngest trader (Kevin) at the Chicago Board of Trade. Roy founded Management Systems Services, an information technology company based in Rockville, Maryland.

Along the way, Adele earned a master's degree in English, became a professor of composition and rhetoric, and taught at the University of Maryland and Montgomery College. In 1985, she founded her own company, Writers' Bloc Consultants, Ltd., which specializes in business and technical writing, and provides training, editing, and consulting services to help clients "unblock" business communications.

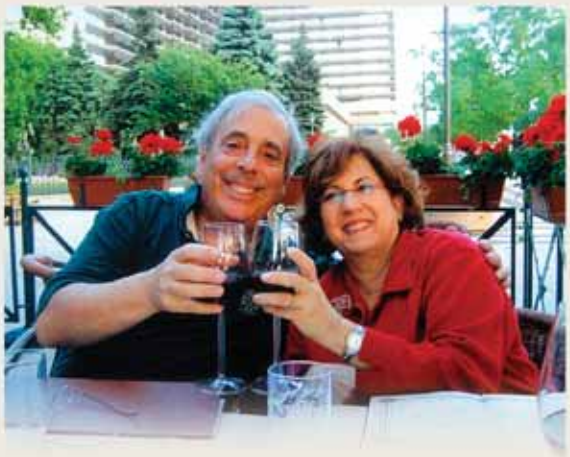
The Knee

In 1998, Adele was bumped off her personal fast track. During a trip to Vail she fell during a skiing lesson, injured her left knee, and not surprisingly, got right up and continued skiing. Back in Maryland, however, she knew something was wrong. The pain in her knee wasn't going away and her mobility was limited. A torn meniscus was the problem, and surgery to remove part of the shock-absorbing structure was supposed to be the solution. It wasn't. There was more pain, even less mobility, buckling of her knee, and eventually, a full-blown case of osteoarthritis—not an unusual development following many cases of knee surgery. Solution #2: another knee operation. It helped the buckling problem, but not the mobility, and she had extensive scar tissue as well as more advanced osteoarthritis.

During a physical therapy session, her personal trainer said, "The next time you go to Vail, you ought to see a doctor named Richard Steadman at the Steadman-Hawkins Clinic. He's the 'big guru' (his words, not hers) on knee problems." Adele took that advice, scheduled an appointment, and went back to Colorado in the summer of 2005.

The Package

"Dr. Steadman said my doctors had done what needed to be done, but that he thought we could go further and give me better mobility and less pain," recalls Adele. "He had developed a technique that was being performed only at Steadman-Hawkins or by Steadman◆Hawkins Research Foundation Fellows around the world." What Adele didn't know was that Dr. Steadman's procedure was gaining international recognition as "The Package," and she was about to receive it.



Roy and Adele Igersheim share a toast during their travels in Eastern Europe.

The Package is a series of arthroscopic procedures conducted during one operation. In Adele's case, the first was chondroplasty, in which a motorized shaving device smoothed out irregular joint surfaces. The second, called lysis of adhesions, removed scar tissue while minimizing bleeding. Two down, two to go. The third part of The Package was a meniscectomy. Dr. Steadman removed what was left of her torn meniscus. The final procedure was a synovectomy—removal of inflamed tissue that lined the joint of her arthritic knee.

"I had surgery in the morning and at 2:00 p.m. someone was in my room and manipulating my leg," says Adele. "At 8:00 the next morning I was downstairs in physical therapy. They didn't give my knee one minute to try to form scar tissue. In my previous two surgeries back East there had been as much as a week before therapy had begun." She also noticed that the focus of her post-op exercises seemed to be more on mobility than on strength training.

Less than a year later, Adele is back on track. She is more "pain-free." No more buckling. She walks, stretches, and exercises regularly. To say she is more mobile is an understatement. In May, she added Eastern Europe to a travel itinerary that, in past years, has included Australia, New Zealand, Peru, the Galapagos Islands, Turkey, Greece, and points in the American West. "I don't plan on skiing downhill anymore, but I'll snowshoe or ski cross-country."

The Gift

During her office visits in Vail, Adele began reading the Steadman◆Hawkins Research Foundation's newsletters. "It was interesting to learn about the research being funded and conducted by the Foundation. Much of what was done on my knee was a direct result of that research."

She suggested to her husband that they find a way to support the Foundation. Philanthropy is not a new idea for the Igersheims. Their family foundation has provided computers to a nonprofit organization in Maryland and an ambulance, a playground, and a greenhouse—all in Israel. Helping the people of New Orleans rebuild after Katrina is on their short list of potential projects.

Adele and Roy decided to fund one of the six Steadman-Hawkins Fellows for a year. Fellows spend a year refining skills and learning new surgical techniques, and they participate in research with Foundation scientists. "We liked the idea of supporting a Fellow who will be trained in Steadman-Hawkins methods and who can take his or her skills to others around the world who have knee and arthritis problems like mine. We will go to Vail in August and meet the Fellow we are sponsoring, and he will stay in touch with us during his stay at Steadman-Hawkins."

Adele Igersheim has a message for others who might read her story. "The Steadman◆Hawkins Research Foundation is doing wonderful research and they are putting it to use. By supporting the Foundation, all of us may someday enjoy a lifestyle as active as we would like it to be."

Corporate and Institutional Friends

Corporate support helps fund the Steadman◆Hawkins Research Foundation's Research and Education Programs in Vail, Colorado, and at six University sites. The Foundation is grateful for the generous support of our corporate donors. In 2006, we received $834,500 in corporate support. This work will benefit patients and physicians for generations to come.

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- **Zimmer**

Bracing Research: Steadman◆Hawkins Research Foundation and Össur Team Up Plus: If 15,000 Knees Could Talk

Common objectives and a shared vision make the Steadman◆Hawkins Research Foundation and Össur a natural match. Össur — a leader in the development and marketing of bracing, support products, and prosthetics — acquired long-time Foundation sponsor, Innovation Sports, in 2006. Now the parent company has demonstrated genuine enthusiasm for continuing and expanding that relationship by supporting our research and education programs.

Palmi Einarsson, vice president of research and development for Össur Americas, agrees. "Ossur is dedicated to helping people live a life without limitations, and the Steadman◆Hawkins Research Foundation has a mission to provide physically active individuals with information and care that can improve their overall quality of life. It's a good fit."

Headquartered in Reykjavik, Iceland, and with operations throughout the world, Össur has developed more scientifically advanced innovations in recent years than any other company in its field. The Unloader One knee brace for sufferers of knee osteoarthritis and related problems is one such example. Össur's Unloader brand name has been so successful within the orthopaedic world, that the terms "unloader" and "unloading" have become common, widely used terms for bracing technology.

A New Brace for Knee Osteoarthritis

Unloaders work by separating the knee bones when the cartilage or ligaments are damaged. They also effectively prevent further joint deterioration and make it possible for knee osteoarthritis sufferers to remain physically active.

Össur's forward-thinking designs resulted in Össur being recognized as a *2006 World Economic Forum Technology Pioneer.* The company also has garnered numerous awards, including *Time*'s "Coolest Inventions of the Year," *Fortune*'s "25 Best Products of the Year," and *Popular Science*'s "Best of What's New" two years running, as well as Frost & Sullivan's number one ranking in the Medical Devices Technology Innovation category for both 2005 and 2006. Össur's products have been featured and highly praised on *CBS Evening News*, and in the *New York Times* and *The Wall Street Journal*, just in the latter half of 2006.

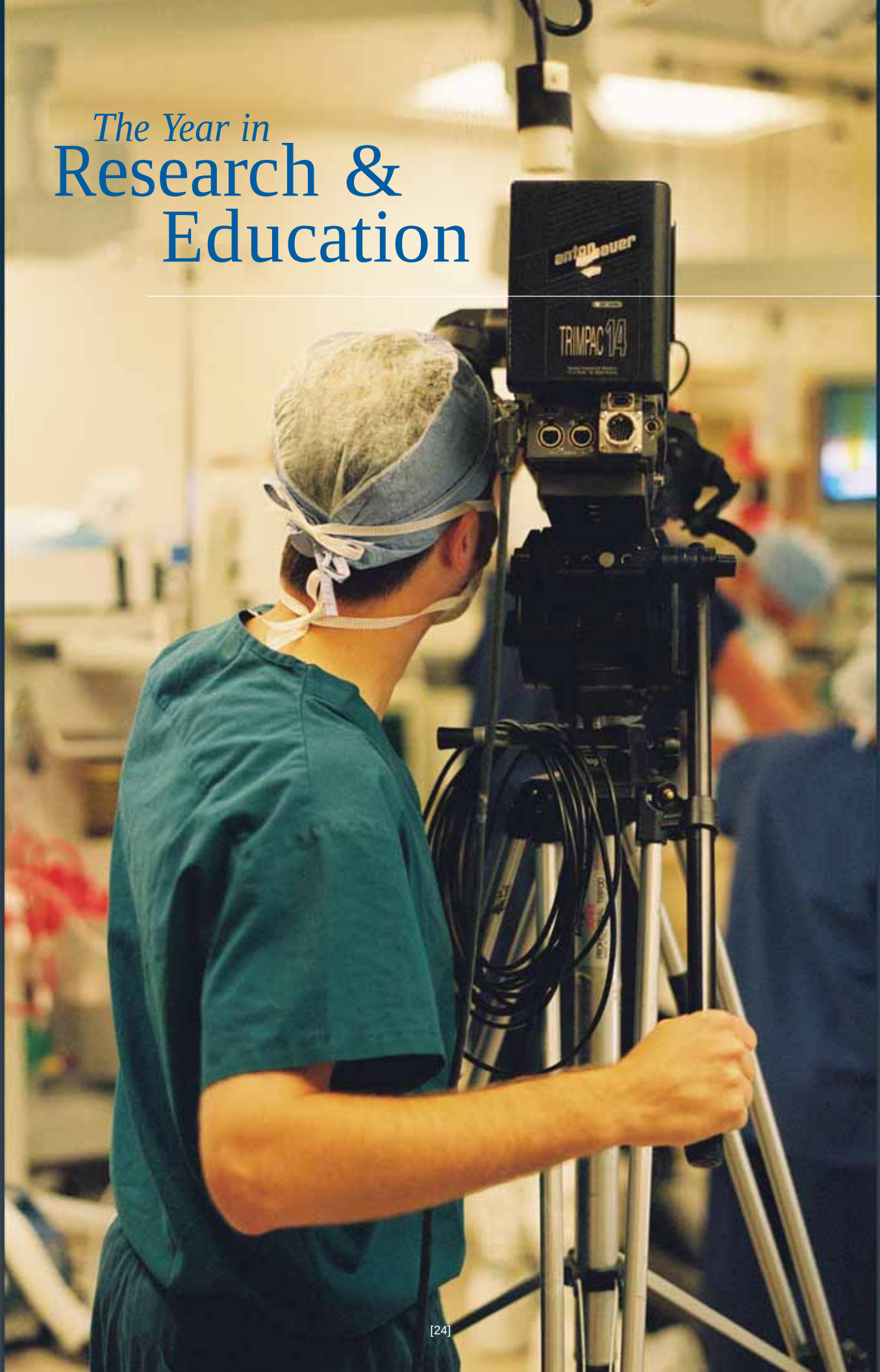
While awards and accolades are undoubtedly gratifying, "What drives us is partnering with health practitioners like Steadman-Hawkins, which uses our products to deliver successful clinical outcomes to patients," says Einarsson.

And there are plenty of patients. Knee osteoarthritis is the most common form of arthritis and one of the most prevalent chronic health problems in the U.S. today. That's not going to improve any time soon as baby boomers reach the "arthritis years." More active for longer than any previous generation, they are also more prone to arthritis and sports injury.

What Can 15,000 Knees Tell Us?

The Foundation is utilizing its database of 15,000 past and present knee patients to undertake an ongoing clinical study to determine whether unloader bracing can delay total knee replacement, as well as the effects of bracing on short- and long-term pain management for these knee osteoarthritis sufferers. This means that the types of solutions that the Steadman◆Hawkins Research Foundation and Össur are researching are going to dramatically affect how engaged people are in living full, active, and pain-free lives into the future.

The Year in Research & Education



Basic Science Research

William G. Rodkey, D.V.M., Director

The purpose of our Basic Science Research is to gain a better understanding of factors which lead to: (1) degenerative joint disease; (2) osteoarthritis; (3) improved healing of soft tissues such as ligaments, tendons, articular cartilage, and meniscus cartilage; and (4) novel and untried approaches of treatment modalities. Our focus is to develop new surgical techniques, innovative adjunct therapies, rehabilitative treatments, and related programs that will help delay, minimize, or prevent the development of degenerative joint disease. In 2006, we collaborated with various educational institutions, predominantly Colorado State University and Michigan State University. We believe that our combined efforts will lead directly to slowing the degenerative processes, as well as finding new ways to enhance healing and regeneration of injured tissues.

The relatively new area of regenerative medicine is an exciting one that has gained global attention. There are many new and innovative techniques under investigation by scientists around the world. One of the broad goals of this work can be stated simply as joint preservation. In 2006 we focused our efforts almost exclusively on regeneration of an improved tissue for resurfacing of articular cartilage (chondral) defects that typically lead to degenerative osteoarthritis. We have been working in the promising area of gene therapy in collaboration with Drs. Wayne McIlwraith and David Frisbie at Colorado State University. We have now completed our initial studies, and we have enough important data to take this project to the next level. In 2006 we also published an extremely important manuscript that examined the effects of leaving or removing a certain layer of tissue during lesion preparation for microfracture. This manuscript will help guide surgeons and should improve outcomes of microfracture performed by surgeons worldwide. We also completed data collection of a study involving electrostimulation to enhance cartilage healing.

The following provides some background information and a summary of our most recent findings. This work is ongoing, and the encouraging results presented here will allow us to continue to focus on this work in the coming years.

Osteoarthritis (OA) is a debilitating, progressive disease characterized by the deterioration of articular cartilage accompanied by changes in the subchondral bone and soft tissues of the joint. Traumatic injury to joints is also often associated with acute damage to the articular cartilage. Unfortunately, hyaline articular (joint) cartilage is a tissue with very poor healing or regenerative potential. Once damaged, articular cartilage typically does not heal, or it may heal with functionless fibrous tissue. Such tissue does not possess the biomechanical and biochemical properties of the original hyaline cartilage; hence, the integrity of the articular surface and normal joint function are compromised. The result is often OA.

William G. Rodkey, D.V.M.

The importance and the global impact of OA must not be underestimated. The U.S. Centers for Disease Control estimates that in the next 25 years at least 71 million Americans (15 percent to 20 percent of the population) will have arthritis, including degenerative arthritis secondary to injury to the articular cartilage surfaces of the joints. Osteoarthritis is the most significant cause of disability in the United States and Canada, moving ahead of low back pain and heart disease. By the year 2020, more than 60 million Americans and six million Canadians will be affected by some degree of osteoarthritis of just the knee. OA of other joints will raise this number significantly. The economic impact is enormous. Osteoarthritis alone will consume more than $85 billion of direct and indirect costs to the American public in 2007. The intangibles of this terrible disease include the chronic pain, disability, and psychological distress on the individual plus the family unit. We believe that our research can have far-reaching effects by greatly enhancing the resurfacing of damaged or arthritic joints before the disease process reaches the advanced and debilitating state.

Several of our earlier studies have shown that a technique, arthroscopic subchondral bone plate microfracture, is a successful method to promote adequate cartilage healing. “Microfracture” consists of making small perforations in the bone plate using a bone awl to access the cells and the growth factors present in the underlying bone marrow. The technique relies on the body’s own cells and healing proteins present in the marrow to promote healing, thus avoiding concerns of immune reactions to transplanted tissues or the need for a second surgery to collect grafts or cells. When we evaluated the healing of full-thickness chondral defects in exercised horses, we were able to show that the use of microfracture increases the amount of repair tissue present in the defect and improved the quality of cartilage repair by increasing the amount of type II collagen (found in normal joint cartilage) present in that repair tissue. Although microfracture was able to increase the major building block of artic-

ular cartilage tissue, it did not enhance the production of the other major components of cartilage thought to be necessary for long-term joint health. Additionally, as we have previously reported, we have found that the mechanical aspect of removing a deep layer of the cartilage, called the calcified cartilage layer, is critical for optimal formation of repair tissue and healing to the subchondral bone. Our work in horses also helped us confirm and refine the rehabilitation program for patients undergoing microfracture.

With respect to our work on the calcified cartilage layer, we had observed that leaving calcified cartilage inhibits the tissue healing and repair response after microfracture. Therefore, we hypothesized that removal of the calcified cartilage and retaining the underlying bone would enhance the amount of attachment of the repair tissue compared to retention of the calcified cartilage layer. We confirmed our hypothesis, and these findings were published in the prestigious *American Journal of Sports Medicine* in 2006.

A new area of research that has attracted our attention involves use of electrostimulation to speed or enhance healing of cartilage defects in conjunction with microfracture. There have been some reports in the literature that electrostimulation may help relieve pain in joints with advanced degenerative osteoarthritis. However, no studies have been reported that evaluate any potential benefits of electrostimulation used in treatment of acute cartilage injuries or in conjunction with early rehabilitation after resurfacing procedures such as microfracture. Therefore, we collaborated with investigators at Colorado State University and used our well-established cartilage healing model to study this potential healing enhancement technique. Eight horses were entered into the study. Using arthroscopic surgical techniques (Figure 1), bilateral chondral (cartilage) defects were made on the ends of the thigh bone in the knee joint. Treatment assignments were done in a randomized fashion so that a functional electrostimulation unit was placed on one leg (treated), and an identical but non-functional unit was placed on the opposite leg (control) (Figure 2). All outcome parameters were evaluated with the observer blinded (unaware) to the treatments. There were no substantial abnormalities or adverse events to report throughout the study. Results of this study in general showed that stimulated limbs had a significantly greater gait abnormality and response to flexion throughout the study period. When the distribution of type II collagen (the main component of normal articular cartilage) was assessed in the repair tissue, a significantly wider distribution was seen in non-stimulated (control) compared to stimulated (treated) limbs. No other significant differences were noted in any of the comparisons which included musculoskeletal, radiographic, gross, biochemical, histological, and immunohistologic outcome parameters. Based on an increase in postoperative gait abnormality and response to flexion, we feel that this treatment, in its present form, cannot be recommended for early postoperative cartilage resurfacing rehabilitation.

Our laboratory model work on the ACL "healing response" is now complete. This information will help other orthopaedic surgeons gain confidence with the healing response procedure, making them more likely to perform it. In so doing, fewer patients will require the expense, time, inconvenience, and discomfort of a formal ACL reconstruction. Additionally, other patients unwilling to have ACL reconstruction can be offered an alternative with much less morbidity. Interestingly, this study has raised some additional questions that we believe can be answered, at least in part, with additional laboratory studies. We will collaborate with other investigators and use an animal model to determine whether making puncture holes in a ligament graft at the time of implantation can lead to more rapid and complete formation of new blood vessels in the graft. If so, and if the number of punctures can be optimized, then faster and more complete healing enhancement of the ACL graft might be possible.

(continued on page 29)

Figure 1. All of the procedures performed on the horses in this study were carried out using arthroscopic surgical techniques at the Colorado State University Orthopaedic Research Center. The surgical set-up and procedures are essentially identical to those used routinely in our operating rooms at the Vail Valley Medical Center.

Figure 2. Postoperatively, an electrostimulation unit was applied to each knee of the horse. Randomly and without knowledge of the investigators, one unit was active (treated) and one was not active (control).

Bone and Joint Research: The Human-Horse Connection

By Jim Brown, Ph.D.

It is not a coincidence that three of the 13 members on the Steadman◆ Hawkins Research Foundation Scientific Advisory Committee (SAC) are veterinarians. Horses, like humans, suffer trauma to the limbs in general and joints in particular. Similar diseases occur in both species. Sixty percent of cases in which horses are retired are due to osteoarthritis. In order to investigate these common problems and develop procedures to treat them, a collaborative research effort has emerged between the Foundation and the Equine Orthopaedic Research Center at Colorado State University.

The men behind the initial arrangement were J. Richard Steadman, M.D., Founder and Chairman of the Foundation; C. Wayne McIlwraith, D.V.M., Ph.D., Director of the Equine Orthopaedic Research Center at Colorado State; and William Rodkey, D.V.M, Chairman of the Advisory Committee and Director of Basic Science at Steadman-Hawkins. A third veterinarian and SAC member is Steven P. Arnoczky, D.V.M., Director of the Laboratory for Comparative Orthopaedic Research at Michigan State. Pioneering work by Dr. Arnoczky has been important in the development of treatment for meniscus injuries.

"In December of 1990," recalls Dr. McIlwraith, "Dr. Rodkey introduced me to Dr. Steadman." He had developed the straightforward but brilliant idea of microfracture to access healing elements in the bone marrow underneath cartilage defects. But he also needed to provide scientific validation with control subjects, and we had the horses to fulfill that role. I had been frustrated with previous methods of bone marrow access, so a research project was begun by the Foundation and our Orthopaedic Research Center. It was initially funded by NFL Charities, the philanthropic arm of the National Football League."

Horses are bigger and stronger than humans, but the thickness of cartilage in their equivalent of the human knee is very similar. Research at CSU showed that, in the long term, there was significantly more repair tissue in defective areas after microfracture. In the short term, microfracture caused an increase in the production of the specific collagen contained in articular cartilage. Dr. Steadman's clinical findings have made microfracture a primary technique used around the world for promoting the repair of defects in articular cartilage.

"Other techniques used in equine research can be useful to humans," says Dr. McIlwraith. "We can control the exercise routine of horses and we can submit them to athletic exercise. It's pretty tough to get sheep to trot on a treadmill. We can also do things arthroscopically, which is not possible with smaller species. The only criticism is that the horse doesn't stand on its hind legs, but it still has the same weight-bearing area where defects in the cartilage occur."

Equine research at Colorado State was able to demonstrate that some of the changes occurring as a result of microfracture could not happen without it. It has also shown that, for microfracture to be more effective, the calcified layer of cartilage has to be removed. Without removing it, healing is inferior. This kind of basic research has changed the way Dr. Steadman and his colleagues at Steadman-Hawkins conduct surgery. Now, research funded by the Foundation and conducted at the Equine Orthopaedic Research Center is investigating ways to further enhance healing through gene therapy. The process has not made its way into the clinical arena for horses or humans, but it's coming. "We're still trying to find an agent to carry the gene into the joint without triggering an immune reaction," says Dr. McIlwraith. In addition, researchers are looking into the effectiveness of using electrostimulation following the microfracture procedure. If it works in horses, it will be tried in humans.

Dr. McIlwrath (right) operating on a horse's stifle (knee) Joint.

"Others are doing equine research," concludes Dr. McIlwraith, "but the relationship between the Steadman◆ Hawkins Research Foundation and the Equine Orthopaedic Research Center is unique. No other groups have so many world-class physicians and researchers like Drs. Steadman, Hawkins, Feagin, Philippon, Sterett, and their colleagues. The combination of our two groups working together and the support we get from individuals and organizations have advanced medicine, as well as the fields of human and equine orthopaedics."

Kim Gustafson: Bad Knee Leads to Good News

By Jim Brown, Ph.D.

The doorbell rang, but Kim Gustafson didn't let it interrupt the conversation. He made his way to the front door, answering questions the entire time, and picked up a package left by a UPS driver. Still talking, he opened the package and looked, for the first time, at the prototype of an experimental "unloading brace" for skiers that he helped design.

The brace isn't Gustafson's first product. He has worked in various marketing, management, and engineering-related positions in the United States and Europe for the past 30 years. "My brother, David, and I have now set up our own company — Opedixlabs — for developing sports-related and medically supported products," says Gustafson, a 1971 graduate of the University of Colorado. "I'll test this prototype on the snow tomorrow and then it will go to the Biomechanics Research Laboratory at the Steadman◆ Hawkins Research Foundation for scientific testing."

If the brace gets to market, a portion of the sales will go back to the Foundation to support additional research. Gustafson has been working with Michael Egan, the Foundation's CEO, and Michael Torry, Ph.D., who directs the work of the Biomechanics Research Laboratory, to establish an ongoing research effort between Opedixlabs and the Steadman◆ Hawkins Research Foundation. Together, they are also developing a pair of compression tights, a piece of apparel that incorporates a special banding component that also takes some of the load off the knees while running, walking, and cycling, as well as many other physical activities.

The Gustafson Family Foundation

But the Steadman◆Hawkins Research Foundation won't have to wait for potential sales from Opedixlabs products to get financial support from Kim and his family. The Gustafson Family Foundation has been giving money to charitable organizations for years. One of the recipients is the Mayo Clinic, which uses the Gustafson donations to fund the da Vinci Surgical System, a product developed by Intuitive Surgical that combines three-dimensional visualization with a robotic arm that can operate through tiny incisions.

Since 2003, the Gustafson Family Foundation has been supporting research at the Steadman◆Hawkins Research Foundation, partly because its mission is so different from that of many other organizations. Gustafson contributions have helped fund a chair in the Biomechanics Research department.

"I became interested in the Steadman-Hawkins Clinic because of a knee injury I got while jogging in a park in London," says Gustafson. "Later, I hyper-extended that same knee to the extent that it ruptured the ACL. I received treatment, but eventually the pain returned, and I had to look somewhere else for help. I met John McMurtry, the Vice President for Program Advancement at the Foundation, and he suggested that I let Dr. Steadman look at my knee. Two microfracture surgeries later, I am able to do three things that I couldn't do before: ski, teach other people to ski as an instructor with the Vail ski school, and work as a wrangler during the summers on a friend's cattle ranch in the high country of Colorado."

From One Foundation to Another

While Kim was being treated at the Steadman-Hawkins Clinic, he became aware of the Steadman◆Hawkins Research Foundation. When he told his father and siblings about the work being done at the Foundation, the family decided that its Foundation money would be well spent at Steadman-Hawkins. "My father is in his 80s and commented that walking is about the only form of exercise for many older adults," explains Gustafson. "He said he would like to support research that is making it possible for millions of Americans who suffer from osteoarthritis to keep on exercising — even if it's just walking."

More Than a Walk in the Park

Kim is not ready to restrict his exercise routine to walking, and he sees another big-picture resulting from Steadman-Hawkins research. "Skiing, especially in Colorado, is a very important industry. If we start losing the baby boomer generation to knee injuries and arthritis, it will have a tremendously negative impact on the state's economy. By conducting research on new products and developing new diagnostic, surgical, and rehabilitation procedures, the Steadman◆ Hawkins Research Foundation will continue to separate itself from other organizations."

"It's ironic," says Gustafson, "that if it hadn't been for my knee injuries, I probably wouldn't have been curious about developing these new products, and I wouldn't have realized the unique nature of the research being done at Steadman-Hawkins. Speaking for myself and for the Gustafson Family Foundation, it is exciting to be associated with the Steadman◆Hawkins Research Foundation, and I hope our relationship will continue to grow and benefit people around the world."

And finally, we are in the early stages of exploring the feasibility of two other areas of research. One area involves the new and exciting use of shockwave therapy to stimulate tissues to heal more rapidly. This shockwave therapy is similar to that used to pulverize kidney stones so that they may be passed without invasive surgery. The second area being considered involves the injection of a type of lubricating compound into the joint immediately at the conclusion of the microfracture procedure. It is possible that such a compound might have a protective effect for the healing cells that come from the bone marrow.

These are exciting times, and we feel that some very exciting research results lie just ahead for the Basic Science Research group and the Steadman◆Hawkins Research Foundation.

Clinical Research

Karen K. Briggs, M.B.A., M.P.H., Director; Marilee Horan, Research Associate; Lauren Matheny, Research Associate; Sarah Kelley-Spearing, Research Assistant; James Bennett, Research Intern; Rebeccca Glassman, Research Intern; David Kuppersmith, Research Intern; Dustin Manchester, Research Intern; Tiffany Tello, Research Intern; Jennifer Thorne, Research Intern.

The goal of Clinical Research at the Steadman◆Hawkins Research Foundation is to conduct outcomes-based research in the area of orthopaedic medicine that will aid both physicians and patients in making better-informed decisions regarding treatment. To achieve that goal, Clinical Research gathers data from patients before and after surgery who seek treatment for knee, shoulder, hip, and spine disorders. Information that is stored in a database provides a tool to understand the patient's perspective and is the key to our research. The focus is improvement of function and quality of life. Future research will target predictors of disability caused by arthritis, predictors of successful surgery, predictors of patient satisfaction, patient expectation of treatment, and patient outcomes following surgery.

Clinical Research published manuscripts accepted by peer reviewed journals year-by-year.

Back row left to right: Sarah Kelley-Spearing, Lauren Matheny, Karen Briggs, M.B.A., M.P.H., Marilee Horan, David Kuppersmith. Front row left to right: Jennifer Thorne, Tiffany Tello, Rebecca Glassman, Dustin Manchester.

THE KNEE

Are Outcomes of Microfracture in the Knee Related to Location?

Chondral defects in the knee may be a significant source of disability for patients. Such lesions are often found in combination with other conditions, such as ligament or meniscal injuries, and they may lead to persistent symptoms or progress to more debilitating arthritis. Isolated chondral defects in the knee are rare. Microfracture is a frequently used technique for the treatment of full-thickness chondral defects in the knee joint. Basic science and clinical studies have demonstrated this technique to be very effective in restoring the articular surface of these lesions and restoring function, while eliminating pain. We hypothesized that the outcomes of microfracture are dependent on the location of the chondral defect.

A review of data was performed among patients who underwent only the microfracture procedure for a traumatic or degenerative

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The Brad Ghent Family: Colorado's First Family of Skiing

By Jim Brown, Ph.D.

Memo #1 - To the Colorado Chamber of Commerce:

Nominations are now open for the position of "Poster Family" to promote Colorado skiing. The first candidate is the Brad and Karen Ghent family of Vail. Allow us to submit their credentials.

- Brad skied at the collegiate level, coached at Colorado University, then joined the coaching staff of the U.S. Women's Ski Team before becoming a successful businessman in Vail. He owns and operates two businesses at the Eagle County Regional Airport in Vail, including the Dollar Rent a Car agency.
- Karen was a member of the U.S. Ski Team for five years, competed in the World Championships, is a certified United States Ski Association National Coach, and is Alpine Director for the Ski & Snowboard Club Vail, a huge organization with more than 200 kids and 20 coaches. Among her many responsibilities is coaching 11- and 12-year-old skiers four days a week.
- Their daughters, Erika, Christa, and Abby, are all skiers, though their schedules are packed with other activities. Christa, 16, competed at the U.S. Nationals earlier this year.

Memo #2 - To the Colorado Chamber of Commerce:

Don't take our word in support of this amazing, multi-tasking Colorado family. Listen to Charlie Meyers, the eloquent, award-winning Outdoors Editor of *The Denver Post*. "Perhaps it was pure serendipity that two of the finest people associated with the U.S. Ski Team came to be married — or simply the way that good folks manage to find each other. That these two were connected by the common thread of top-level ski-racing competition serves to complete that bond. Suffice to say that Brad Ghent and Karen Lancaster Ghent have given so much to skisport, both as coach and competitor. They represent the best spirit of connecting through generations of the sport."

Memo #3 - To the Colorado Chamber of Commerce:

Nominations are closed. The Ghents win. They are the unofficial spokespersons for Colorado skiing and may be nominated for another position — "Colorado's First Family of Skiing."

Needless to say, Brad, Karen, and the girls do not endorse this announcement nor do they want the attention. Their lives are moving along quite nicely without these new titles.

The Ghent Family: Band and Karen; front, left to right, Erika, Christa, and Abby.

Bumps Along the Way

The contributions Brad and his family have made to skiing have come at a price. Karen broke her leg in a skiing accident when she was 16. Brad ruptured his ACL and tore a meniscus when he was skiing at CU, and he re-injured it at least one more time later in his skiing career. Christa hit a couple of bumps the wrong way earlier this year at the U.S. National Ski Championships and suffered essentially the same injury (torn ACL, torn meniscus) that her dad had experienced as a collegiate skier. By the way, Christa's injury happened exactly 27 years after her mom's broken leg. Same event, same hill (Sugarloaf), same leg, same date — Karen's birthday. This is starting to get spooky.

The common denominator that emerged during the Ghent family's history of sports injuries was Dr. Richard Steadman. He was a young orthopaedic surgeon in Lake Tahoe who mended Karen's broken leg. She hasn't had a problem since. He was already becoming a nationally known surgeon when he "cleaned up" Brad's damaged knee in 1982. Ten years later, Dr. Steadman performed his signature microfracture procedure on Brad. The microfracture approach is now being used by thousands of doctors around the world. Skiing is difficult for Brad, but his knee feels great and he can still bike and fish, two more of his recreational interests. This year, Dr. Steadman first repaired Christa's meniscus and later operated on her torn ACL. She is two months ahead of schedule in her rehabilitation program, anticipates a 100 percent recovery, and expects to be running and skiing by the end of the year. By the way, Christa played youth soccer and, with her older sister, Erika, was a member of last year's state high school championship cross-country team.

Investing in the Foundation

The experience and friendship the Ghent family has had with Dr. Steadman has brought them into an ever-widening group of people who support the Steadman◆Hawkins Research Foundation. "Anything we have done for the Foundation is also an investment in us," says Brad. "Just look at what the Foundation's research has done for Christa. By tracking thousands of cases and making that data available to a worldwide medical community, and by training scores of young doctors in the Steadman-Hawkins Fellowship Program, the probability of success in treating injuries like hers continues to improve.

"The work of the Foundation gives people like us, as well as those with degenerative arthritis," concludes Brad, "the chance to extend our active lifestyles for many years to come. I urge other families to join us in supporting the Foundation. It will be an investment that will pay solid dividends to themselves and others around the world."

Memo #4:

There is no Colorado Chamber of Commerce. No "Poster Family." No "First Family of Colorado Skiing." But if there were...

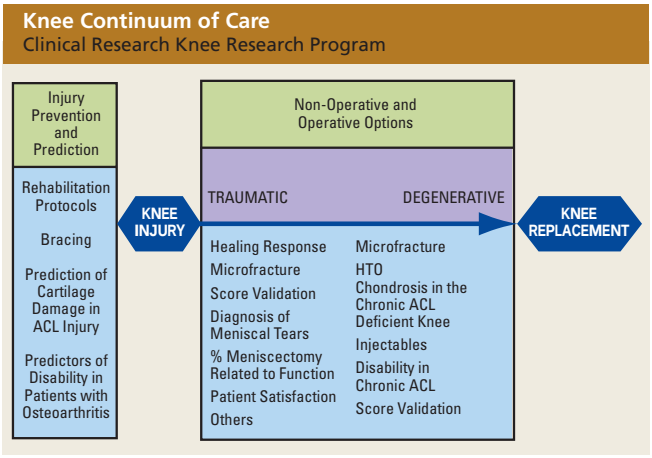
This analysis of the different locations of full-thickness chondral lesions treated with microfracture in the knee joint demonstrated that lesions of the femoral condyles respond better to microfracture than those of the patellar surfaces.

full-thickness chondral defect. At a minimum follow-up of two years, the Lysholm score, a score that measures patients' function, the Tegner activity scale, and patient satisfaction score were obtained. There were 107 patients available for follow-up at an average of 4.2 years. The mean age of this patient population was 36. Forty-five patients were female and 62 male. The incidences of lesions at each of these locations were: 28 medial femoral condyle, 14 lateral femoral condyle, 40 trochlear groove, 19 patellar, 5 lateral tibial plateau, and 1 medial tibial plateau.

There was no significant difference in the size of the lesions between compartments. The postoperative Lysholm score was not associated with age, lesion size, or time of follow-up. However, there was a significant relationship with the pre-operative Lysholm score and the postoperative Tegner score. The postoperative Tegner score was associated with age. Males had higher preoperative Lysholm scores (61 vs. 49) and higher postoperative Tegner scores. When lesions located on the femoral condyles were compared to trochlear groove lesions, there was no difference in post operative Lysholm score, patient satisfaction, or Tegner score. For patellar lesions, the Lysholm score was significantly lower compared to femoral condyle lesions. Independent predictors of postoperative Lysholm scores were postoperative Tegner scores and the locations of the lesions.

This analysis of the different locations of full-thickness chondral lesions treated with microfracture in the knee joint demonstrated that lesions of the femoral condyles respond better to microfracture than those of the patellar surfaces. In isolated chondral defects treated with microfracture, location may be an important predictor of success. In spite of these findings, high subjective patient satisfaction was seen, regardless of location. This paper was authored by Stephen Hunt, M.D.; David Noble, M.D.; Karen Briggs, M.P.H.; and J. Richard Steadman, M.D. The paper will be presented at the 2007 AAOS Annual Meeting in San Diego, California and at the 2007 Biennial Meeting of the International Society for Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine, in Florence, Italy.

Microfracture completed on the femoral condyle of the knee.

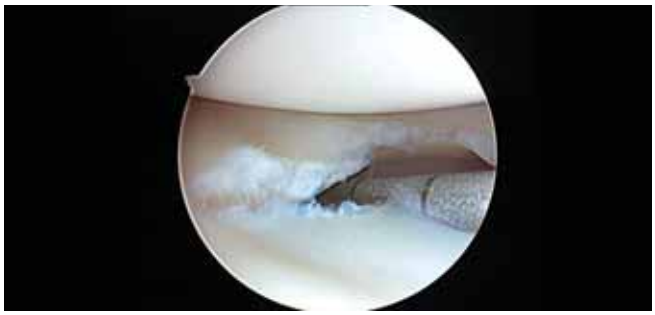


Tissue loss at meniscectomy correlates with clinical symptoms, function, and activity levels

Injuries to the meniscus cartilage of the knee are common. A torn meniscus is one of the most common reasons to undergo arthroscopic surgery. Absence of meniscus tissue leads to decreased clinical function and reduced activity levels. As the percentage of meniscus removed increases, contact area and contact stresses increase. A recent study showed that meniscectomies of greater than 50 percent of the meniscus resulted in the greatest changes in the knee. However, it is unclear how the amount of meniscus tissue lost correlates with clinical symptoms, function, and activity.

Lysholm and Tegner Scores

The Lysholm score (0-100, 100=highest) and Tegner activity level (0-10, 10=highest satisfaction) are common scoring systems utilized to evaluate outcomes of arthroscopic knee surgery. The Lysholm score measures symptoms and function. The Tegner categorizes individuals based on the activities in which they participate. Outcomes following arthroscopic knee surgery have recently shifted focus to the patient's perspective. Patient perspective is often driven by various factors, including previous experiences. The Lysholm score and Tegner activity level measure the patient's perspective of function and activity. The pre-surgical score is often compared to the follow-up score to rate improvement. Improvement in function and activity, along with patient satisfaction, are the primary goals for most knee surgeries. However, these results do not say how the knee compares to someone with normal knee function.



Meniscus tear in the knee.

The purpose of this study was to determine the relationship between the amount of meniscus removed and the function and activity level of the patient two years following the meniscectomy. The hypothesis of this study was that patients with greater than 50 percent of the meniscus removed would experience greater decreases in function and activity levels.

The study included 149 patients. The patient age ranged from 18 to 60 years. Eighty-one patients had an acute injury and no previous surgery to the involved meniscus. Chronic injuries were documented in 68 patients who had undergone 1- 3 prior surgeries on the involved meniscus. At the time of the surgery, following the partial meniscectomy, the size of the meniscus defect was physically measured. The percent of meniscus loss was calculated based on actual measurements.

At surgery, patients had an average of 50 percent of their medial meniscus removed. At two years, the amount of meniscus tissue remaining after surgery statistically correlated patients' ability to squat. Patients with no difficulties squatting had on average 51 percent meniscus remaining, while those who were unable to go beyond 90 degrees or not at all had on average 24 percent meniscus remaining.

The ability to climb stairs was also significantly correlated with the amount of tissue remaining. Patients with no difficulties climbing stairs had on average 51 percent meniscus remaining, while patients who could only climb one stair at a time had on average 20 percent meniscus remaining. Swelling of the knee was also correlated with the amount of meniscus remaining. Patients with no swelling had 52 percent meniscus remaining, and patients with severe to moderate swelling had on average 35 percent meniscus remaining. Patients who had worse or no improvement in pain symptoms at two years averaged 42 percent of the meniscus remaining, while patients who had improved pain scores had 51 percent meniscus remaining. In the chronic group of patients, patients who had worse or no improvement in pain symptoms average 11 percent meniscus remaining.

The change in Tegner activity for all patients with less than 50 percent meniscus remaining average 1.3 compared to 2.7 for patients with greater than 50 percent meniscus remaining. In the acute group, in patients with less than 50 percent remaining, the average change in Tegner was 1.6 compared to 2.8 for patients with greater than 50 percent remaining. In the chronic patient group, with less than 50 percent remaining, the average change was 1.1, compared to 1.9 for patients with greater than 50 percent remaining.

This study showed significant correlation at two years follow-up between the amount of meniscus removed at meniscectomy and function, activity, and pain. Few studies have demonstrated a relationship between the amount of meniscus tissue removed and the patient functional outcome. In conclusion, this study confirms the importance of preserving as much meniscus as possible at time of the meniscectomy. The more meniscus patients lose, the more disability they suffer. This is compounded by decreased activity levels in these patients. In order to prevent loss of function and decreased activity, the meniscus should be preserved by repair whenever possible instead of meniscectomy. The authors of this study are Karen K. Briggs, M.P.H.; William G. Rodkey, D.V.M.; and J. Richard Steadman, M.D.

Do second-look arthroscopic findings and clinical outcomes correlate in the treatment of degenerative chondral lesions with microfracture and valgus high tibial osteotomy?

Full-thickness chondral defects in the knee present difficult problems with numerous proposed treatment options, including microfracture, shaving, and cartilage transplantation. These treatments have shown beneficial results when chondral defects are seen in isolation, but a more difficult situation involves chondral pathology in the setting of varus (turning inward) malalignment and global degenerative chondral changes. While knee replacement remains a viable option for these patients, many of these individuals desire to maintain a physically active lifestyle that may not be recommended with a total joint replacement. The purpose of this study was to see if high tibial osteotomy, in combination with microfracture, provides a suitable treatment for degenerative arthritis, varus malalignment, and chondral defects of the knee.

The cornerstone of non-prosthetic treatment for the varus degenerative knee in the active patient remains high tibial osteotomy (HTO). High tibial osteotomy involves an incision made diagonally through the tibia without completely cutting through the tibia. The tibia is then opened to a specific, measured degree. A metal plate is placed over the opening on the inside of the leg to secure the opening permanently. A bone and blood mixture is placed in the opening between the tibia and the plate. The bone then consolidates and heals, causing a realignment of the knee and pressure to be taken off of the problem areas, where cartilage has been worn away.

In addition to HTO, many have attempted to add regenerative cartilage procedures to improve patient outcomes and increase the longevity of the procedure. Our chondral resurfacing technique began with the removal of any loose flaps of unstable articular cartilage. The calcified cartilage layer was then removed using a motorized shaver. A microfracture awl was used to make several two-millimeter holes in the subchondral bone. These holes were placed as closely together as possible without breaking into each other. This caused a bleeding response in order to generate new cartilage.

The average time to second-look arthroscopy was 13 months. At the time of second-look arthroscopy, all microfractured lesions were evaluated for the percent of fill with repair cartilage by visual

Microfracture prior to high tibial osteotomy.

Repair tissue 8 weeks following microfracture and high tibial osteotomy.

examination and measurements made using an arthroscopic probe of the lesion on both the medial femoral condyle (MFC) and medial tibial plateau (MTP). The average fill of medial femoral condyle lesions was 84 percent. The average fill of medial tibial plateau lesions was 74 percent. Twenty-two knees of the 30 with MFC lesions (73 percent) had greater than 80 percent fill. Seventeen knees of the 23 with MTP lesions (74 percent) had greater than 80 percent fill. Seventeen knees of the 23 that had both MTP and MFC lesions had greater than 80 percent fill.

The results of this study support the use of combined opening wedge medial high tibial osteotomy and microfracture for the degenerative varus knee. The addition of microfracture increased the amount of coverage of degenerative lesions on the MFC and MTP. The addition of microfracture to opening wedge medial high tibial osteotomy for the treatment of the degenerative varus knee in active patients may be an effective treatment option. The observation of improved fill of degenerative chondral lesions compared to historic controls supports this addition.

Ultimately, outcomes and patient satisfaction scores support the combined procedure of microfracture and HTO. This study has been submitted for presentation at the American Academy of Orthopaedic Surgeons for 2008. The authors of this study are Dr. David King, Dr. Andrew Chen, Karen Briggs, Lauren Matheny, Dr. William Sterett, and Dr. J. Richard Steadman.

Chondral resurfacing and high tibial osteotomy in the varus knee: How long will it last?

Active patients with arthritic malalignment of the knee are difficult to manage. Addressing chondral damage with a resurfacing procedure is not recommended in the face of axial malalignment. Joint replacement may not be appropriate in this group of people who want to remain highly active. Multiple authors have treated acute chondral lesions with a variety of resurfacing procedures that include microfracture, shaving, and cartilage transplants.

Survivorship, or the percentage of patients who did not require a total knee replacement, was 97 percent at five years and 91 percent at seven years.

High tibial osteotomy has been recommended for the treatment of varus osteoarthritis in order to decrease pressure on the damaged medial compartment. A medially based opening wedge high tibial osteotomy has the advantage of avoiding some of the complications associated with lateral closing wedge osteotomies, such as further shortening of the limb, problems associated with the proximal tibiofibular joint, and operating near the peroneal nerve.

We have been treating both chondral damage and axial malalignment in patients with varus malalignment and degenerative cartilage defects since 1995 with a combined microfracture and valgus-producing opening wedge high tibial osteotomy. The purpose of this study was to document how long the HTO and microfracture last, patient satisfaction, and functional outcomes. The goal is to avoid knee replacement with a combination of microfracture and opening wedge medial high tibial osteotomy . Our hypothesis was that there would be a higher survivorship rate at five to seven years following this combined procedure.

Survivorship, or the percentage of patients who did not require a total knee replacement, was 97 percent at five years and 91 percent at seven years. Average time to knee replacement was 81.3 months in the 12 patients who elected to proceed with knee replacement. All patients who underwent knee replacement had medial compartment damage at the time of HTO and microfracture. At three years, mean Lysholm was 73, mean Tegner was 2.8, and mean patient satisfaction was 7.8. At five years, mean Lysholm was 73, mean Tegner activity level was 3.8, and mean patient satisfaction was 7.1. At nine years, mean Lysholm was 67, mean Tegner was 3.1, and mean patient satisfaction was 7.1. The degree to which the osteotomy was opened

Opening wedge high tibial osteotomy with plate.

correlated with postoperative Lysholm. Patients with medial meniscus pathology identified at the time of surgery were 9.2 times more likely to undergo knee replacement than those without the condition.

These early-to-intermediate term results are better than those published with osteotomy alone. The improved survivorship may be due to the addition of the chondral resurfacing procedure or using a medially based opening wedge osteotomy rather than a lateral closing wedge osteotomy. Offering an unloading osteotomy to patients undergoing chondral resurfacing or meniscus replacement with minimal degenerative changes may postpone knee replacement indefinitely. Many of our patients were candidates for knee replacement at the time of HTO and microfracture but chose to avoid knee replacement. Reasons to avoid knee replacement included age, desired activity level, and personal preference. Patient outcomes also improved significantly in our study.

Surgical management of the malaligned, painful, arthritic knee in an active individual is challenging. Treatment with combined chondral resurfacing (microfracture) HTO can survive multiple years, postponing knee replacement. Patient satisfaction was high and Lysholm and Tegner scores significantly improved after this procedure. This study has been submitted for presentation at the American Academy of Orthopaedic Surgeons for 2008. The authors of this study are Dr. Michael Huang, Lauren Matheny, Karen Briggs, Rebecca Glassman, Dr. William Sterett, and Dr. J. Richard Steadman.

Early ACL reconstruction in combined MCL/ACL injuries

Most of the orthopaedic literature regarding isolated medial collateral ligament (MCL) injuries supports nonoperative treatment, but treatment strategies remain more controversial for combined injuries of the anterior cruciate ligament and medial collateral ligament (ACL-MCL). A multitude of approaches have been proposed, including isolated MCL repair, combined treatment of the ACL-MCL, and combined nonoperative treatment.

Furthermore, timing of ACL reconstruction after a combined ACL-MCL injury remains even more controversial. Some surgeons propose allowing the MCL to heal before ACL reconstruction, while others support early reconstruction of the ACL, which they believe augments MCL healing.

The purpose of this paper is to present our clinical results with early reconstruction of the ACL and nonoperative treatment of the MCL after combined injuries of the ACL-MCL. ACL reconstruction involves debriding the torn ACL and replacing it with a graft of tendon taken from the patient's own tendons — either the patella or the hamstring tendon, or through the use of an allograft (cadaveric tendon, either the Achilles or patella tendon). Our hypothesis was that patients undergoing treatment for combined injuries within three weeks of injury would have improved outcomes and activity levels.

All patients in this study had a complete ACL tear reconstructed within three weeks of injury, a minimum grade 2 (1-4, with 1 being a sprain and 4 being a complete tear) MCL injury treated nonoperatively, were at least 15 years old, and were at least two years out from index surgery. The average follow-up time was 63 months. The average time from injury to surgery was six days. Excellent Tegner scores were obtained postoperatively in 67 percent of patients, good scores were seen in 5 percent of patients, fair scores were seen in 10 percent, and poor scores were seen in 18 percent. Excellent Lysholm scores were obtained in 26 percent of patients, good scores were observed in 35 percent, fair scores were obtained in 23 percent, and poor scores were seen in 16 percent of patients. The mean patient satisfaction was 8.5 on a scale of 1-10, 10 being most satisfied. Of the 74 patients, 78 percent of patients rated their results as excellent, 13 percent of patients rated their results as good, and 9 percent of patients rated their results as poor.

This study specifically addresses two controversial issues regarding combined ACL-MCL injuries: (1) non-operative treatment of the MCL lesion, and (2) appropriate timing for surgical reconstruction of the ACL following a combined injury. Our results in regard to Lysholm knee scores, Tegner activity scores, and patient satisfaction demonstrate that nonoperative treatment of the MCL and an early reconstruction of the ACL is a reasonable and safe treatment strategy. This study has been submitted for presentation at the American Academy of Orthopaedic Surgeons for 2008. The authors of this study are Dr. Colin Looney, Dr. Peter Millett, Lauren Matheny, Karen Briggs, Dr. William Sterett, and Dr. J. Richard Steadman.

Synvisc Study

Arthritis is a very common joint disease in which the cartilage of the joints wears away. As people get older, cartilage loss increases, and joint lubrication decreases. Although there are viable surgical options, many patients desire a treatment without the invasive nature of surgery. Synvisc is a viscosupplementation administered to people with joint fluid loss (synovial fluid). Viscosupplementation and hyaluronic acid injections have shown to improve symptoms in patients with osteoarthritis. To improve these results, some physicians have combined corticosteroid with viscosupplementation. The purpose of this study was to document outcomes following corticosteroid injection, in conjunction with Synvisc injections, in a series of three.

All patients who participated in this study were given pain and function questionnaires each time they had an injection. Patients were asked to record pain, function, and symptoms every day for one week after each injection. After the last injection, patients were asked to complete questionnaires at 1, 3, 6, and 12 weeks and 6 months after the third injection. Currently, we have 25 patients with complete six-months data. We are still enrolling patients and collecting data. Enrollment will be completed in 2007. An abstract will be submitted to the 2007 World Congress of Osteoarthritis. The authors of this study are Karen Briggs, Lauren Matheny, and Dr. J. Richard Steadman. This study is funded by a research grant from Genzyme.

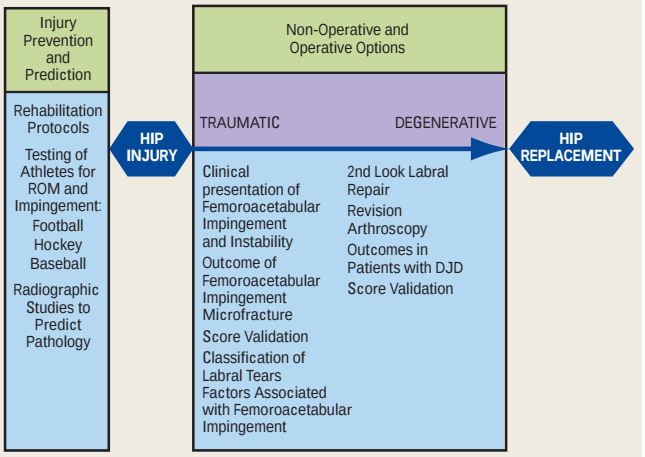
THE HIP

Time frame for Improvement Following Arthroscopic Hip Surgery

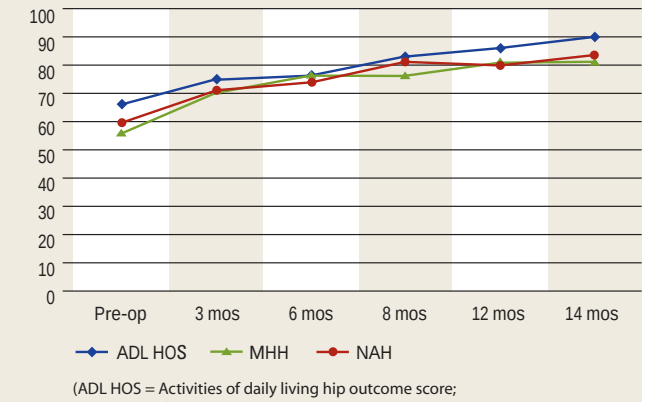
This paper will be presented at the 2007 Annual Meeting of the American Academy of Orthopedic Surgeons. Promising results following arthroscopic hip surgery have been reported. However, few studies indicate the duration of rehabilitation and time to functional recovery. Patient satisfaction is heavily influenced by patient expectations. Discrepancies exist between the time frame in which patients expect to improve and the timeframe in which improvement realistically occurs. The purpose of this study was to document the time frame for improvement of hip function following arthroscopy.

Three hundred thirty-five hip arthroscopies were performed by Dr. Marc J. Philippon between March 2005 and January 2006. Subjective, patient-completed questionnaires were distributed to patients before surgery and at time intervals of 3, 6, 8, 12, and 14 months after surgery. Four hip arthroscopy outcome measures were used to report patient pain, function, improvement, and satisfaction.

Hip Continuum of Care
Clinical Research Knee Research Program



Improvement in hip outcome following hip arthroscopy.



(ADL HOS = Activities of daily living hip outcome score; MHH = modified Harris Hip Score; NAH = arthritic Hip Score

The average patient age was 40 years. Patients had to be a minimum of six months post-surgery to be included. This study showed that the greatest improvement in patients under the age of 30 was seen in the first three months following surgery. The greatest improvement in patients over the age of 30 was seen at six months after the operation.

In our experience, patients tend to expect the function of their hip to be back to normal by about three months postoperatively. While this can and does happen for many patients, a large number of patients do not see as much improvement as they would like within the first three months. This extended duration of time necessary for recovery can be a source of frustration and dissatisfaction for patients who expect to progress much faster than they actually do. The ability to show patients, particularly those over 30, that the majority of improvement following hip arthroscopy may not be seen until six months after surgery may help to avoid this scenario.

Improvement following hip arthroscopy is seen as early as three months and continues for at least the first 12 months afterwards. Younger patients see improvement earlier than older patients. Guiding patient expectations based on these findings may result in higher patient satisfaction following hip arthroscopy.

The authors of this article are Dr. Marc Philippon, Karen Briggs, Brian Maxwell, David Kuppersmith, and Sophie Hines.

Hip Injury Patterns in Professional Hockey Players

Little has been published in the literature on intra-articular hockey-related hip injuries. However, they cause significant disability and are a potential cause of early retirement. The description of hip injury patterns in the National Hockey League is important in understanding, treating, and returning athletes to play. And as the sport of hockey continues to increase in popularity, it is important to identify potential risk factors. The purpose of this study is to describe patterns of intra-articular hip injuries identified at arthroscopy in the professional hockey player.

Between October 2001 and September 2006, the senior author, Dr. Philippon, arthroscopically treated 39 hips in 35 male professional hockey players who had debilitating hip pain and an inability to participate in their sport. The average age was 26.5 years. There were nine defensemen, 13 goalies, and 17 offensemen. At the time of arthroscopy, 87 percent had complete labral tears, 87 percent had cam-type femoroacetabular impingement, and 56 percent had pincer-type impingement. Thirty-one percent required microfracture technique to treat articular cartilage defects. One hundred percent of goalies had chondral defects. All goalies and offensemen were treated for labral pathology as well as femoroacetabular impingement. The most commonly treated conditions were labral tears, chondral damage, and femoroacetabular impingement.

Twenty-nine athletes remain currently active in the NHL level. Three players returned to sport following hip arthroscopy but have since retired, and three athletes did not return.

(continued on page 38)

Impingement Can Lead to Arthritis in the Hip

Early intervention may lead to prevention.

By: Marc J. Philippon, M.D.; Mara Schener; and David Kuppersmith

Dr. Philippon is an orthopaedic surgeon at the Steadman-Hawkins Clinic who specializes in treating hip injuries.

Approximately 120,000 hip replacements are performed every year in the United States. This invasive, open technique is recommended for individuals with extensive osteoarthritis. We use a minimally invasive arthroscopic technique that may delay the need for this procedure by slowing the progression of hip osteoarthritis.

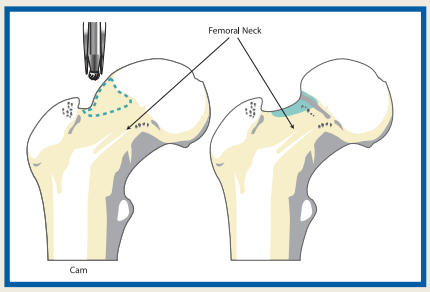
A significant cause of osteoarthritis in the hip is thought to be femoroacetabular impingement (FAI). FAI occurs when abnormally shaped bones of the hip repetitively bump into each other during movement. As a result, soft tissue structures of the hip, including the acetabular labrum and the articular cartilage, are often entrapped and injured. Impingement is particularly common in hip flexion and internal rotation, a position frequently encountered during activities of daily living. Difficulty with putting on shoes and socks, and getting into and out of a car are common complaints in patients with extensive impingement.

There are two distinct types of femoroacetabular impingement — cam and pincer. Most commonly, patients have a combination of the two types. Cam impingement results from excess bone located on the femoral neck. Pincer impingement results from excess bone on the acetabulum. The precise cause of the impingement is unknown. However, it likely has both developmental and activity-related (contact in sports, for example) components.

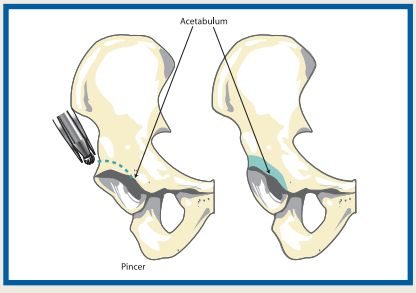
In both types of impingement, the abnormal contact between the femoral head and acetabulum during movement causes injury to the labrum and articular cartilage. Injuries to the labrum lead to increased movement of the femoral head within the acetabulum, resulting in an unstable joint. Also, tears of the labrum result in increased contact forces between the femoral head and the acetabulum. With these increased forces, damage to the articular cartilage may result. Injuries to the cartilage over time may increase in size and depth, and ultimately result in bone-on-bone contact. At this point in the disease, the only current solution is a total hip replacement.

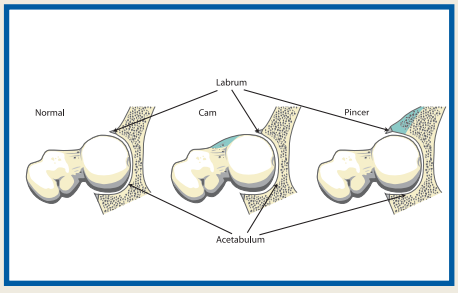
A recent study we conducted at the Steadman◆Hawkins Research Foundation showed that FAI directly correlates to large articular cartilage injuries of the acetabulum. Hips with cam impingement proved more likely to have large chondral defects compared to hips without cam impingement. This may hasten the onset of hip osteoarthritis. Knowing the damage that can be caused to the labrum and articular cartilage by FAI, two surgical options have been described to treat this disorder. The first is an open surgical technique that requires a large skin incision and dislocation of the hip joint to treat the impingement. This approach has shown good results, but it is a very invasive procedure. The second approach, which we developed, uses two small arthroscopic incisions to remove the excess bone from the femoral neck and the acetabulum. The goal of the arthroscopic procedure is to relieve the impingement and create joint clearance to stop the bony abutment and soft tissue damage. This may lessen the damage to cartilage and reduce the later need for total hip arthroplasty. With this technique the patients do very well after surgery. Our recent study will be presented at the Annual Meeting of the American Academy of Orthopaedic Surgeons, and it has shown that professional athletes can return to elite sports following treatment with this procedure.

In conclusion, impingement leads to cartilage damage, which causes osteoarthritis. Femoroacetabular impingement in the hip is a major cause of injury to the acetabular labrum and articular cartilage, hip pain, reduced hip motion, and accelerated progression of hip osteoarthritis. By intervening early in this disorder, we are hoping to delay or prevent the onset of hip osteoarthritis and the need for total hip replacement.



With cam impingement, the burr, a small cutting instrument, is used to remove excess bone from femoral neck.





With pincer impingement, the burr, a small cutting instrument, is used to remove excess bone from acetabulum.

Illustrations: Marty Bee

The emerging trends of hip arthroscopy have proven to be safe and effective in correcting hip pathologies

The emerging trends of hip arthroscopy have proven to be safe and effective in correcting hip pathologies There is an apparent trend within the sport of hockey that predisposes athletes to hip pathology. It is important for the professional hockey community, including team physicians, physical therapists, and trainers, to understand the incidence of hip pathology associated with hockey. Early detection and intervention of hip pathologies in the professional athlete will be the focus of future studies. The authors of this study were Dr. Marc Philippon, David Kuppersmith, and Mara Schenker.

Hip Alpha Angles as Radiographic Predictors of Chondral Injury and Decreased Hip Range of Motion in Femoroacetabular Impingement

The Arthroscopy Association of North American will present the Fellows Award for this paper at the 2007 annual meeting in San Francisco. This paper will will also be presented at the 2007 Annual Meeting of the American Academy of Orthopedic Surgeons in San Diego, and at the Biennial Meeting of the International Society for Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine, 2007, Florence, Italy.

Femoroacetabular impingement (FAI) has been proposed as a cause of early arthritis in the hip. The femoral head has been described as a round convex ball and the acetabulum a concave socket. In "cam-type" impingement, abnormal bony extensions of the femoral head are thought to cause increased friction and damage to the articular cartilage of the acetabulum. A measurement routinely used in the clinic to assess bony abnormality in the hip is known as the alpha angle. A large-degree alpha angle corresponds to a large bony abnormality of the femoral head/neck. The purpose of this study was to determine whether larger preoperative alpha angles correlated with damage to the articular cartilage or changes in hip range of motion.

A specific x-ray image was used to measure the alpha angle on 107 consecutive professional and amateur athletes who had hip pain between March and December 2005. Three films were of insufficient quality to make measurements. There were 64 males and 43 females, and the average age was 28.5. Alpha angles were measured with a digital goniometer (an instrument to measure hip angles). The angle in which the femoral head became out of round and the mid-axis of the femoral neck was measured. One hundred athletes in this series underwent hip arthroscopy, and surgery data were obtained from a prospective database. In this series of patients, alpha angles were related to age, with older patients having higher angles. Larger alpha angles were significantly related to decreased hip flexion, decreased internal rotation, and decreased external rotation. Higher alpha angles were statistically related to full-thickness and large acetabular chondral defects. In patients with full-thickness acetabular chondral defects, the average alpha angle recorded was 66.14 degrees vs. 54.20 degrees in patients without these defects. In patients with large acetabular chondral defects, the average alpha angle recorded was 71.5 degrees vs. 56.9 degrees in patients without these defects.

Cam-type femoroacetabular impingement as measured by increased alpha angles was statistically associated with loss of hip range of motion and operative findings of full-thickness and large chondral defects on the acetabulum. This supports the hypothesis that cam-type FAI is associated with early osteoarthritis and that subsequent treatment to reduce the size of the aspheric portion of the femoral head may prevent the occurrence or progression of osteoarthritis. The authors of this presentation were Todd L Johnston, Mara Schenker, Dr. Marc Philippon, and Karen Briggs.

Microfracture of the femoral head of the hip joint.

Outcomes Following Hip Arthroscopy with *Microfracture*

The article will be published in a 2007 issue of the *Journal of Arthroscopy.* It will also be presented at the 2007 Annual Meeting of the Arthroscopy Association of North America in San Francisco. Chronic pain is a common condition within the hip, especially in the older population. The emerging trend of hip arthroscopy has allowed for the evolution of many common orthopaedic procedures. Articular cartilage defects rarely heal, due to its limited restorative capacity. The purpose of this study was to report on early outcomes in patients who underwent hip arthroscopy with microfracture. The authors hypothesized that under the correct indications, patient selection, and compliant rehabilitation protocol, patients would have improved clinical outcomes following microfracture in the hip.

Forty-one patients underwent microfracture in the hip and were available for one year follow-up. The average age of the patients was 44 years, and there were 28 males and 13 females. Surgical data and patients' completed questionnaires were used. Four outcome measures were used to quantify patient improvement and function.

The microfracture technique in the hip is indicated and performed similarly to that described by Dr. Steadman in the knee. Furthermore, the physical therapy protocol following arthroscopic microfracture in the hip is rigorous and crucial to success.

This study demonstrated that microfracture technique to treat articular cartilage defects in the hip can result in patients regaining some of their lost function, result in high patient satisfaction, and reduce symptoms at one-year follow-up

The average period from time of injury to time of surgery was 3.97 years. At minimum one-year follow-up, patients demonstrated statistically significant improvement in outcomes measures. The average patient satisfaction was 7 (1-10, 10=highest satisfaction) at follow-up. This study demonstrated that microfracture technique to treat articular cartilage defects in the hip can result in patients regaining some of their lost function, result in high patient satisfaction, and reduce symptoms at one-year follow-up. The authors of this article were Dr. Marc Philippon, Karen Briggs, David Kuppersmith, Brian Maxwell, and Sophie Hines.

Early Results of Acetabular Labral Repair

The paper was published in the *Journal of Arthroscopy*. It will also be presented at the 2007 Annual Meeting of the Arthroscopy Association of North America in San Francisco. Previous arthroscopic intervention has included labral debridement, excision, and repair. It is believed that arthroscopic labral repair restores proper labral structure, therefore preserving its physiological function. The purpose of this study was to report early results of function and patient satisfaction in patients undergoing labral repair.

Eighty-six patients underwent arthroscopic repair of the labrum. The average age was 36, with 50 males and 36 females. The data that was collected included surgical data, as well as four hip arthroscopy outcomes measures that quantify level of improvement after surgery.

Patients experienced improvement in function at one year following surgery. Early results demonstrate that labral repair in the hip leads to improved function and high patient satisfaction. This study demonstrates the potential of labral repair to facilitate improvement in pain management and joint preservation. The authors of this study were Dr. Marc Philippon, Dr. Michael Huang, Karen Briggs, and Sophie Hines.

Anchor placed in hip for repair of torn labrum.

Labral Tear Morphology Is Associated with Type of Femoroacetabular Impingement

This study will be presented at the 2007 Annual Meeting of the American Academy of Orthopedic Surgeons in San Diego. With recent advances in imaging and arthroscopic treatment of hip disorders, there has been increased attention focused on the acetabular labrum. Patterns of acetabular labral tears have been reported to vary with the type of femoroacetabular impingement, but no clear associations have been made. Cam-type femoroacetabular impingement is defined as a bony abnormality contributing to an aspherical femoral head. Pincer-type impingement occurs at the acetabulum where there is excess

bony overgrowth in which the front wall impedes the posterior wall of the acetabulum. The purpose of this study was to identify an association between labral pathology and type of femoroacetabular impingement.

In this study, 57 patients requiring hip arthroscopy were analyzed. Preoperative x-rays were used to evaluate the type of femoroacetabular impingement. Surgical images were reviewed for labral pathology. Seven descriptive terms were employed to note differences in labral pathology (detached, mid-substance, flattened, complex, frayed, flap, bruised). These same images were also reviewed to evaluate labral color (yellow, white), as well as size.

The average age of the group was 40 years. Patients with moderate osteoarthritis were significantly older than those with minimal or no osteoarthritis. Cam-type femoroacetabular impingement (FAI) was found to occur in older patients when compared to pincer-type FAI. Patients with pincer type lesions had no or mild osteoarthritis. Patients noted to have flattened labri had pincer impingement, which was more common in females with no or mild osteoarthritis. Detached labri were related to cam impingement. Bruised labri were related to pincer impingement and were more common in patients with mild or no osteoarthritis. Flap labral tears were more common in older patients. Yellow labri were more common in older patients. White labri were more common in younger patients.

Labral pathology varies not only according to severity but also according to underlying hip pathology, specifically bony abnormalities at the femoroacetabular interface. Based on the results of this study, there appears to be an association between labral tears and type of femoroacetabular impingement. Cam-type femoroacetabular impingement more consistently produced detached labral tears, while pincer-type impingement produced more bruised and flattened labri. The information from this study should be useful as treatment strategies for labral pathology increase. Furthermore, a clear and concise classification system for labral tears could serve as a basis for outcomes data in the future. The authors of this study were W. Scott Kimmerly, Mara Schenker, Karen Briggs, and Dr. Marc Philippon.

THE SHOULDER

Complications of clavicle fractures treated with intramedullary fixation

Collarbones or clavicle fractures account for 25 percent of all fractures. This bone covers the top of the chest, between the breastbone (sternum) and shoulder blade (scapula). These fractures occur in men under 25 years more frequently than women. The majority of patients have shoulder pain and difficulty moving their arm. Swelling and bruising of the fracture site is common and once the swelling subsides the fracture can be felt through the skin. Displaced fractures are recognized by prominent "tenting" position of the clavicle under the skin. Many acute midshaft clavicular fractures are treated nonoperatively. However, surgical options are appropriate for severely displaced fractures, tenting, and fractures associated with shortening

of the clavicle and in high-demand athletes that may request surgical intervention.

A few studies have been published looking at the outcome from surgical fixation of displaced claviclar fractures. While most clavicle fractures are treated nonsurgically with satisfactory outcomes, some progress to nonunions and present a problem for the surgeon. Nonunion of clavicle fractures is uncommon, but the incidence is higher than once thought. Since clavicle non-unions can compromise shoulder function, some surgeons elect to surgically repair displaced middle-third clavicle fractures. Surgical stabilization of a fractured clavicle has typically been done with either plate-and-screw fixation or an intramedullary pin device. Several published reports have shown good clinical results in which the patients regained shoulder function and returned to prior sporting activities.

The purpose of this study was to look at the complication rate of 63 people who underwent surgical treatment of mid-shaft clavicle fractures with intramedullary fixation. Complications were grouped into major (infection, nonunion, malunion) and minor (skin wear and tear, painful hardware, hardware breakage without consequence) categories. Twelve patients experienced complications 22.2 percent of the time. Sixteen percent were classified as minor (one delayed union of the fracture, one person experienced hardware breakage, four had skin wear and tear, four had painful hardware). Four people

(6.3 percent) were classified as major complications (one loss of fixation that led to nonunion, one other nonunion, and two infections). In this series, no nerve injuries were seen.

This is a large series of patients with a low surgical complication rate. Overall, excellent union rates and function were achieved in the majority of patients, with only a 6.3 percent risk of major complications. While minor complications were common, most were managed easily and did not interfere with ultimate shoulder function. Historically, the unique S-shape of the clavicle posed a problem for intramedullary fixation, but many of the newer surgical techniques and devices have been developed to accommodate the clavicle's unique form. Intramedullary device design modifications, along with improved surgical technique, should decrease future complication rates even further.

Outcomes of Full-Thickness Articular Cartilage Injuries of the Shoulder Treated with Microfracture

Up to 20 percent of the older population is affected by degenerative joint disease (DJD). People with shoulder DJD can obtain pain relief and improved function from partial or total shoulder replacements. Prosthetic use in younger people provides excellent pain relief but comes with significant restriction in activity and has a limited implant life span. Young, active patients with cartilage damage in the shoulder present a treatment challenge. Current treatment for chondral injuries of the shoulder rely primarily on non-operative treatment, which includes anti-inflammatory medication, injections, and/or physical therapy, to relieve painful symptoms.

Research has shown that chondral defects rarely heal on their own. The microfracture technique developed by Dr. Steadman is the preferred treatment for chondral defects in the knee by orthopaedic surgeons, and several studies have shown good clinical results following the procedure. Although the literature on shoulder microfracture is sparse compared to the knee, the same basic principles of the surgical technique and healing process are thought to apply.

The purpose of this study was to report findings of microfractured lesions in the shoulder joint. We hypothesize that shoulder microfracture can result in fill of the chondral lesions and produce satisfactory pain relief and improved functional outcomes.

Twenty-two patients with 23 shoulders under the age of 60 underwent shoulder arthroscopy and had microfracture of full-thickness chondral lesions with an intact rotator cuff. Included were 17 men and four women with an average age of 45.5 years. Patients' pain and functional outcomes were measured using the American Shoulder and Elbow Score (ASES = 0-100 points) and patient satisfaction level (1=unsatisfied, 100=very satisfied).

Five patients had microfracture treatment of both the humeral and glenoid cartilage, 10 patients had microfracture treatment just on the glenoid, and eight had microfracture of the humerus only. In this series of 22 patients and 23 shoulders treated for full-thickness articular defects, six patients went onto a subsequent surgery at an average of 35 months. Three subsequent surgeries were shoulder replacements at an average of 41 months.

Microfracture of the humeral head of the shoulder joint

Mean patient-reported pain scores decreased from 3.6 preoperatively to 1.6 postoperatively (0=no pain, 10=worst pain). Patients' ability to work, Activities of Daily Living, and sports activity had a significant improvement postoperatively. Painless use of the arm improved after surgery and the average American Shoulder and Elbow Surgeons Score improved from 60 before surgery to 80 afterwards. Average satisfaction with surgical outcome was 7.6 out of 10. There was no association between age and surgery outcomes. Pain and function improved significantly following surgery. Half of the patients were involved in sports and reported that their ability to compete improved after the surgery. Greatest improvements were seen in patients who had isolated lesions of the humerus. Two patients who underwent second-look arthroscopy for new injuries were remarkable in that the area of the previous microfracture was well filled with fibrocartilage.

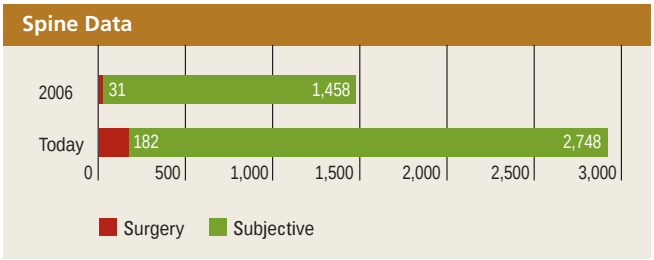
Based on our experience, microfracture is a safe and effective method for treating shoulder full-thickness chondral lesions. These early results show that microfracture, combined with other necessary surgical treatments, is able to significantly increase patients' ability to perform activities of daily living and to participate in athletics. Our data showed the greatest improvement for smaller lesions of the humerus with the worst results in those with lesions of both joint surfaces. Additionally, our research shows significant decreases in pain and improvement in patients' functional scores. This study will be presented at the 2007 Arthroscopy Association of North America Annual Meeting in San Francisco. The authors of this study are Benjamin H. Huffard, M.D.; Marilee P. Horan, B.S.; Peter J. Millett, M.D., M.Sc.; and Richard J. Hawkins, M.D.

THE SPINE

Spine research was started at Steadman-Hawkins in early 2006. In its first year of existence the focus was primarily upon creating the spine database. The key to successful research is the database, as it allows us to compare patient subjective outcomes before and after treatment to look at the percent of improvement and assess our care. The database was built with these patient subjective outcomes, physi-

cian assessment (physical exam and diagnosis), and surgical data (including injections and nonsurgical invasive spine procedures). Our spine database currently consists of 1,658 patient subjective entries for back pain and disability, 1,090 patient subjective entries for neck pain and disability, 589 lumbar physical exams, 219 cervical physical exams, 138 physician diagnoses, 182 surgical cases, and 353 injections or nonsurgical invasive spine procedures. Once we have patient subjective data two years after surgery, we can begin detailed assessment of outcomes after various surgeries. We can also look at outcomes after two years of conservative care (physical therapy, injections, etc., but no surgery).

The first studies that can be completed when creating a new database are diagnostic studies. For example, one can compare physician assessment to patient subjective assessment of disability and the extent to which they correlate. These studies allow us to assess the data we are currently collecting. Thus, we have focused on these types of studies, as well as one cadaveric study and one study using data from patient charts.



Physical Exam Findings Relate to Perceived Disability in Spine Patients

Both back and neck pain can be extremely disabling to patients, many finding they are unable to participate in any of their regular activities or even walk around their own homes comfortably. However, the standard physician's spine exam may or may not indicate the level of disability that a patient feels. This was examined in back and neck patients, the purpose being to discover which specific tests in a lumbar physical exam or a cervical physical exam correlate with patient-perceived disability.

In both neck and back, decreased range of motion (flexion and extension) correlated with increased subjective disability. Abnormal sensory findings in both back and neck also correlated with increased subjective disability. In the back, the other tests associated with the level of disability felt by the patients were normal versus abnormal stance, motor strength testing, and presence of pain with the straight-leg test. In the neck, the other tests associated with the level of disability felt by the patients were (1) presence versus absence of pain with lateral range of motion (left lateral bending and right lateral bending), (2) brachioradialis reflex testing, and (3) motor strength testing. These results showed that most of the primary spine physical exam parameters are closely related to patient-perceived disability, and more research is needed to determine which tests are most important in determining disability. These studies will be presented at the 2007 North American Spine Society 22nd Annual Meeting. The authors of these studies are Donald S. Corenman, M.D., D.C.; Sarah A. Kelley-Spearing, B.A.; David C. Karli, M.D.; Eric L. Strauch, P.A.-C.; and Rebecca D. Glassman, B.A.

General Health Relates to Disability in Back and Neck Patients

With disabling back or neck pain, patients' perceptions of their own health are often decreased. Data is collected on both of these subjects, and while the back and neck disability indexes are for spine-specific pathologies, the health survey is a general form that is used for our knee patients as well. The purpose of this study was to investigate whether patient-reported spine-specific disability correlates with patient-reported general health. They do in fact correlate. Patients who reported increased disability both in neck and back also reported decreased general health, both in the physical categories of general health and the mental categories of general health.

This study will be presented at the 2007 North American Spine Society 22nd Annual Meeting. The authors of this study are Sarah A. Kelley-Spearing, B.A.; Donald S. Corenman, M.D., D.C.; Rebecca D. Glassman, B.A.; and Karen K. Briggs, M.P.H.

Upper Extremity Range of Motion and the Effect on Tension of the Cervical Nerve Roots.

Patients with a compressed cervical nerve root (radiculopathy) have pain and/or numbness and tingling down their shoulder and/or arm and hand. Often these patients have what is called a Bakody's

Sign – they hold the arm of the affected side up in the air with the forearm or hand resting on top of their head. This position is believed to release tension on the cervical nerve roots of that side. Thus, if one of those nerve roots was compressed, this position would decrease the compression. The purpose of our study was to use specimens obtained from cadavers and a tensiometer to measure tension on each cervical nerve root contributing to the brachial plexus, as it varies with different arm positions.

Specimens from three cadavers of different height, weight, and age, all female, were used in this study. In all specimens, tension of all cervical nerve roots C5 through C8 was decreased with arm elevation above 170 degrees and with maximum scapular elevation (humeral abduction above 170 degrees also causes scapular elevation). The position of the arm in the Bakody's Sign includes both humeral abduction and scapular elevation. This study and continuation of related studies could help identify the presentation of a patient with cervical radiculopathy both in the office and on the playing field and could also help offer temporary positions and solutions to ease the pain for these patients.

This study has been submitted to the American Academy of Orthopaedic Surgeons Annual Meeting and to the Cervical Spine Research Society Annual Meeting and is pending review. The authors of this study are Donald S. Corenman, M.D., D.C.; David C. Karli, M.D.; Dhruv B. Pateder, M.D.; Sarah A. Kelley-Spearing, B.A.; and Eric L. Strauch, P.A.-C.

Stenotic Low Back Pain: Outcomes of Decompression Surgery

Low back pain affects at least 80 percent of us at some point in our lives. The most common cause of this pain is degenerative disc disease. However, occasionally low back pain can be caused by central stenosis, a diagnosis not commonly considered, which we refer to as stenotic low back pain. Central stenosis occurs when something (central disc herniation, spondylolisthesis [slipped vertebra], bone spurs, ligament hypertrophy, etc.) compresses the central canal, which below L1 is a bundle of nerves rather than the central cord. This causes back pain unique in nature, for it is clearly aggravated with extension activities when the diameter of the central canal decreases and thus the compression of the nerves is increased. Through a detailed patient history, this diagnosis of stenotic low back pain can be determined, which then offers a different treatment option than the standard fusion for back pain. The doctor can decompress the central canal by removing the factor or factors creating the compression (a central hernia ion, bone spur, etc.). The purpose of this study was to determine how many patients here have ever undergone a decompression surgery for stenotic low back pain and how much relief this procedure offered.

Charts were reviewed for all patients who underwent a decompression surgery here and 12 were found that were operated upon for stenotic low back pain. Two were lost to follow-up (one is deceased and one has Alzheimer's), and one (10 percent) required a fusion (the decompression failed). Of the nine remaining, we were able to obtain questionnaires from eight (89 percent follow-up). Average satisfaction was 6.9 on a 0-10 scale, 10 being completely satisfied. Patients were also asked if they had any new spine symptoms. For patients without new symptoms, average satisfaction was 8.8. Patients are always asked to scale their average pain and their worst pain on a scale of 0 (no pain) to 10 (excruciating pain).

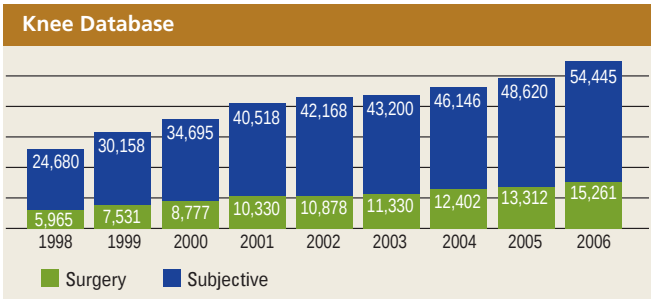
Before surgery the average low back pain was 4, and that number decreased postoperatively to 3. Seventy-five percent of patients improved. Preoperatively, the worst low back pain (LBP) of 9, decreasing postoperatively to 6.4. Eighty-seven percent of patients improved.

For patients without new symptoms, preoperative pain means were 4 for average LBP and 9 for worst LBP, and the postoperative average LBP decreased to 2.25 (87 percent improved) and worst LBP decreased to 5.5 (100 percent improved). One patient had low back numbness rather than pain and reported 100 percent relief of the paresthesia after surgery.

This study demonstrates that a decompression surgery can provide relief to patients with stenotic low back pain and that this surgery succeeds in about 90 percent of the patients (90 percent had enough improvement with the decompression that they did not go on to a fusion surgery). This study has been submitted to the American Academy of Orthopaedic Surgeons Annual Meeting and is pending review. The authors of this study are Donald S. Corenman, M.D., D.C.; Eric L. Strauch, P.A.-C.; Sarah A. Kelley-Spearing, B.A.; Karen K. Briggs, M.P.H.; and David C. Karli, M.D.

The Clinical Research Database

The Clinical Research Database began in 1993 and continues to grow. The database includes data on knee, shoulder, hip, and spine patients. The key to the success of this database is effective management of information. At the Steadman◆Hawkins Research Foundation, we have developed a method of managing patients' outcome information. In an effort to assess patient outcome following treatment at the Steadman-Hawkins Clinic, data are collected on every patient seen. This data consists of both patient and physician assessment of improvement over the preoperative status. All of the collected data is stored in a Clinical Research Database. This database is governed by an Internal Review Board from Vail Valley Medical Center. Our goal is to learn from our patients and validate our treatment protocols in an effort to provide high-quality health care.

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Biomechanics Research Laboratory

Michael R. Torry, Ph.D.; Kevin B. Shelburne, Ph.D.; Takashi Yanagawa, M.A.; J. Erik Giphart, Ph.D.; Feng Zhang, M.S.; John Brunkhorst, Research Intern; Nils Horn, Research Intern; Ted O'Leary, Research Intern

The Foundation's Biomechanics Research Laboratory (BRL) is a multidisciplinary laboratory in which the principles of mathematics and engineering are applied to solving complex problems in orthopaedic medicine. A main objective of the BRL is to explain (empirically) the how and why injuries, treatments, surgeries, and various therapies work for some individual and not for others.

MISSION AND GOALS

The Biomechanics Research Laboratory's mission is to further the scientific understanding of basic biological processes and to develop innovative approaches for the understanding, prevention, diagnosis, and treatment of musculoskeletal disease.

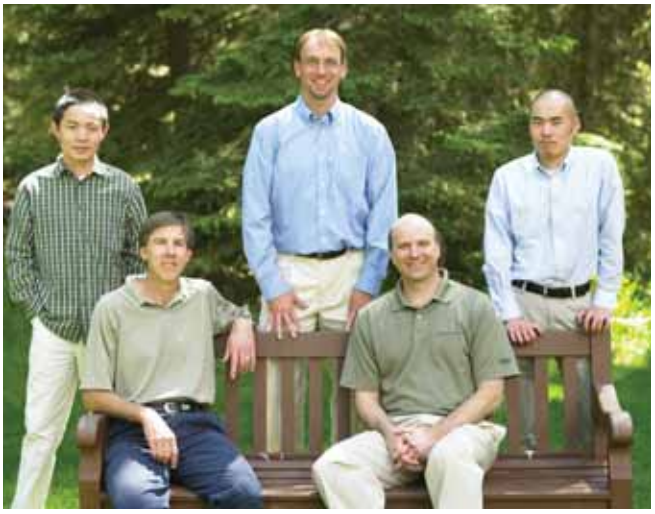
Our goals are to:

(1) Foster excellence in teaching, research, scholarship, and service in orthopaedic biomedical engineering.
(2) Prepare orthopaedic medical doctors with functional capabilities to utilize biomedical technology to enhance patient care.
(3) Educate the medical profession on the uses of such technical equipment in the clinical decision-making process.
(4) Serve as a center for education, research, and leadership in biomedical engineering.
(5) Prepare students for careers in biomedical engineering characterized by leadership and communication skills and a commitment to lifelong learning.
(6) Educate the public about the uses of biomedical engineering in orthopaedic medicine.
(7) Publish scholarly research in scientific, peer-reviewed journals in order to increase the quality of care in orthopaedic in general.

OVERVIEW

The Foundation's Biomechanics Research Laboratory (BRL) is a multidisciplinary laboratory that applies quantitative, analytical, and integrative methods to the field of orthopaedic medicine. The staff of kinesiologists, mechanical engineers, biomedical engineers, and computer scientists integrate clinical care, research, and education with the resources of world-renowned medical doctors in order to improve the treatment of musculoskeletal diseases. This focused approach is designed to maintain and enhance athletic performance, health, and quality of life for the professional, semi-professional, collegiate, high school, and the recreationally active individual. The programs provided by the Biomechanics Research Laboratory are unique, diverse, and encompass a complete range of services for the physically active or those wishing to return to an active lifestyle after injury.

With the statement *"helping physicians to make clinical decisions"* as its doctrine, the Biomechanics Research Laboratory also seeks to enhance a world-renowned medical doctor Fellowship Program by providing quality research education, guidance, support, and consultation to the partners and medical fellows of the Steadman-Hawkins Clinic.

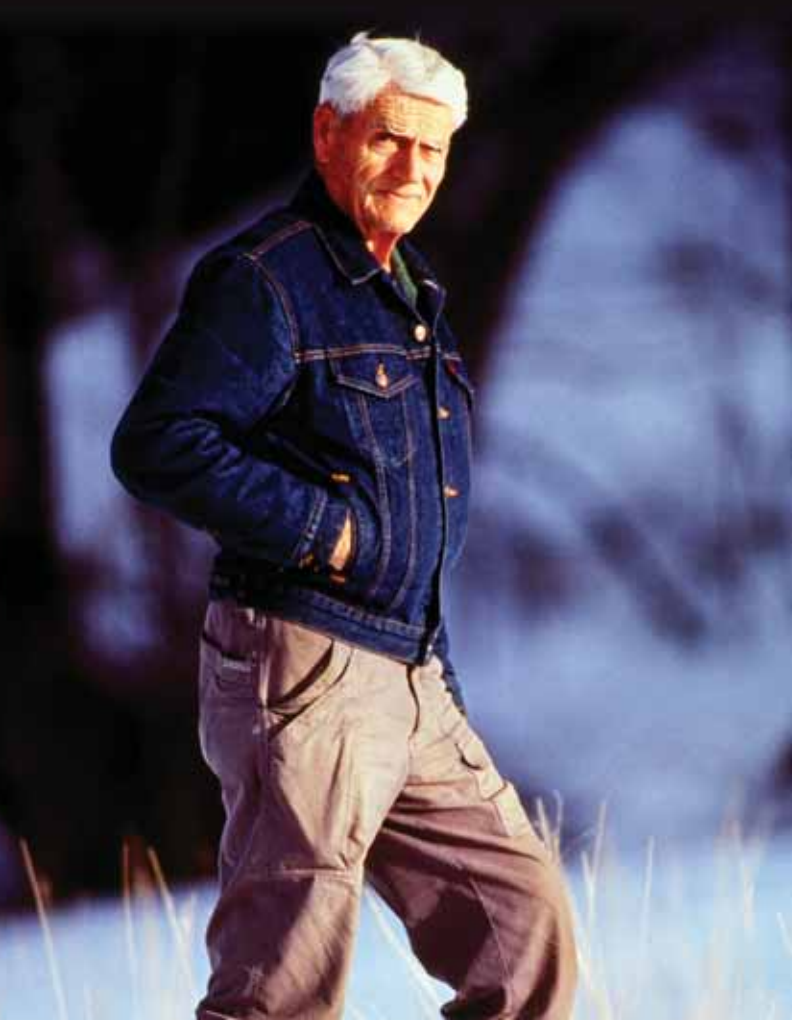


Back row left to right: Feng Zang, M.S.; Erik Giphart, Ph.D.; Takashi Yanagawa, M.A. Front row left to right: Kevin Shelburne, Ph.D.; Michael Torry, Ph.D.

Research intern Ted O'Leary, the captain of the University of Denver's two-time NCAA championship hockey teams, prepares for a slap shot in the Biomechanics Research Laboratory.

2006 IN REVIEW: DIRECTOR'S MESSAGE

2006 (and 2007 to come) was deemed largely an in-house development and growth period for the BRL group. I am tremendously pleased with the effort the BRL has shown over the last year. In 2006, we dedicated ourselves to building a one-of-a-kind, biplane fluoroscopy system. This system is quite complex and has required considerable development time from the staff, and anytime you charge through areas of scientific discovery there are always delays and obstacles to overcome. Despite these, the BRL still managed to publish at a rate that is consistent with its publication history. The work output for the BRL for the year 2006 has been exemplar, with 13 refereed abstracts presented at four national and international scientific



conferences. The BRL has also produced seven original full-length research papers. It is important to note that the quantity of the work is backed by substantial quality. Each year our research gets stronger and stronger, and we are receiving recognition from our peers for the quality of our work, states Dr. Torry. Some of our research for the year 2006 is summarized below.

EFFECTIVENESS OF FOOT ORTHOSIS AND KNEE BRACING FOR REDUCING KNEE LOADS DURING WALKING.

For most people, the majority of the joint load at the knee is borne by the medial, or inner, side. This concentration of joint load may explain the clinical observation that knee osteoarthritis (OA) occurs most frequently toward the medial side of the knee. The aim of treating knee OA with orthotics is to reduce pain and increase function by reducing the knee load. The strategy is supported scientifically by the relationship between pain and knee load in knee OA patients. The use of lateral heel wedges to relieve knee pain and reduce knee load is based on the premise that placing a lateral wedge under the foot will shift load away from the medial side of the knee. The clinical success of lateral wedges has been documented in a number of studies that found reduced use of pain medication in patients who wore a lateral heel wedge. However, clinical studies also indicate that the effect of the lateral wedge may be limited because it has little positive impact on persons with more advanced knee OA and no impact on progression of the disease.

Akin to lateral heel wedges, there is good evidence that knee bracing provides some pain relief and a modest degree of improved function. However, like lateral heel wedges, there is no convincing evidence that valgus (outward angulation) bracing slows the progression of knee OA. The mechanism by which valgus bracing relieves pain and improves function is not fully understood, perhaps because there are multiple factors involved. Valgus bracing applies an external load to the knee that may shift knee load from the medial side to the lateral side. In addition, unlike lateral heel wedging, knee bracing produces measurable changes in how people walk.

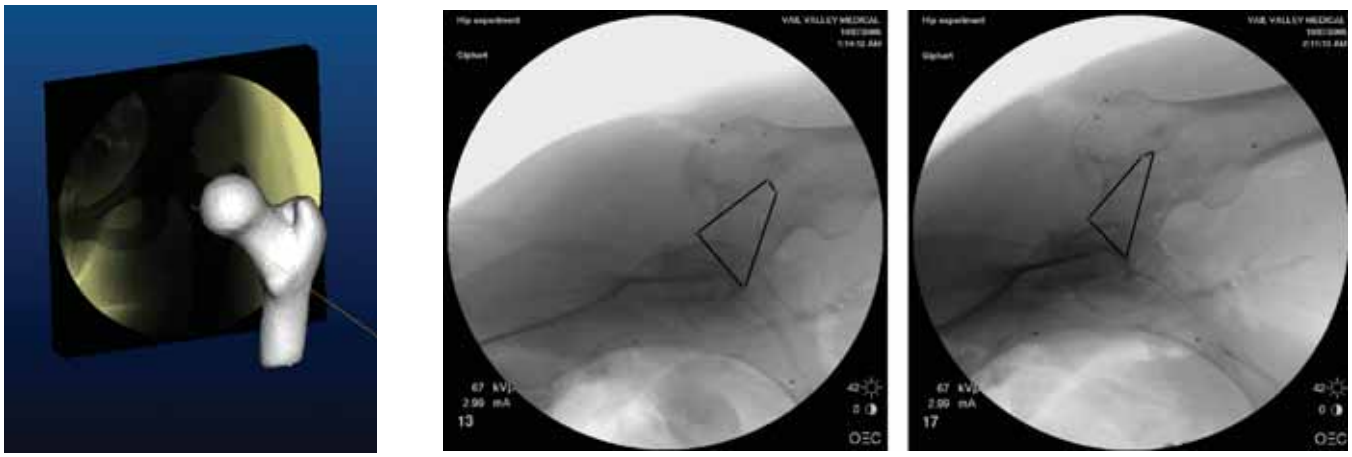
Recently, the Biomechanics Research Laboratory undertook a study to determine the change in knee load that may be achieved by a lateral heel wedge and a valgus knee brace during level walking. Based on the results of previous studies, our primary hypothesis was that both lateral heel wedges and valgus knee braces produce significant changes in the force transmitted by the medial side of the knee. The effect of a lateral heel wedge and valgus brace on knee load was calculated using a combination of laboratory measurements and three-dimensional computer simulation.

The results showed that both lateral heel wedging and valgus knee bracing reduce medial knee loading during walking. However, knee bracing had a greater capacity for reducing medial knee load than did lateral heel wedging. The valgus brace achieved a reduction in medial knee load throughout each stride of walking, whereas the lateral heel wedge was effective only when the force between the foot and the ground was high. Nonetheless, the effect of either intervention was not dramatic. Even with a knee brace and lateral heel wedge, the medial side of the knee still transmitted the vast majority of joint load. In addition, the ability of lateral heel wedges and valgus bracing to reduce medial knee load is reduced when knee loads are high to begin with. These results are consistent with the clinical finding that these treatments are less effective in patients with moderate to severe knee OA.

MECHANICAL VALIDATION OF A CLINICAL TEST TO IDENTIFY HIP INSTABILITY

The majority of patients who require hip arthroscopy are young, active individuals with a history of hip or groin pain. In these athletes, sometimes the onset of hip pain is traumatic after a fall or collision. At other times the onset is chronic due to excessive range of motion and overuse. These injuries often lead to excessive hip laxity, which if left undetected or untreated, develops into debilitating labral tears. Thus, the early identification and diagnosis of hip instability is paramount to effective treatment and prevention of further hip degeneration. An established and reliable clinical exam to detect hip instability is needed and is currently non-existent.

Dr. Marc J. Philippon has significant experience treating patients with hip capsular laxity. He has developed a clinical exam, the hip log roll test, to assess varying degrees of capsular laxities. During the hip log roll test, the patient will lie straight on his or her back on the examination table and is instructed to relax into a resting position. The examiner firmly places his hands around the knee, rotates the leg outward, and assigns one of four hip log roll grades indicating “no to severe” hip laxity.



Images from biplane fluoroscopy system that is used to validate hip clinical exams.

To mechanically validate the 4-grade hip log roll test, we have designed the following two experiments: (1) a selective cutting experiment of the iliofemoral ligament in cadaver specimens to establish the sensitivity of the log roll test to deficiencies in the two bands of the iliofemoral ligament (the hip's primary constraint to outward rotation); and (2) an objective evaluation of the iliofemoral ligament and, as well, the hip log roll test in patients while in the operating room. Outward rotation while performing the log roll test will be measured objectively with a highly accurate x-ray motion analysis system (3D fluoroscopy; translational and rotation accuracies of 0.1 mm and 0.1 degrees, respectively). All hip log roll evaluations will be performed by Dr. Philippon and three athletic trainers to assess inter-observer reliability of the grading of the hip log roll test. To date, a successful pilot study has been performed, and we are actively pursuing funding for this project.

The results of this study will help validate the hip log roll as a clinical exam to pre-operatively identify and diagnose hip laxity, as well as help assess the ability of operative capsular modification procedures (such as thermal capsulorrhaphy and/or capsular plication) to correct this laxity. It is our belief that a validated hip log roll test will improve the identification and diagnosis of hip instability, as well as assist rehabilitation following arthroscopic repair. This will greatly benefit patients who are currently undiagnosed or even misdiagnosed and those who will be treated arthroscopically.

3-DIMENSIONAL MEASUREMENT OF IN VIVO SHOULDER MOTION USING BIPLANE FLUOROSOCOPY

Patients who have continued shoulder pain and loss of function in the presence of advanced joint disease and who have failed non-operative treatment are often managed by undergoing a total shoulder replacement or Total Shoulder Arthroplasty (TSA). The number of TSAs performed annually in the United States increased from about 5,000 in the early 1990s to over 20,000 in 2005. This is largely due to the aging population and its desire to stay active, but it is also due to better prosthesis designs, better surgical techniques, and more experienced surgeons. Depending on the underlying pathology, two types of prostheses are used: primary or inverse. While the overall outcomes that are reported after shoulder replacements are good, normal shoulder function is on occasion not fully restored and the reasons for this are not well understood.

Currently, the laboratory techniques used to measure shoulder motion (kinematics) in living subjects *(in vivo)* are quite limited as they do not measure with sub-millimeter levels of accuracy. In addition, it is impossible to measure the motion of the shoulder blade (scapula) using standard laboratory techniques due to its significant movement under the skin during shoulder motion. Even attaching optical markers to pins inserted directly into bones will result in joint kinematic errors of 2-4mm, which is still insufficient to measure the subtle motion changes expected to cause significantly different functional outcomes after shoulder TSA. Therefore, new experimental data during functional motions measured with sub-millimeter accuracy are needed to improve our understanding of the shoulder as well as prosthesis motion and function.

This study uses a novel biplane fluoroscopy system that images the bones and implants in patients directly to measure shoulder kinematics with sub-millimeter accuracy. We will record kinematics of 20 primary TSA, 20 inverse TSA, and 20 healthy subjects while performing four basic motions of daily living, which are also part of standard clinical evaluations. Measurements will be made of the shoulder joint pre- and six months post-TSA for both implant types and will be compared to healthy shoulder motion. We hypothesize that these measurements will reveal that shoulder kinematics following primary or inverse TSA are significantly improved (closer to normal) compared to pre-TSA. We also hypothesize that kinematic differences

Very little information exists to describe the motions of the body in youth or adult ice hockey players.

will be directly correlated with clinical outcome and with durability/survivorship of the implants. To date, we have recruited several healthy subjects, are in the process of imaging the first shoulders, and are actively pursuing funding for this project.

The results of this study will lead to a deeper understanding of diseased shoulder motion and of implant motion following TSA, and of normal shoulder motion. We hope it will also lead to the discovery of outcome predictors based on postoperative (abnormal) implant motions, improved implant designs, and more satisfied patients.

SIMULATIONS OF SUBSCAPULARIS CLINICAL EXAMINATIONS.

The "belly-press test" is a clinical examination to help diagnose a subscapularis tear (one of the rotator cuff muscles) in the clinic. A patient is asked to press the abdomen region by rotating the arm internally as shown in the figure below. Despite widespread clinical use, the actual mechanics of how this test actually works is largely unknown. The purpose of this study was to understand the function of the subscapularis muscle during this examination and to determine whether, in fact, this test is appropriate to isolate a subscapularis tear. An upper extremity computer model was employed to estimate forces in the shoulder. The subscapularis muscle produced the largest torque (3.6 Nm) during the negative position. In the negative position without the subscapularis, the force to the abdomen by hand was decreased from 93 N to 5 N. Thus, the subscapularis muscle is the major contributor to internal rotation torque during the belly-press test. This data provides theoretical evidence that the belly-press test is an appropriate exam for a subscapularis muscle tear.

ANALYSIS OF ICE HOCKEY MOVEMENTS IN YOUTH AND ADULT PLAYERS

Ice hockey is a popular winter sport throughout Canada and many parts of the United States, and its popularity is rising due to increased exposure in many non-traditional, geographic areas. Ice hockey combines tremendous speeds with aggressive physical play and therefore has great inherent potential for injury. A large majority (more than 75 percent) of the injuries suffered by hockey players occurs due to an impact with either another player or with the boards. These impacts lead to the high number of concussions, knee medial collateral ligament sprains, acromioclavicular joint injuries, and ankle sprains. In addition to these common injuries, many other

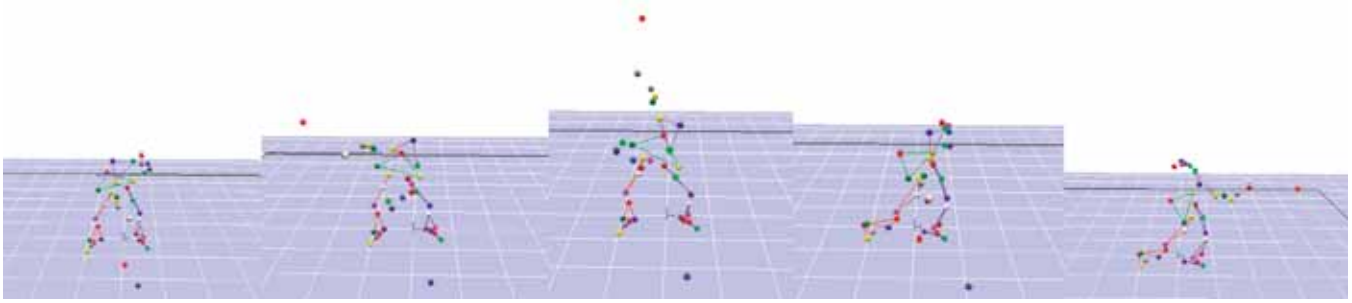


Image of professional hockey player being analyzed in Biomechanics Research Laboratory.

injuries do not result from impact. Adductor strains, sacroiliac dysfunction, chondral injuries, labral injuries, and many of the previously mentioned problems occur without the influence of impact.

The Biomechanics group has dedicated itself to understanding hockey injuries. While sounding simple, this is no small feat. The first issue was to build an "ice rink" in our laboratory, because if you want to study hockey, you have to study skating techniques. With help from BRL Intern Ted O'Leary (former Denver University Hockey Team member and two-time NCAA Champion) the BRL laid down a 12- by 28-foot ice slab. "It's not real ice, but a really, really close facsimile," states Torry. The research project is designed to provide performance data on ice hockey players ranging in age from 12 to over age 40. The data derived from this study will be compared among the age ranges to determine similarities and differences in different shot and skating mechanics across the lifespan. This data, it is hoped, will provide information on how and why both youth and adult hockey players obtain or exacerbate orthopaedic injuries.

Taking Advantage of the Charitable Gift IRA Rollover Legislation: "It Was Easy and It's Good Stuff for Mankind"

"We wanted to utilize the full minimum distribution required from our IRA and have it make a difference," says O.B. Shelburne. "It was so easy. And a gift to the Foundation — that's good stuff for mankind." That's what prompted him and his wife, Rita, to take advantage of Congress' 2006 legislation, the Pension Protection Act, permitting charitable gifts to be transferred from IRAs directly to charitable organizations.

The Shelburnes' tax bracket is at a level that making an outright gift to the Foundation isn't financially advantageous. By taking advantage of the legislation, they made a wonderful gift and satisfied their minimum distribution requirement without increasing their taxable income.

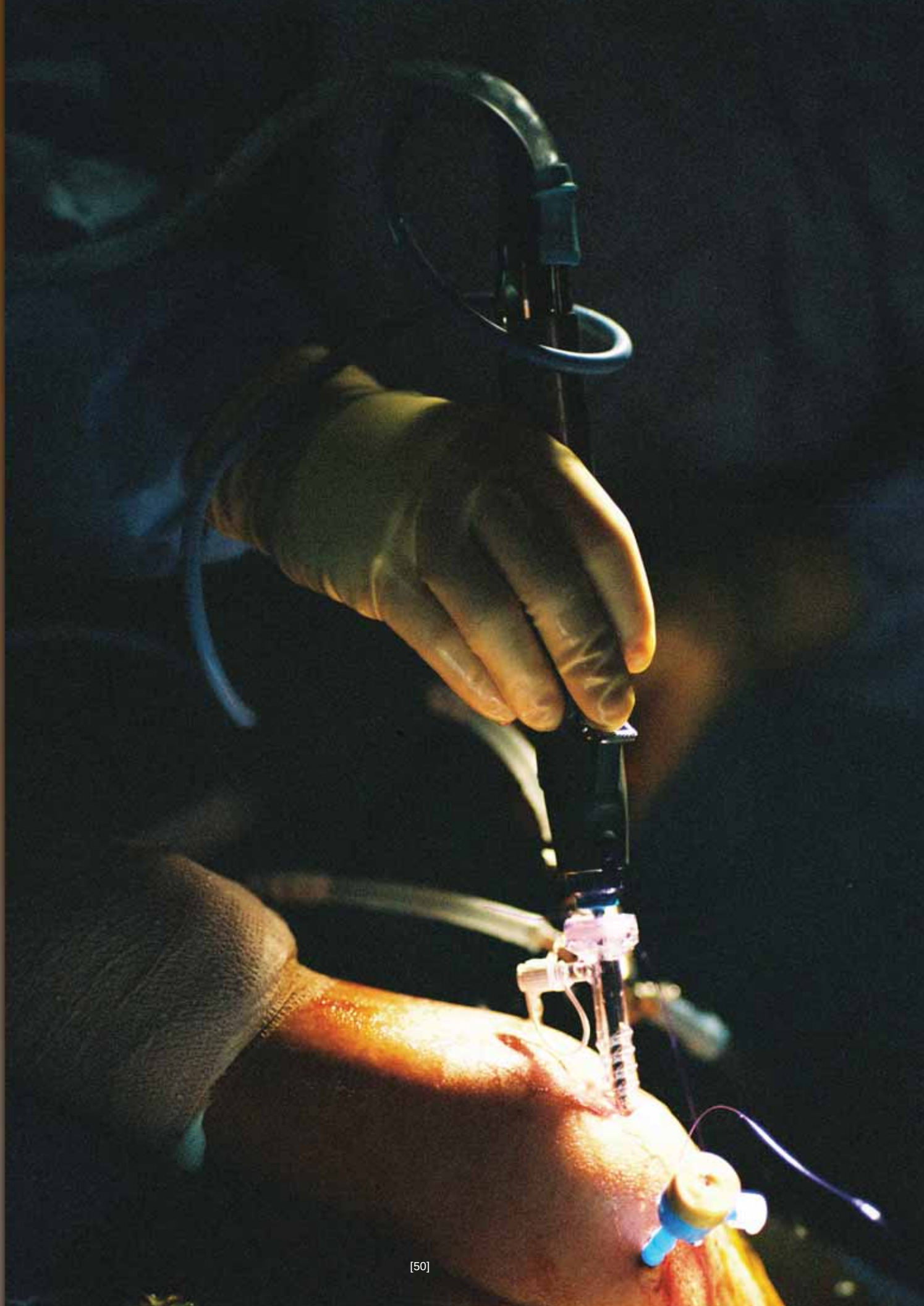
Our Gift Did That!

The Shelburnes created the Rita and O.B. Shelburne Fellowship Fund in the Biomechanics Lab. Why did they make that choice? Their son, Kevin B. Shelburne, Ph.D., a senior staff scientist in the lab, keeps them abreast of the cutting-edge research and accomplishments of the lab. With a distinguished career in the space program, Kevin is now a leading world researcher in biomechanics and computer modeling of joints, which is transforming approaches to surgery and treatment.

The Shelburnes, with a family of three children, eight grandchildren, and two great-grandchildren, are retired and live in the Texas hill country. After growing up and marrying in Texas, they moved to Wisconsin, where Mr. Shelburne received a Ph.D. in geology and pursued a 32-year career with Mobil Oil.

"We don't have a medical history with the Foundation," adds Mr. Shelburne. "We've never been patients, but we like the research areas of the Biomechanics Lab, and when advances occur we can say our gift did that! It's a great way to feel connected to the difference you can make."

For others who may be considering a gift, Mr. Shelburne encourages folks to do so. "It's a great feeling to help people. And this was a wonderful and easy opportunity to get involved."



Education

Greta Campanale, coordinator

The Foundation's primary mission is to conduct research that can be applied directly to orthopaedic medicine. To this end, education is also an important part of our work. We offer training throughout the year to physicians in residence, to visiting medical personnnel, and during international medical meetings. In addition, the education department produces videotapes and educational programs on the internet. Members of the staff report their research through publications, presentations, and posters. The education department provides administrative support for educational programs and conferences, responds to the press, and teaches high school students about human anatomy and injury.

FELLOWSHIP PROGRAM: Learning As We Teach

Considered one of the most prominent and rigorous academic fellowship programs in orthopaedic sports medicine, the Steadman-Hawkins Fellowship Program is at the core of the Foundation's educational effort. Each year, six young orthopaedic surgeons are chosen from more than 100 candidates to become Steadman-Hawkins Fellows. They are with us for an intensive 12-month training period to refine their skills in orthopaedic surgery and to investigate the causes, prevention, and cures of degenerative arthritis, as well as the treatment and prevention of injuries. Our goal is to prepare our Fellows to be the leaders in the field of orthopaedic sports medicine for the remainder of their careers.

The Foundation currently maintains a network of more than 160 Fellows who share advanced ideas and inspire each other to higher levels. We are fortunate in Vail to work with the best young physicians in the world. Their insight and enthusiasm during this rewarding program has demonstrated to us many times over that we, too, learn as we teach.

2006-07 Steadman-Hawkins Fellows

Six new members of the incoming "class" of Steadman-Hawkins Fellows spend a year refining their skills as they make final preparations for a career as orthopaedic surgeons. Each Fellow has the opportunity to be actively involved in Clinical Research, Basic Science, and Biomechanics research. In addition, they also experience hands-on medical coverage of Major League Baseball's Colorado Rockies, the NFL's Denver Broncos, the U.S. Ski Team, and Eagle County High School sports teams.

(continued on page 53)

The stream of knowledge and information flows both ways. The Fellows, having completed their formal training in leading orthopaedic programs, share knowledge they have gained from years of training with the physicians and scientists of the Foundation.

Dr. Brett Cascio was born and raised in New Orleans, Louisiana. He attended Duke University, where he majored in history and biology and played club football and baseball. He graduated with honors from Louisiana State University Medical School in New Orleans, where he was president of Alpha Omega Alpha. Dr. Cascio completed his orthopaedic surgery residency at The Johns Hopkins Hospital, where he was named Administrative Chief Resident. Dr. Cascio is a captain in the U.S. Army Reserves. His two main areas of research are cartilage regeneration and the medicolegal aspects of compartment syndrome. Dr. Cascio has presented his research at several national meetings, including the American Academy of Orthopaedic Surgeons and the International Cartilage Repair Society, and has published his work in journals such as the *Journal of Bone and Joint Surgery* and *Clinical Orthopaedics and Related Research*.

Dr. Michael Huang graduated summa cum laude with an undergraduate degree in neuroscience from the University of Pennsylvania. He attended medical school at Washington University School of Medicine in St. Louis. His orthopaedic surgery residency was completed at the University of Iowa Hospitals and Clinics. Dr. Huang was involved with the Cedar Rapids Roughriders Hockey team, helping them win the United States Hockey League's Clark Cup

(continued on page 53)

How do surgeons get accepted into the Fellowship Program?

Every year, on average, approximately 600 surgeons graduate from orthopaedic residency programs in the United States. These surgeons become board certified and are ready to enter practice. A select few elect to continue their education for one more year in a fellowship program such as Steadman-Hawkins' program. Last year more than 160 applications were received by the Foundation from young surgeons around the world. After interviews and presentations, six were selected by the screening committee.

Local Students Get a Look at a Real Knee: Research Foundation Provides Students with a Close Look at Medicine

By Scott N. Miller, *Preston Utley/Vail Daily*

Kate McAtavey thought she might be the one to run out of the room, but she did fine. McAtavey and a group of students from an anatomy class at Colorado Mountain College were recently invited to a special presentation in the depths of Vail Valley Medical Center. There, Dr. Brett Cascio would stick an arthroscope into a real human knee, then dissect the joint. The knee came from someone who donated his or her body to science after death.

"I was a little nervous about it," McAtavey said of watching Cascio explain how the knee joint works. "But I'm doing all right now."

In fact, as Cascio got deeper into the anatomy of the joint, the students gathered around for a closer look at the tendons, arteries, and nerve bundles.

"This is taking what we read and making it real," McAtavey said.

The chance to look at real body parts up close is an experience usually reserved for students at universities and teaching hospitals. This class got the chance because of the Steadman◆Hawkins Research Foundation. The Foundation, which works with, but is separate from, the Steadman-Hawkins Clinic, brings in doctors from around the world to study surgical techniques at the Clinic, then engage in their own research projects.

The doctors' work also includes some teaching sessions. Classes from local high schools take part in those sessions once or twice a year. Matt Smith's Colorado Mountain College students have started coming only recently, thanks to a connection. “One of my students worked at the hospital and arranged this,” Smith said.

Several of Smith's students work at the hospital this semester. One of those students, Heather Thomson, cares for patients before and after surgery. Thomson plans to attend nursing school starting next year and was excited to see some up-close medical work. "It really helps make the connection between class work and reality," Thomson said.

Dr. Brett Cascio shows Colorado Mountain College students the inside of a knee.

The reality, seen from just one joint, is that human anatomy is complex, and any surgery has little room for error. "If this looks hard, that's because it is," Cascio said as students watched on a video screen as he examined the knee joint with the tiny, flexible arthroscopic camera. "If it looks easy, that's because I've practiced. Because it's so easy to leave scars or damage nerves, much of that practice is done on donated body parts when doctors are still in training.”

After orthopaedic residency, many physicians apply for "fellowships." The Steadman-Hawkins Fellowship Program is one of the most sought after in orthopaedics. Of the approximately 600 physicians who graduate from orthopaedic residency programs in the United States, approximately 120 (160 applied in 2006) apply for the Steadman-Hawkins Fellowship. From this pool of applicants, only six per year are selected.

Coming to Vail has been a good experience for Cascio, whose own research has focused on regenerating human cartilage, something that not long ago couldn't be done. Some of that work involves "microfracture" knee surgery, a procedure that, in many cases, can get professional athletes playing again.

"People are working on a lot of things," Cascio said. "But nothing really works better than microfracture." That work, with research conducted by the Foundation and surgery performed by the Clinic, has applications far beyond stadiums and arenas.

For Smith, that benefit is filtering down to his students. "This kind of thing is huge," Smith said as Cascio continued his work in another room. "To get in here and see a real human knee is a unique experience."

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Dr. Steadman, right, with Steadman-Hawkins Fellow Dr. Kevin Crawford.

championship in 2005. His research experience includes evaluation of the role of angiogenesis in osteochondral healing. He is published in journals such as *Spine, Journal of Pediatric Orthopaedics*, and the *Iowa Orthopaedic Journal.*

Dr. Benjamin Huffard graduated from Lehigh University in Bethlehem, Pennsylvania, with a bachelor of science degree in civil engineering. He attended Yale University for the post-baccalaureate premedical program from 1995 to 1996. Following his premedical training, Dr. Huffard attended the Yale University School of Medicine, graduating with his doctorate of medicine, in 2001. Dr. Huffard completed an internship in general surgery at the New York Hospital in 2002 and his orthopaedic surgery residency was completed at the Hospital for Special Surgery. Dr. Huffard's current research is *"A comparison of Achilles tendon repair strength using the Krackow Suture with the Achillon7 Tendon Repair System: An anatomic in vitro biomechanical study."* Additionally, Dr. Huffard spent time as a research assistant at the Young-Penny Lab in Boston, Massachusetts, from 1996 to 1997. He is published in *Foot & Ankle International* and has made presentations at the American Pediatric Society for Pediatric Research, the Society for Neuroscience, and the World Federation of Neurology Research Group on Huntington's disease.

Dr. David King graduated from the University of Virginia, where he was an interdisciplinary major in neuroscience. He then obtained a medical degree from Emory University and completed his residency in orthopaedic surgery at Washington University in St. Louis. During his training, Dr. King's research was published in *The Journal of Bone and Joint Surgery, Seminars in Arthroplasty*, and *Techniques in Sports Medicine.* Dr. King was the recipient of the Leonard Marmor Foundation Award for outstanding resident research for his paper on femoral deformity in tibia vara. His other areas of interest include biologic resurfacing in glenohumeral arthroplasty and meniscal repair devices.

Dr. Colin Looney graduated magna cum laude from Washington and Lee University with a bachelor of science degree in biology. He was a member of the Phi Beta Kappa Honor Society. He completed his doctorate of medicine in 2001 from Duke University School of Medicine, graduating as a member of the Alpha Omega Alpha Honor Society. He finished his orthopaedic surgical residency at the Duke University Medical Center in Durham, North Carolina. Dr. Looney served as the resident team physician for the Duke University basketball and football teams and has also served as the resident physician for the North Carolina Central University. He has been published in numerous journals, presented at several meetings, and has been active in research.

Dr. Yi-Meng (Beng) Yen graduated cum laude from the University of California, Los Angeles, with degrees in chemical engineering and economics. He completed his master of science degree in engineering before starting in the Medical Scientist Training Program at UCLA. He completed his Ph.D. in biological chemistry and was named Alpha Omega Alpha during medical school. He finished

Where are they now. . .

Members of the graduating class of 2005/2006 Steadman-Hawkins Fellows are busy establishing new careers in orthopaedics.

Mark Adickes, M.D., has joined the medical staff at the Roger Clemens Institute for Sports Medicine and Human Performance in Houston, Texas.

Dominic Carreira, M.D., is completing foot and ankle fellowships with Dr. Pierce Scranton in Kirkland, Washington, and Dr. Mark Myerson in Maryland. Ultimately, he will reside in Fort Lauderdale, Florida, where he will practice as a foot, ankle, and hip arthroscopy specialist providing orthopaedic services for high schools in Broward County and professional teams.

A. Martin Clark, M.D., has moved to the Phoenix area, where he is working as a sports medicine specialist in a growing group called The Core Institute.

Stephen A. Hunt, M.D., has joined a private practice in Bedminster, New Jersey.

Todd L. Johnston, M.D., proudly joins his father's busy practice in Waterloo, Iowa, at the Cedar Valley Medical Specialists. He is excited to have the opportunity to make an impact on the community in which he grew up.

Scott W. Kimmerly, M.D., has joined the practice at Emory University Department of Orthopedics.

his orthopaedic residency training at the University of California, Los Angeles. He has been published in numerous journals and has received awards for both basic and clinical science. Once he completes his fellowship at Vail, he will start a Pediatric Orthopaedic Fellowship at Boston Children's Hospital.

Dr. Thomas Viehe hails from Newport Beach, California. In 1995, he graduated with distinction in all subjects with his bachelor of arts degree in history from Cornell University. In 2001, Dr. Viehe graduated from the Medical College of Wisconsin. He served as the student body president from 1999 to 2000. Dr. Viehe comes to Vail after having completed his orthopaedic residency training at Emory University in Atlanta. Once he completes his fellowship at Vail, he will start a Foot and Ankle Fellowship with Dr. Roger Mann in Oakland, California. Dr. Viehe has been active in researching several projects involving femur fractures. His findings have been presented before the American Academy of Orthopaedic Surgeons, the Orthopaedic Trauma Association, the Southern Orthopaedic Association, and the Georgia Orthopaedic Society. Additionally, he has been part of a spine infection research project presented at the annual meetings of the American Academy of Orthopaedic Surgeons, the North American Spine Society, the Southern Orthopaedic Association, and the Georgia Orthopaedic Society. Dr. Viehe has also published a paper in *Arthroscopy* on the effects of electrocauterization in the arthroscopic management of chondromalacia of the knee.

Dr. Yi-Meng Yen, left, assists Dr. Philippon, center.

A. Martin Clark, M.D., and Mark Adickes, M.D.: Different Paths, Same Destination

By Jim Brown, Ph.D.

One was born in Minnesota and raised in northern Virginia. The other was born in Germany, the son of an Army chaplain, and grew up on military bases all over the world. One did his undergraduate work at Harvard; the other earned a business degree at Baylor. One went to Columbia Medical School, then to New York Presbyterian for his residency; the other to Harvard Medical School at age 35, where he was the second-oldest in his class, then to the Mayo Clinic. Impressive résumés so far, but there's more.

One played professional squash, won four U.S. National Championships, and represented the United States in the World Games and Pan American Games. The other had at 10-year career in professional football, including three with the Washington Redskins, where his team won a Super Bowl. One is newly married. The other has been married 13 years and has five children.

Who are these former sports stars and future orthopaedic superstars, and how did their paths finally converge as Steadman-Hawkins Fellows?

Dr. Clark (left) assists Dr. Steadman.

Dr. Adickes examines a patient.

Why Steadman-Hawkins?

"I started hearing about Steadman-Hawkins when I was a resident in New York," recalls A. Martin Clark, M.D., "not only because of its reputation as one of the premier clinics in the world, but also because of the volume of research conducted at the Foundation and published in scientific journals."

Mark Adickes, M.D., heard about Steadman-Hawkins when he was a player in the United States Football League and the National Football League, and later when he began his medical studies. "You have these incredibly accomplished surgeons out there who are also brilliant scientists and world-class researchers. Almost everybody I knew wanted to get in as a Steadman-Hawkins Fellow, but only a few are invited. (Six per year out of approximately 120 applicants, to be exact.) "I did well in med school and on my MCAT, but I was still nervous about my chances."

Research Interest

In addition to clinical, operating room, and educational responsibilities, each Fellow at the Steadman◆Hawkins Research Foundation participates in research efforts. Clark is looking into the differences in results of two kinds of ACL surgery, working on hip arthroscopy papers with Dr. Marc Philippon, and writing a chapter in a book chapter on rotator cuff repairs with Dr. Peter Millet.

Adickes is investigating the outcomes of arthroscopic knee and hip surgery on NFL players, and he is reviewing 130 videotapes of microfracture procedures to compare the results performed on those with degenerative knee conditions to patients who suffered traumatic knee injuries.

Says Clark, "The Foundation generates so many ideas for research, there is never a lack of projects from which to choose." Adickes adds that, although the staff makes you think the research was your idea, they probably knew what needed to be done all along and were waiting for the right person to come along.

One way those who are interested can support the Foundation is by sponsoring a Steadman-Hawkins Fellow. During their August-to-July terms, each Fellow is asked to stay in touch with his or her sponsor. Clark, Adickes, and their colleagues write letters, talk on the phone or in person, and keep their sponsors informed about their work and their plans.

Looking Back

Now that both men are completing their one-year Fellowship programs, they can look back at their experiences with a perspective that lived up to their expectations. "When you are not part of the Steadman-Hawkins family, you sort of wonder why their outcomes are so good," says Clark. "But once you are there, you begin to understand that there is a magic about the Clinic and the Foundation and the way the whole thing works. I soaked it up and have enjoyed every minute. It is one year in your life when you get to train with the best orthopaedic surgeons in the world, as well as spending time with your family and enjoying the surroundings."

Adickes shares that sentiment. "I am amazed at how collegial the Clinic and Foundation staffs have been. Dr. Steadman is a truly humble man—and there are not many humble surgeons — who cares deeply about patients. At Steadman-Hawkins they only hire people who treat colleagues and patients the same way. It was like wearing a pair of well-worn slippers — very comfortable — right from the start. My wife, Jackie, is amazed that every person she meets there is so nice and so happy."

What's Next?

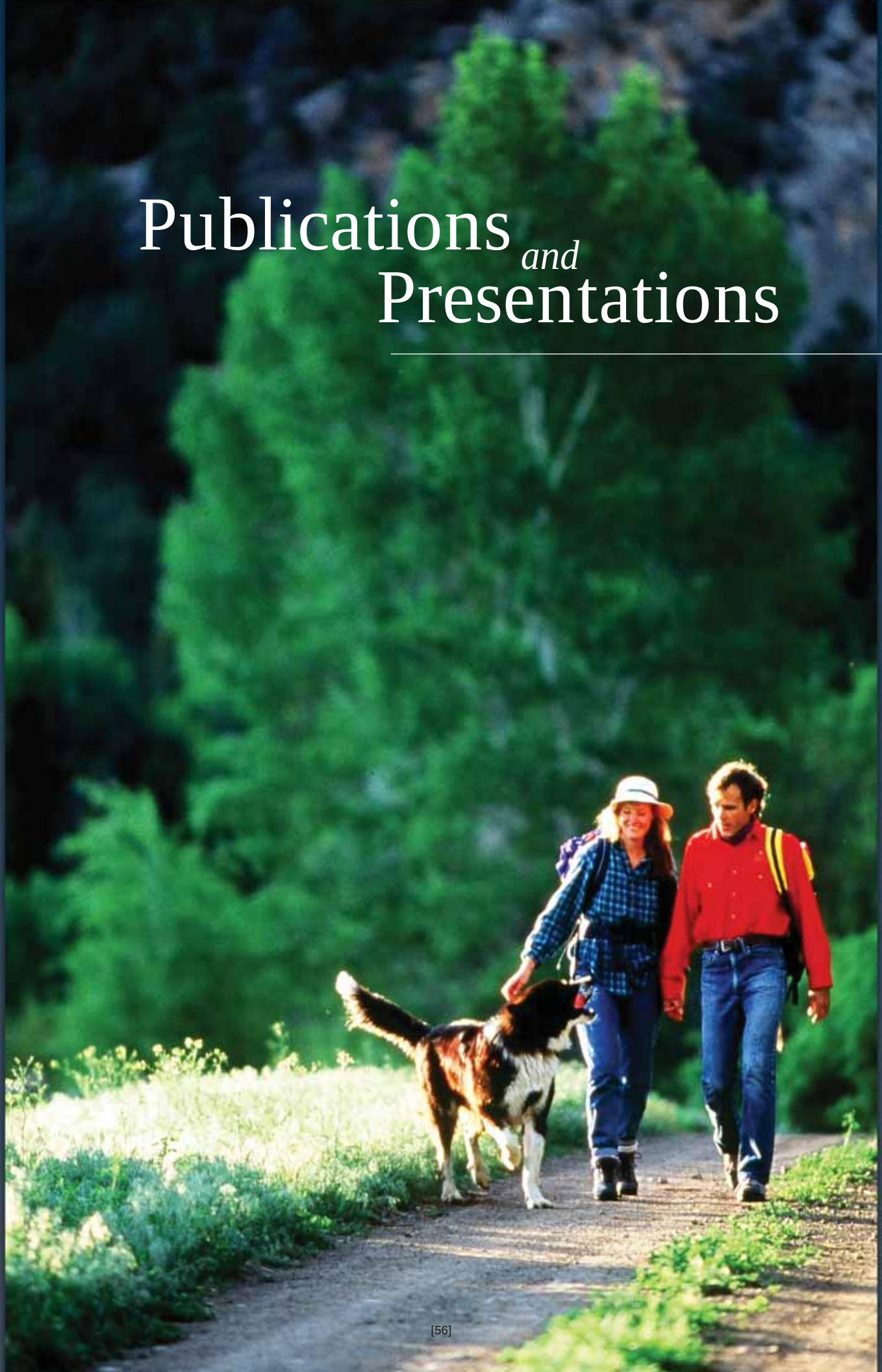
Dr. Clark and his wife, Maja, will be moving to Phoenix this summer. He will be a sports medicine and hip arthroscopy specialist at the Core Institute, a clinic and research facility with a structure closely resembling that of the clinic in Vail and the Steadman◆Hawkins Research Foundation. Dr. Adickes will join the staff at Memorial Hermann Hospital in Houston as co-director of a new sports medicine group that will, among its other programs, provide services to the Houston Rockets, Houston Comets, and Rice University.

A Personal Message

What would Drs. Clark and Adickes tell potential supporters of the Steadman◆Hawkins Research Foundation? "You would be investing your money in research that is meant to help active people maintain an active lifestyle," says Clark.

"At Steadman-Hawkins, there is a group of dedicated surgeons and fellows who take research that has been done, is being done, and will be done very seriously," concludes Adickes. "The Foundation's research will better the lives of people with orthopaedic problems. Your support will be money well spent."

Publications *and* Presentations



A primary goal of the Foundation is to distribute the results of its research. In 2006, principal investigators and Fellows published 47 papers in scientific and medical journals and delivered 189 presentations to a variety of professional and lay audiences worldwide.

2006 PRESENTATIONS

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Reaching Out to the World

The Foundation's research findings are shared with physicians and scientists around the world. We offer training throughout the year to physicians in residence, visiting medical personnel, and participants at the international medical conferences that we host.

To reach professionals who are unable to come to us, Foundation scientists and physicians report their research worldwide through peer-reviewed publications and presentations. We have produced more than 480 papers, 1,200 presentations and 80 teaching videos — many award-winning — that have been accepted by medical and scientific journals and organizations worldwide.

We disseminate our findings to the general public and school students as well, through videotapes, educational programs, the Internet, and media outlets.

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Millett PJ. Nonunion and Post-Traumatic Arthritis of the Shoulder: Arthroplasty Challenges. *Orthopaedic Update 2006: Shoulder, Elbow, Hip and Knee,* Vail, Jun 2006.

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Millett PJ. Partial articular-sided supraspinatus tendon avulsions repair technique. *International Shoulder Symposium,* Naples, Fla, Apr 2006.

Millett PJ. Management of the patient with an acute dislocation with a rotator cuff repair. *International Shoulder Symposium,* Naples, Fla, Apr 2006.

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Millett PJ. Complex and revision shoulder surgery. *Visiting Guest Surgeon — Country of Bermuda,* Oct 2006.

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Philippon MJ. My approach to labral tears. *Masters Course Arthroscopy Association of North America,* Chicago, Jan 2006.

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Philippon MJ. Arthroscopic Partial Femoral Head Resurfacing. *Advances of Hip Arthroscopy,* Paris, France, May 2006.

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Recognition

The Steadman◆Hawkins Research Foundation made headlines in 2006 with numerous papers being accepted by prestigious medical and scientific societies and journals.

The year started off with a very significant acceptance. *The Journal of Knee Surgery* published the first Foundation paper on a procedure pioneered by Dr. Steadman and developed and validated by the Foundation, "A Minimally Invasive Technique ('Healing Response') to Treat Proximal ACL Injuries in Skeletally Immature Athletes."

Another paper produced, *"Patient Knee Function and Activity Level Five-Year Post-Arthroscopy Compared to Normal Values,"* was the featured headline article in the March 24 issue of *Academy News*, the daily publication of the 73rd Annual Meeting of the American Academy of Orthopaedic Surgeons held in Chicago.

Congratulations to the Clinical Research Department and to former Steadman-Hawkins Fellow Dr. Kevin Crawford. The Arthroscopy Association of North America presented the 2006 Resident Fellow Essay Award to Kevin Crawford, M.D., for the paper *"Reliability, Validity and Responsiveness of the IKDC Score for Meniscus Injuries of the Knee."* Co-authors included Karen Briggs, M.B.A., M.P.H.; William G. Rodkey, D.V.M.; and J. Richard Steadman, M.D.

In the Media

THE FOUNDATION HAS BEEN MENTIONED OR FEATURED RECENTLY IN NATIONAL AND INTERNATIONAL MEDIA.

The December 17 *The Sunday Times* (London) edition reported on the return to action of professional soccer player Joey O'Brien (Bolton Wanderers). Team Manager Sam Allardyce says, "O'Brien has gone under the knife of the Colorado surgeon Richard Steadman, who was responsible for rescuing the careers of Ruud van Nistelrooy and Alan Shearer.

"Joey will be back soon," Allardyce said. "Steadman spotted an area of scar tissue under Joey's knee that was so small it could be easily missed by a scan. He has cleaned the knee out and given Joey a rehab program. He has no problems at all now."

Dr. Steadman and the Foundation were featured in the November 16 issue of the German news magazine *Focus*. The article is titled "Audience with the Knee Pope." "He has treated Kahn, Ronaldo, Deisler, and Klitschko. When the knees of the stars are in a pinch, they fly to the Rocky Mountains to see Richard Steadman, the famous knee surgeon."

In the article Dr. Steadman remarked that the satisfaction is incredible when a patient wins a gold medal. But it is much better when you know you have improved the lives of millions of recreational athletes.

"Since 1990, Steadman-Hawkins, with 90 employees and physicians in the Clinic and the separate Research Foundation, has developed and perfected many new procedures such as the meniscus implant and microfracture."

Sports injury? They go to Steadman first

John Marshall, Associated Press

VAIL, Colo. - We needed a hockey puck for a biomechanics demonstration, so lab director Mike Torry headed upstairs.

"He'll probably come back with one signed by Mario Lemieux," someone joked.

Torry returned a few minutes later with a puck and, sure enough, it was signed by Lemieux.

"We might not want to scuff this one up," Torry said, drawing laughter from the group.

Thing is, there was probably a few more Lemieux pucks up there. In fact, there's just about every kind of sports memorabilia imaginable in the clinic - signed footballs, photos and jerseys from athletes like David Beckham, Martina Navratilova, and Greg Norman.

But this isn't some kind of memorabilia museum. It's actually a world-renowned sports medicine clinic and research center called the Steadman◆Hawkins Research Foundation.

This is the most-published sports medicine institute in the world, the place that made aggressive rehab popular, the origination of the microfracture procedure for regrowing knee cartilage, and where it seems just about every elite athlete goes when they need to get fixed up (though anyone can go if they have a referral).

Steadman◆Hawkins Research Foundation CEO Michael Egan said there's a misconception that so many athletes come to the clinic because, well, it's where other athletes have gone before.

"But these athletes and the people who represent them are very sophisticated when it comes to health care," he said, "because it's such a big part of their financial well-being. They come here because of care and because of results. If we didn't have that, they wouldn't be coming here."

THE MAN BEHIND THE METHOD

It all started with Dr. Richard Steadman.

He was running a successful orthopedic clinic in South Lake Tahoe back in the 1970s - specializing in knee procedures - when he was approached by the owner of Vail to switch mountain ranges. Dr. Steadman was reluctant at first, but changed his mind when he was offered a donation to start up a foundation.

A strong believer in research, Dr. Steadman wanted to quantify his own results instead of relying on others. To do that, he set up a database that could track every procedure — it's up to about 15,000 knees and 5,000 shoulders — which he used to prove or disprove whether what he was doing was working.

"In doing the research ourselves, we can have our own results. It gives us an opportunity to talk to patients about the success rate for surgery. We can tell them it's a success rate that we have, not something available in literature," said Dr. Steadman, who opened the Vail clinic in 1990. "That's given us a leg up."

The key to the foundation's success starts with Steadman's creative mind. He was one of the first doctors to advocate aggressive rehab, which means mobilizing patients as quickly as possible after surgery, working on their range-of-motion so they'll heal faster. Dr. Steadman also developed numerous innovations for surgical techniques. But his most famous contribution to the orthopedic world is a procedure called microfracture.

BREAK IT TO FIX IT

Using work other people had done with bone marrow, Dr. Steadman believed he could drill tiny holes in the bone so that cells from the marrow could help regenerate damaged cartilage and prevent the onset of arthritis. It has become the treatment of choice for doctors around the world since the foundation validated the technique in 1994.

"It (the success) has very much been the genesis of Dr. Steadman," Egan said. "Lots of doctors start foundations, but it's very rare that you would see one become the top institute of its kind. That's because of his original, tremendous dedication."

But Steadman didn't do it alone. He brought in Dr. Richard Hawkins, one of the world's top shoulder specialists, to help run the foundation and has surrounded himself with some of the best minds in orthopaedic medicine, both on staff and on the Foundation's medical advisory board. The Foundation also brings in six fellows each year, who are typically the top medical students from around the world.

Now the Foundation, located in the Vail Valley Medical Center, has an annual budget of over $2 million, treating foot and ankle, spine, hand and, most recently, hip injuries. It has spent over $22 million over the past decade on research, education, and support programs, and has had more than 400 papers accepted by scientific journals.

And the Foundation keeps pushing toward the front of the field, searching for new ways to prevent and heal injuries, including a new initiative to combat arthritis.

There is a Basic Science Department that looks at healing from the cellular level, a Biomechanics Lab loaded with Batman-like gadgets to analyze motion and the retrospective look at the clinical research to verify what they're doing on the operating table.

"It's the best of both worlds to have these two entities — the clinic, which is totally devoted to the research side, and the research side, which is totally committed to either proving or disproving the procedures as we develop them," Dr. Steadman said.

John Marshall is AP's sports writer based in Denver.

Associates

The Steadman◆Hawkins Research Foundation is proud to recognize its team of associates, who carry out the Foundation's research and educational mission in Vail. The staff has been internationally selected for its diverse training and background in biomechanics, engineering, clinical research, veterinary science, and computer science. Together, the staff members take a multidisciplinary approach to their work in solving orthopaedic sports medicine problems.

ADMINISTRATION

J. Michael Egan
Chief Executive Officer and President

Marc Prisant
Executive Vice President and Chief Financial Officer

Amy Ruther
Human Resources Manager

Rachele Palmer
Administration

DEVELOPMENT

John G. McMurtry, M.A., M.B.A.
Vice President for Program Advancement

Paige Prill
Vice President for Development and Communications

BASIC SCIENCE

William G. Rodkey, D.V.M.
Director

CLINICAL RESEARCH

Karen K. Briggs, M.B.A., M.P.H.
Director

Marilee Horan
Research Associate

Lauren Matheny
Research Associate

Sarah Kelley-Spearing
Research Assistant

James Bennett
Research Intern

Rebeccca Glassman
Research Intern

David Kuppersmith
Research Intern

Dustin Manchester
Research Intern

Tiffany Tello
Research Intern

Jennifer Thorne
Research Intern

BIOMECHANICS RESEARCH LABORATORY

Michael Torry, Ph.D.
Director

Kevin B. Shelburne, Ph.D.
Senior Staff Scientist

J. Erik Giphart, Ph.D.
Staff Scientist/Motion Laboratory Director

Takashi Yanagawa, M.A.
Staff Scientist/Senior Programmer

John Brunkhorst
Research Intern

Nils Horn
Research Intern

Ted O'Leary
Research Intern

EDUCATION

Greta Campanale
Coordinator

VISUAL SERVICES

Joe Kania
Coordinator

Meet Our Staff

Greta Campanale

Erik Giphart

Greta Campanale

Greta Campanale joined the Steadman◆Hawkins Research Foundation in September of 2000 as Educational Program Coordinator and has remained in that role ever since. Her main responsibility is to organize the Steadman◆Hawkins Sports Medicine Fellowship Program, in which six orthopaedic surgeons spend one year under the tutelage of the physicians in the Steadman-Hawkins Clinic, refining their surgical and clinical skills in sports medicine and contributing to the research of the Foundation. Greta also plans educational conferences hosted by the Foundation, such as the Vail Cartilage Symposium and the Steadman-Hawkins Fellows Meeting, as well as the weekly and monthly academic lectures presented by our physicians and guest lecturers.

Born and raised a faculty child at The Taft School, a prep school in Connecticut, Greta attended Taft and then earned her bachelor's degree in English at Georgetown University in Washington, D.C. While enrolled in a post-baccalaureate pre-med program in Bryn Mawr, Pennsylvania, Greta met her husband Mike, a Philadelphia native, and decided to pursue a path other than medicine. The couple happily transplanted themselves to Colorado, where Mike had lived and gone to college, to new jobs and married life. Although they assured their East Coast families that they would return upon having children, Greta and Mike find that their roots have grown deeply in Vail since Sofia, age 3, and Stella, 2, were born. For the foreseeable future, their families have a beautiful Rocky Mountain destination when visiting Greta, Mike, and the girls.

Erik Giphart, Ph.D.

Erik Giphart joined the Steadman◆Hawkins Research Foundation staff in January of 2004 as an Intern and currently holds the position of Motion Analysis Laboratory Director. His primary focus is on designing and building a second-in-the-world, high-speed biplane fluoroscopy system in the Biomechanics Research Laboratory. With this sophisticated x-ray system, which creates movies of moving bones, joint motion can be tracked with sub-millimeter accuracy. This allows for the measurement of ligament lengthening and perhaps even cartilage indentation during activities such as walking, running, and throwing a ball. Not only are these measurements currently unknown, they are critical in understanding ligament and cartilage function and their surgical reconstruction or repair, as well as their contribution to the development and progression of osteoarthritis. This project will open entirely new avenues of research for the Foundation, as well as greatly improve ongoing research projects.

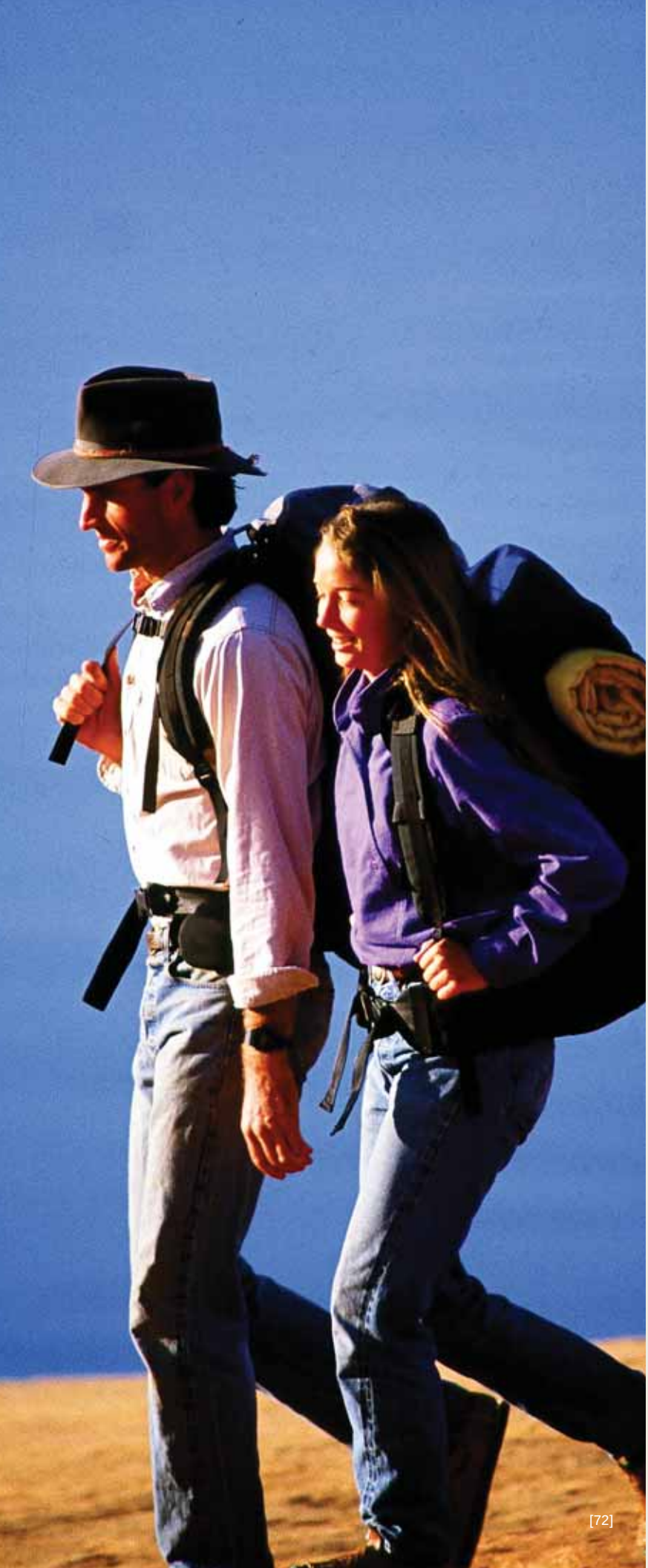
Erik, a Dutch citizen, earned his master of science degree in electrical engineering from Delft University of Technology in 1994 with a focus on computer science and information theory. As part of his M.S. program he was required to complete a three-month internship outside of the university. He found an internship at the Neuro Muscular Research Center (NMRC) in Boston and has been in the United States ever since.

"You have to be flexible to take advantage of great opportunities. I was going to visit the U.S. for three months plus a vacation. That was 12 years ago." In 2001 Eric received his Ph.D. in biomedical engineering at Boston University after completing his dissertation work on postural control at the NMRC. After graduation, he created a virtual reality laboratory at Sargent College of Health and Rehabilitation Sciences, Boston University, to study how perceptual deficits modify

locomotion in patients who suffer from various diseases. “I feel that with my new position I have essentially come full circle with my training. I almost completed my M.S. thesis in medical image processing in the Netherlands, but decided to stay and complete my thesis work at the NMRC in Boston instead. This got me involved with human movement studies and biomechanics. After working with 3D VR environments for three years and furthering my skills in motion analysis, I found out about the great work the Biomechanics group does at the Foundation. With the advanced image processing and 3D modeling, as well as cutting-edge biomechanics required to analyze the fluoroscopy data, I feel I have found my home.”

Applying his engineering skills to medical and orthopedic problems is very fulfilling for Erik and is inspired by his family. Erik’s mother, Johanna, suffers from post-polio syndrome, and she had her ankle fused many years ago. He clearly remembers her suffering after countless surgeries on her ankle and foot. Being able to understand her limitations and to give her some advice based on his current knowledge is satisfying for him. Erik’s sister, Anja, is an M.D.-M.P.H. who has lived and worked in Africa for most of the past 14 years. After being the only Western doctor in small regional hospitals in Zambia and Mozambique, saving lives every day, she now lives in Dar es Salaam, Tanzania, with her husband and adopted children, and works for the Elizabeth Glaser Pediatric AIDS Foundation to prevent transmission of the HIV virus from mother to child. Erik draws a lot of inspiration from his sister’s work.

Erik and his wife, Courtney, an architect for Morter Architects in Vail, moved to Courtney’s home state of Colorado in the summer of 2003 after deciding it was time to start a family. They currently live in Edwards with their two children. They enjoy skiing, hiking, and snowshoeing with their dog Brooke, and all other activities the mountains bring.

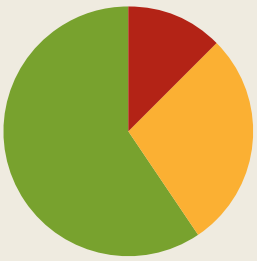


Philanthropic Highlights in 2006

2006 New Gifts

Steadman◆Hawkins Research Foundation, supporters — individuals, corporations and foundations — increased their philanthropy in 2006.

Total: $2,950,574

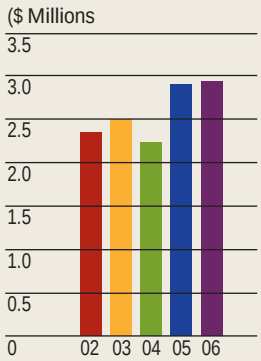


- Foundations and Grants $ 370,000
- Corporations $ 834,500
- Family and Friends $ 1,746,290

Increasing Generosity

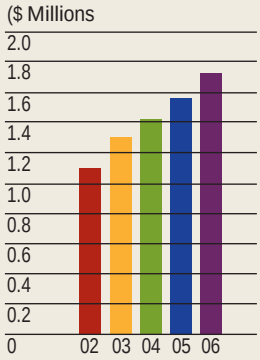
Individuals, corporations and foundations contributed $2,950,574 in 2006, breaking the record for total giving.

Five years of support.



Annual Giving

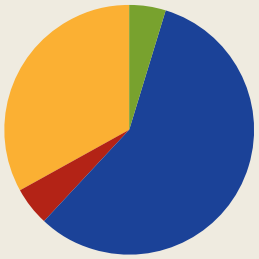
The generosity of our friends making annual gifts to the Foundation between 2002 and 2006 has shown a positive trend. In 2006, contributions, including special events, totaled $1,723,124.



Our Future

The Steadman◆Hawkins Research Foundation has carefully managed its investment portfolio to reduce risk. The investments of the carefully structured portfolio are diversified in asset allocation and exposure.

Total investment portfolio: $4,037,657.



- Fixed Income 5%
- Alternative Investments 33%
- Cash 4%
- Equity 57%

Independent Accountant's Report

Board of Directors
Steadman◆Hawkins Research Foundation
Vail, Colorado

We have audited the accompanying statements of financial position of Steadman◆Hawkins Research Foundation (the Foundation) as of December 31, 2006 and 2005, and the related statements of activities, cash flows and functional expenses for the years then ended. These financial statements are the responsibility of the Foundation's management. Our responsibility is to express an opinion on these financial statements based on our audits.

We conducted our audits in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management as well as evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for our opinion.

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Steadman◆Hawkins Research Foundation as of December 31, 2006 and 2005, and the changes in its net assets and its cash flows for the years then ended in conformity with accounting principles generally accepted in the United States of America.

\s\ BKD, LLP
June 19, 2007
Colorado Springs, Colorado 80903

STATEMENTS OF FINANCIAL POSITION

DECEMBER 31, 2006 AND 2005

ASSETS

	2006	2005
Cash	**$ 585,011**	$ 915,096
Accounts receivable	**128,167**	149,965
Accounts receivable, related party	**2,836**	1,633
Investments	**4,130,879**	3,119,858
Contributions receivable	**279,893**	291,054
Contributions receivable, related party	**750**	5,750
Prepaid expenses and other assets	**65,609**	56,740
Property and equipment, net	**328,583**	214,577
Total assets	**$ 5,521,728**	$ 4,754,673

LIABILITIES AND NET ASSETS

Liabilities		
Accounts payable	**$ 72,594**	$ 108,358
Accrued expenses	**96,148**	88,936
Deferred revenue	**18,000**	134,500
Total liabilities	**186,742**	331,794
Net Assets		
Unrestricted	**4,561,769**	3,835,466
Temporarily restricted	**773,217**	587,413
Total net assets	**5,334,986**	4,422,879
Total liabilities and net assets	**$ 5,521,728**	$ 4,754,673

See Notes to Financial Statements

STATEMENTS OF ACTIVITIES

YEAR ENDED DECEMBER 31, 2006

	Unrestricted	Temporarily Restricted	Total
REVENUES, GAINS AND OTHER SUPPORT			
Corporate partner support	$ 572,500	$ 262,000	$ 834,500
Contributions	893,699	460,578	1,354,277
Grants	15,000	354,937	369,937
Fundraising events, net of $156,720 of expenses	368,847	—	368,847
Fellows and other meetings	—	3,400	3,400
Video income	4,100	—	4,100
Other income	15,513	—	15,513
Net assets released from restrictions	895,111	(895,111)	0
Total revenues, gains and other support	2,764,770	185,804	2,950,574
EXPENSES			
Biomechanics research program	531,758	—	531,758
Basic science program	69,057	—	69,057
Bioskills	54,839	—	54,839
Clinical research program	442,830	—	442,830
Education program	266,354	—	266,354
Office of Information Services	173,015	—	173,015
Management and general	407,269	—	407,269
Fundraising	513,534	—	513,534
Total expenses	2,458,656	—	2,458,656
OTHER INCOME (EXPENSE)			
Investment income	479,372	—	479,372
Other	(59,183)	—	(59,183)
Total other income (expense)	420,189	—	420,189
CHANGE IN NET ASSETS	726,303	185,804	912,107
NET ASSETS, BEGINNING OF YEAR	3,835,466	587,413	4,422,879
NET ASSETS, END OF YEAR	$ 4,561,769	$ 773,217	$ 5,334,986

See Notes to Financial Statements

STATEMENTS OF ACTIVITIES

YEAR ENDED DECEMBER 31, 2005

	Unrestricted	Temporarily Restricted	Total
REVENUES, GAINS AND OTHER SUPPORT			
Corporate partner support	$ 520,000	$ —	$ 520,000
Contributions	832,853	386,881	1,219,734
Grants	5,000	768,554	773,554
Fundraising events, net of $136,052 of expenses	335,768	—	335,768
Fellows and other meetings	10,050	—	10,050
Video income	11,915	—	11,915
Other income	28,815	—	28,815
Net assets released from restrictions	764,955	(764,955)	0
Total revenues, gains and other support	2,509,356	390,480	2,899,836
EXPENSES			
Biomechanics research program	443,245	—	443,245
Basic science program	114,704	—	114,704
Bioskills	50,918	—	50,918
Clinical research program	319,967	—	319,967
Education program	438,099	—	438,099
Office of Information Services	171,755	—	171,755
Management and general	415,810	—	415,810
Fundraising	431,440	—	431,440
Total expenses	2,385,938	—	2,385,938
OTHER INCOME			
Investment income	265,387	—	265,387
CHANGE IN NET ASSETS	388,805	390,480	779,285
NET ASSETS, BEGINNING OF YEAR	3,446,661	196,933	3,643,594
NET ASSETS, END OF YEAR	$ 3,835,466	$ 587,413	$ 4,422,879

See Notes to Financial Statements

STATEMENTS OF CASH FLOWS

YEARS ENDED DECEMBER 31, 2006 AND 2005

	2006	2005
OPERATING ACTIVITIES		
Change in net assets	**$ 912,107**	$ 779,285
Items not requiring (providing) cash		
Depreciation	**119,457**	93,470
Realized and unrealized gains on investments	**(381,618)**	(203,739)
Loss on disposal of fixed assets	**59,183**	—
In-kind contributions of investments	**(109,204)**	(43,717)
Changes in		
Accounts receivable	**20,595**	(50,125)
Contributions receivable	**16,161**	(294,904)
Prepaid expenses and other assets	**(8,869)**	(30,073)
Accounts payable	**(35,764)**	60,839
Accrued expenses	**7,212**	(2,110)
Deferred revenue	**(116,500)**	134,500
Net cash provided by operating activities	**482,760**	443,426
INVESTING ACTIVITIES		
Purchase of property and equipment	**(292,646)**	(65,828)
Purchases of investments	**(1,750,686)**	(1,055,100)
Sales of investments	**1,230,487**	700,000
Net cash used in investing activities	**(812,845)**	(420,928)
INCREASE (DECREASE) IN CASH	**(330,085)**	22,498
CASH, BEGINNING OF YEAR	**915,096**	892,598
CASH, END OF YEAR	**$ 585,011**	$ 915,096

See Notes to Financial Statements

STATEMENTS OF FUNCTIONAL EXPENSES

YEAR ENDED DECEMBER 31, 2006

	Programs									
	Biomechanics Research	Bioskills	Basic Science	Clinical Research	Education	Office of Information Services	Total	Management and General	Fundraising	Total
Salary and benefits	$361,758	$ —	$25,372	$331,421	$117,097	$ 62,989	$ 898,637	$264,183	$194,613	$1,357,433
Payroll taxes	20,679	—	1,845	20,833	7,711	4,516	55,584	17,348	11,514	84,446
Travel	15,356	2,479	367	9,782	35,447	2,668	66,099	15,974	2,725	84,798
Utilities	4,196	—	1,501	3,248	2,784	5,104	16,833	8,352	2,088	27,273
Telephone	2,892	—	248	2,460	548	1,696	7,844	4,653	1,574	14,071
Consulting and contract labor	12,364	63,299	7,493	14,089	18,600	2,173	118,018	30,000	69,750	217,768
Legal and accounting	8,234	654	115	7,524	1,172	1,424	19,123	10,475	3,510	33,108
Postage and freight	3,905	8	404	4,496	1,130	1,282	11,225	3,136	6,211	20,572
Exhibits and meetings	2,620	—	—	617	29,605	—	32,842	—	—	32,842
Research projects	50,000	—	—	3,989	12,439	—	66,428	—	—	66,428
Facility rent	5,461	—	1,855	4,365	3,426	6,232	21,339	10,327	3,356	35,022
Promotion	1,000	—	—	—	269	—	1,269	—	42,329	43,598
Repair, maintenance and equipment	—	—	—	—	—	33,206	33,206	—	—	33,206
Board meetings	—	—	—	—	1,535	—	1,535	—	20,907	22,442
Dues, subscriptions, books and journals	541	—	11	927	9,108	81	10,668	113	805	11,586
General insurance	960	—	111	1,070	185	221	2,547	14,042	480	17,069
Printing	1,453	403	32	7,529	1,963	63	11,443	190	107,487	119,120
Supplies	16,103	—	6,541	9,942	13,844	9,310	55,740	4,392	8,543	68,675
Program support	57	—	7	63	14	24	165	46	25,488	25,699
Depreciation	23,722	—	8,937	12,352	9,308	41,961	96,280	12,211	10,966	119,457
Other	457	2,214	—	8,123	169	65	11,028	11,827	1,188	24,043
	$531,758	$69,057	$54,839	$442,830	$266,354	$173,015	$1,537,853	$407,269	$513,534	$2,458,656

See Notes to Financial Statements

STATEMENTS OF FUNCTIONAL EXPENSES

YEAR ENDED DECEMBER 31, 2005

	Programs									
	Biomechanics Research	Bioskills	Basic Science	Clinical Research	Education	Office of Information Services	Total	Management and General	Fundraising	Total
Salary and benefits	$301,547	$ —	$22,589	$224,553	$110,176	$ 81,860	$ 740,725	$266,348	$187,477	$1,194,550
Payroll taxes	18,911	—	1,610	15,363	7,446	5,858	49,188	18,941	11,378	79,507
Travel	7,858	4,977	—	4,569	36,670	4,487	58,561	12,755	1,846	73,162
Utilities	4,997	—	3,103	3,447	2,955	5,417	19,919	7,006	2,216	29,141
Telephone	2,831	—	202	2,105	472	1,875	7,485	3,441	1,655	12,581
Consulting and contract labor	13,968	108,033	3,336	14,837	250	2,430	142,854	40,301	70,047	253,202
Legal and accounting	8,460	607	145	6,522	1,505	2,259	19,498	4,767	3,970	28,235
Postage and freight	4,405	56	758	5,055	2,789	1,909	14,972	3,549	4,578	23,099
Exhibits and meetings	1,590	—	—	1,160	245,725	—	248,475	45	—	248,520
Research projects	50,000	—	—	10,457	5,087	—	65,544	—	—	65,544
Facility rent	8,323	—	4,226	5,839	4,115	7,435	29,938	9,817	3,872	43,627
Promotion	2,000	—	—	579	90	219	2,888	750	37,534	41,172
Repair, maintenance and equipment	20	—	3	23	5	11,945	11,996	198	36	12,230
Dues, subscriptions, books and journals	1,327	—	11	91	7,509	32	8,970	67	1,857	10,894
General insurance	693	—	54	668	134	399	1,948	13,217	321	15,486
Printing	3,463	140	276	5,766	679	844	11,168	5,524	75,800	92,492
Supplies	7,241	—	5,646	7,091	2,947	9,156	32,081	5,021	7,352	44,454
Program support	198	—	22	212	47	89	568	146	4,217	4,931
Depreciation	5,282	—	8,937	11,630	9,308	35,541	70,698	10,427	12,345	93,470
Other	131	891	—	—	190	—	1,212	13,490	4,939	19,641
	$443,245	$114,704	$50,918	$319,967	$438,099	$171,755	$1,538,688	$415,810	$431,440	$2,385,938

See Notes to Financial Statements

NOTES TO FINANCIAL STATEMENTS

YEARS ENDED DECEMBER 31, 2005 AND 2004

NOTE 1: NATURE OF OPERATIONS AND SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Nature of Operations

Steadman◆Hawkins Research Foundation (the Foundation) is a not-for-profit foundation located in Vail, Colorado, that is organized for educational and scientific purposes to advance medical science and research. The Foundation's primary sources of support are public donations, grants and corporate partners.

Corporate Partners

The Foundation has agreements with several corporations who sponsor the Foundation's research. This research is for the general use of and publication by the Foundation. These agreements are recorded as income in the year payment is due.

Contributions

Gifts of cash and other assets received without donor stipulations are reported as unrestricted revenue and net assets. Gifts received with a donor stipulation that limits their use are reported as temporarily or permanently restricted revenue and net assets. When a donor-stipulated time restriction ends or purpose restriction is accomplished, temporarily restricted net assets are reclassified to unrestricted net assets and reported in the statements of activities as net assets released from restrictions.

Gifts of land, buildings, equipment and other long-lived assets are reported as unrestricted revenue and net assets unless explicit donor stipulations specify how such assets must be used, in which case the gifts are reported as temporarily or permanently restricted revenue and net assets. Absent explicit donor stipulations for the time long-lived assets must be held, expirations of restrictions resulting in reclassification of temporarily restricted net assets as unrestricted net assets are reported when the long-lived assets are placed in service. Unconditional gifts expected to be collected within one year are reported at their net realizable value. Unconditional gifts expected to be collected in future years are reported at the present value of estimated future cash flows. The resulting discount is amortized using the level-yield method and is reported as contribution revenue.

Cash

At various times during the year, the Foundation's cash accounts exceeded federally insured limits.

Accounts Receivable

Accounts receivable are stated at the amount billed to customers. The Foundation provides an allowance for doubtful accounts, which is based upon a review of outstanding receivables, historical collection information and existing economic conditions. Accounts receivable are ordinarily due 30 days after the issuance of the invoice. Accounts past due more than 120 days are considered delinquent. Delinquent receivables are written off based on individual credit evaluation and specific circumstances of the customer.

Property and Equipment

Property and equipment are depreciated on a straight-line basis over the estimated useful life of each asset. Leasehold improvements are depreciated over the shorter of the lease term plus renewal options or the estimated useful lives of the improvements.

Investments and Investment Return

Investments in equity securities having a readily determinable fair value and all debt securities are carried at fair value. Investment return includes dividend, interest and other investment income and realized and unrealized gains and losses on investments carried at fair value. Investment return is reflected in the statements of activities as unrestricted or temporarily restricted based upon the existence and nature of any donor or legally imposed restrictions.

Use of Estimates

The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues, expenses, gains, losses and other changes in net assets during the reporting period. Actual results could differ from those estimates.

Income Taxes

The Foundation is a qualifying organization under Section 501(c)(3) of the Internal Revenue Code and a similar provision of state law. Consequently, no provision for income taxes has been made in the financial statements.

Reclassifications

Certain reclassifications have been made to the 2005 financial statements to conform to the 2006 financial statement presentation. These reclassifications had no effect on the change in net assets.

NOTE 2: INVESTMENTS AND INVESTMENT RETURN

Investments at December 31 consist of the following:

	2006	2005
Stock and equity funds	**$ 2,311,208**	$ 1,612,089
Equity securities	**51,812**	40,137
Fixed income funds	**202,696**	194,750
Money market funds	**36,886**	111,140
Limited partnerships	**1,328,277**	1,161,742
	$ 4,130,879	$ 3,119,858

At December 31, 2006 and 2005, approximately 89% and 90%, respectively, of the Foundation's investments consisted of equity securities and equity mutual funds.

Investment income during 2006 and 2005 consists of the following:

	2006	2005
Interest and dividend income	**$ 97,754**	$ 61,648
Net realized and unrealized gains on investments	**381,618**	203,739
Investment income	**$ 479,372**	$ 265,387