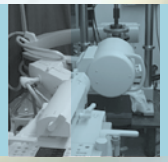
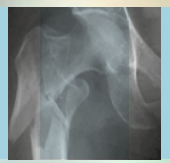
OTC Osteosynthesis & Trauma Care Foundation

OTC Foundation RESEARCH 10 Years





OTC RESEARCH PROGRAM

2005 - 2015

Content

10 Years OTC Foundation Research

Preface
10 Years OTC Foundation Research

The Osteosynthesis and Trauma Care Foundation (OTCF) is an educational and scientific professional organization dedicated to the advancement of musculoskeletal trauma treatment.
The OTC Foundation recognizes the importance of scientific discovery and has committed funding to promising research projects since its inception. In particular, the organization has supported the work of young and less experienced investigators, as well as the scientific studies of established researchers and their teams. To this end research grants are awarded annually.
The present booklet highlights basic, biomechanical, and clinical research activities supported by the OTC Foundation over the last ten years. Many of these research projects have gone on to garner additional funding from other private and public agencies, and have resulted in multiple presentations and publications. We expect that the results of this research will stimulate future discoveries, and we look forward to the further dissemination of this interesting work.
The OTC Research Committee (RECO) was established in 2005 and since then oversees this program.

Ten Years Research at OTC Foundation are celebrated at the 25th session of RECO in Athens, June 10th 2015.

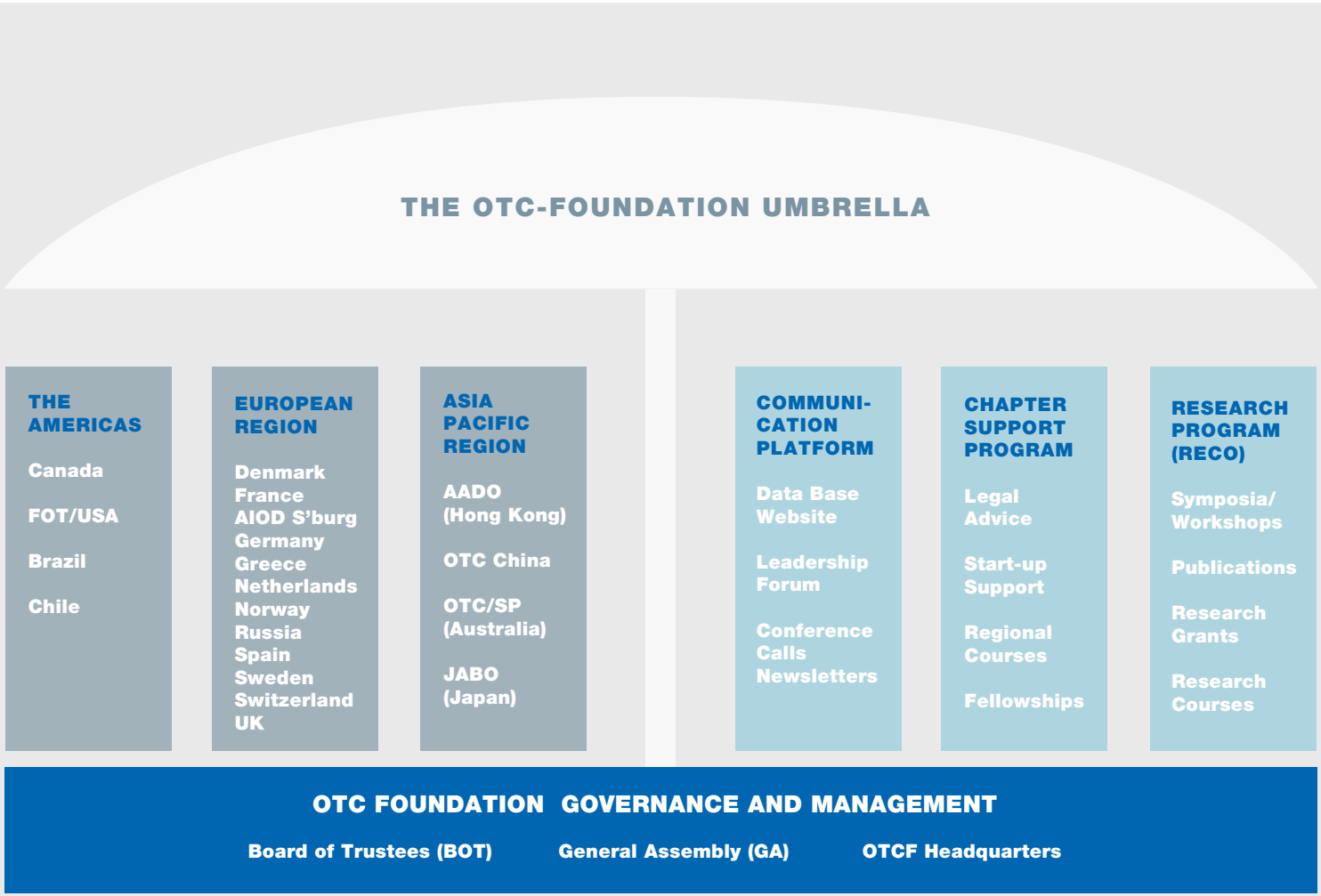
PETER PATKA
Past President

ESTHER VAN LIESHOUT
Scientific Coordinator

THEODORE MICLAU
President

ACKNOWLEDGEMENT
The research program of the OTC Foundation is supported by a grant from Stryker.

Introduction
OTC Foundation Framework



Introduction
OTC Foundation Framework

The OTC Foundation (OTCF) is a non-profit Swiss Foundation incorporated in the Canton of Solothurn, Switzerland. In 2007 Stryker Trauma SA founded OTCF and has been its main sponsor ever since. With funding based primarily on grants and related donations and as a legally independent entity, OTCF complies with all restrictions and/or financial limitations. Such funding may contain very specific allocations or restrictions regarding how the funding may be spent or allocated. All funding is tied to specific work plans and budgets that were independently generated by the Health Care Professionals who participate in OTC Foundation Activities.

Today the OTC is an **interactive global network of surgeons and scientists,** dedicated to the advancement of osteosynthesis and trauma care through education, research and professional networking. The common goal is to attract both younger and experienced professionals, that strive to be competent in the fields of fragility fractures and osteoporosis and related surgical interventions.

OTC FOUNDATION ACTIVITIES

The program objective of the OTC Foundation is to undertake, support and promote the global advancement of osteosynthesis and trauma care through, but without limitation to, education, training, research, scientific studies, symposia, publications, and evidence-based clinical practices. All activities are designed to reflect, fulfill and advance the stated mission of the OTC Foundation to advance Osteosynthesis and Trauma Care.
The OTC Global Alliance is made up of the OTC Foundation and 20 independent Chapters located around the world. The OTC Chapters are mainly locally-funded entities that focus on education, offering a wide array of established local courses. Where needed, the OTC Foundation provides direct support to OTC Chapters in their activities. The General Assembly of Chapter Presidents oversees this program.

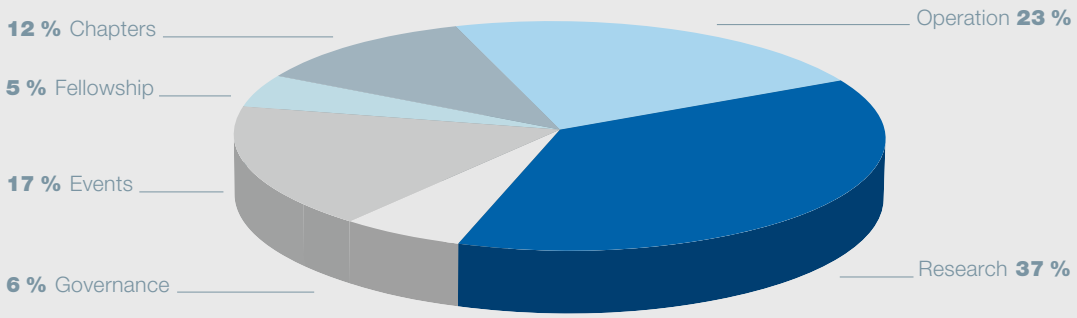
The OTC Chapter Presidents through the General Assembly mechanism oversee educational activities in their chapters and support their educational programs. Courses take place worldwide at local heath care centers. Other activities include an annual Leadership Forum and regional events, and a visiting fellows' travel grant program.

Introduction
OTC Foundation Framework

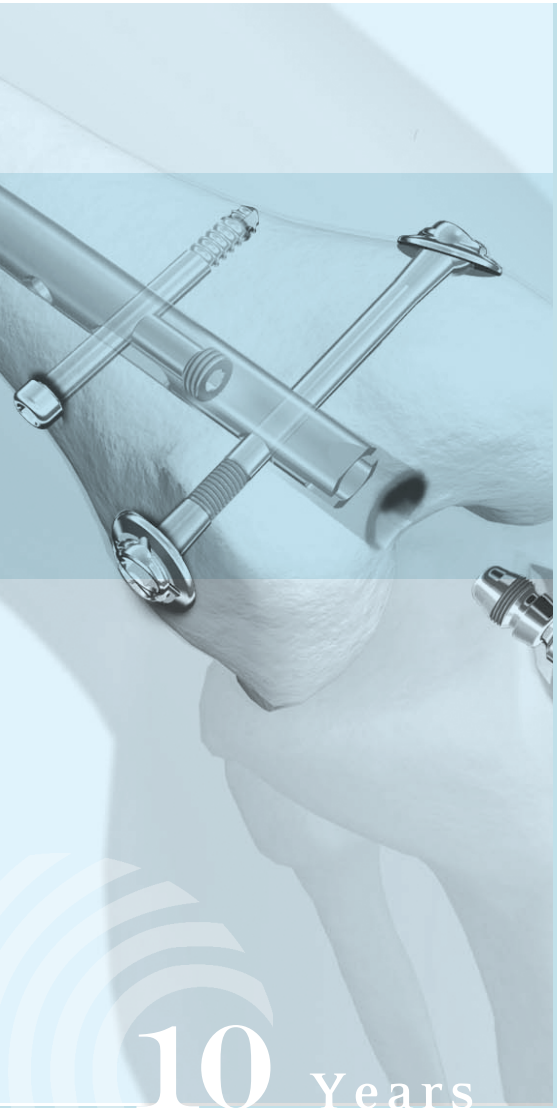
OTC FOUNDATION RESEARCH PROGRAM

The objective of this program is to stimulate scientific studies in support of evidence-based research in surgical practice. Knowledge expansion is considered as key to solving clinical problems and improving outcomes in orthopaedic trauma care. Support of pre-clinical, basic, biomechanical, experimental, and translational research is the main focus of the program. The OTCF Research Committee (RECO) guides significant global research grants, research courses and international symposia pertaining to osteosynthesis and trauma care. Research activities cover methodology publications such as books, and research supplements to international journals. More than one third of the OTC Foundation annual budget is allocated to research demonstrating the high importance allocated to this sector.

OTC FOUNDATION PROGRAM BUGDET 2015



Introduction
OTC Foundation Framework



The current trends in development of trauma care technology are governed by the increase in the aging population, particularly in industrialized countries. The OTCF Research Program aims at mobilizing more resources being allocated to pre-clinical musculoskeletal research.
The translational research program develops around selected “Hot Topics” and consists of four key activity components:

- Reviews and analysis of the scientific literature on the selected topic
- Symposia convened on an annual basis as multi-disciplinary workshops focusing on the selected “hot topic” and bringing together surgeons and scientists
- Provision of research grants for funding scientific studies related to that topic
- Stimulation of publications, individual books or in form of supplements to scientific journals

In addition, the OTC Foundation promotes development of methodology on experimental research, to be published in a reference textbook. This continues the series of textbooks on clinical research methodology. The annual courses on clinical research will be resumed by national OTC Chapters, and expanded by future OTC Foundation courses on experimental research, all based on the methodology compiled in these textbooks.
The purpose of the present publication is to report on the activities of this program since its inception in 2005, and to document ten years of achievement in orthopaedic and trauma research. Events and results are highlighted which demonstrate the wide array of scientific and clinical subjects covered, and the large community of surgeons and scientists which had been reached out to over these ten years. This would have not been possible without the dedicated engagement of the members of the research committee which had been faithful to the program over these ten years.

Starting with a brief account of the history of the OTCF research program, its activities are presented in the following key areas:

- Research grants
- Clinical research
- Biomechanical research
- Hot topic workshops
- Translational research

Program details and achievements are contained in three chronological booklets which can be consulted on the OTCF website **www.otcfoundation.org >Publications, and >Research.**

History
OTC Research Program

At a Kick Off meeting in Washington, DC, on 22 February 2005, the AIOD Research Committee was founded. For three years, from 2005 to 2007, the program was implemented under the auspices of the “Association Internationale de l’Osteosynthèse Dynamique” (AIOD) in Strasbourg.

At its first meeting the committee identified its mission as:

- Progress in orthopaedic trauma care through research and education
- Increase scientific knowledge to improve trauma care
- High quality research
- Basic and applied and clinical research
- Principles of evidence based medicine

AIOD Research Committee Meeting
Washington February 22nd, 2005

Research Committee

PETER PATKA
chairman

First Committee meeting

Dr. V. Alt	MD	Giessen, Germany
Dr. Cheung Wing-hoi	Biochemist	Hong-Kong, China
Prof. M. Kossman	Orthop. Surgeon	Melbourne, Australia
Prof. T. Miclau	Orthop. Surgeon	San Francisco, USA
Prof. P. Patka	Orthop. Surgeon	Rotterdam, Netherlands
Prof. E. Schemitsch	Orthop. Surgeon	Montreal, Canada
Dr. A. Speitling	Stryker	Kiel, Germany
Dr. D. Wientjens	MD	Rotterdam, Netherlands

Research fields

Basic research and clinical projects in...

Biology and enhancement of fracture healing and non-unions Growth factorsStem cells Bone substitutes

New technologies for fracture fixation Bone glue Biodegradable implants CAOS and automation

Osteoporosis and fracture fixation in osteoporotic fractures Biology of osteoporosis Prophylaxis of osteoporosis Augmentation of fracture fixations

Prophylaxis and treatment of infections Infection pathophysiology Antimicrobial coating of implants

History
OTC Research Program

VOLKER ALT, MD PHD, GERMANY SINCE 2005
Orthopaedic Trauma Surgeon (University Hospital Giessen, Giessen, Germany)

PETER AUGAT, PHD, GERMANY SINCE 2008
Professor of Biomechanics (Institute of Biomechanics, Murnau, Germany)

MOHIT BHANDARI, MD MSC, CANADA FROM 2008 TO 2010
Professor, McMatsres University, Hamilton, Canada

LOUIS WING-HOI CHEUNG, BSC PHD, CHINA FROM 2005 TO 2012
Research Associate Professor, Deputy Director of Musculoskeletal Research Laboratory
(Department of Orthopaedics&Traumatology, The Chinese University of Hong Kong, Hong Kong, China)

SUNE B.A. LARSSON, MD, PHD, SWEDEN SINCE 2014
Professor and Consultant in Orthopedic Surgery, Uppsala University Hospital, Sweden

THEODORE MICLAU, III, MD, USA SINCE 2005; CHAIRMAN SINCE 2011
Orthopaedic traumatologist, vice Chairman and Director of Orthopaedic Trauma
(Dept. of Orthopaedic Surgery, University California San Francisco, San Francisco, USA)

PETER PATKA, MD PHD, THE NETHERLANDS CHAIRMAN FROM 2005 TO 2011
Rotterdam University Chair in Trauma Surgery
(Dept. of Surgery-Traumatology, Erasmus MC, University Medical Center Rotterdam, Rotterdam, the Netherlands)

EMIL SCHEMITSCH, MD PHD, CANADA FROM 2005 TO 2010
Professor of Surgery, St. Michael's Hospital, University of Toronto

A.H.R.W. SIMPSON, MD PHD, UK SINCE 2006
Professor of Orthopaedics and Trauma (Dept. of Orthopaedic Surgery, Royal Infirmary, Edinburgh, Scotland)

ESTHER M.M. VAN LIESHOUT, PHD, THE NETHERLANDS SINCE 2006 SCIENTIFIC COORDINATOR
Research Coordinator in Trauma Surgery
(Dept. of Surgery-Traumatology, Erasmus MC, University Medical Center Rotterdam, Rotterdam, the Netherlands)

History
OTC Research Program

A first list of research fields was identified. The key activity concerned the assessment, management and sponsoring of research projects. To this end research grants were offered with up to USD 50’000 per project. The target group were senior researchers as well as young investigators who could obtain grants of up to USD 10’000.

With the transition from AIOD to the OTC Foundation at the beginning of 2008, such grants were provided as OTC Research Grants. The essence of the program was maintained, including the Research Committee (RECO). An historic list of members of RECO shows the long-term commitment of most of them.

AIOD Research Committee – fourth session (ReCo 4), Chicago, March 2006:
Peter Patka (Chairman)
Volker Alt, Germany
Louis Cheung, Hong Kong
Theodore Miclau, USA
Emil Schemitsch, Canada
Andreas Speitling (Stryker)
Peter Illig (OTCF)

History
OTC Research Program

10 Years

TENTH MEETING OF RECO IN SAN FRANCISCO,
4 MARCH 2008

As of the tenth meeting of RECO in San Francisco, 4 March 2008, the Biomechanical Research Program was integrated into the OTC research program and its Chairman, Prof. Peter Augat, joined the committee.
As of the eleventh meeting of RECO in Nice, 25 June 2008, the Clinical research Program was also integrated into the OTC Research program and its Chairman, Prof. Mohit Bhandari, joined the committee.
As of 2014 the committee is composed of six members. Its administrative office is today located at the OTC Foundation headquarters in Zuchwil, Switzerland. Annual RECO meetings are held in conjunction with the General Assembly of OTCF in June of each year.

The work of RECO was recognized by the OTCF General Assembly in 2014 by dedicating an honorary award to Prof. Peter Patka as Past RECO Chairman

OTC RESEARCH COMMITTEE (ReCo)
SESSIONS 2005-2015

ReCo 1:	Washington DC	February	2005
ReCo 2:	Nice	June	2005
ReCo 3:	Rotterdam	November	2005
ReCo 4:	Chicago	March	2006
ReCo 5:	Nice	June	2006
ReCo 6:	Amsterdam	November	2006
ReCo 7:	San Diego	February	2007
ReCo 8:	Nice	June	2007
ReCo 9:	Amsterdam	November	2007
ReCo 10	San Francisco	March	2008
ReCo 11:	Nice	June	2008
ReCo 12:	Amsterdam	November	2008
ReCo 13:	Las Vegas	February	2009
ReCo 14:	Nice	June	2009
ReCo 15:	Amsterdam	November	2009
ReCo 16:	Amsterdam	June	2010
ReCo 17:	Munich	November	2010
ReCo 18:	Zurich	March	2011
ReCo 19:	Barcelona	November	2011
ReCo 20:	Berlin	June	2012
ReCo 21:	Boston	December	2012
ReCo 22:	Copenhagen	June	2013
ReCo 23:	London	November	2013
ReCo 24:	Lisbon	June	2014
ReCo 25:	Athens	June	2015

History
OTC Research Program

Today, the mission of OTC is to foster evidence-based research that increases knowledge to solve clinical problems and improve orthopaedic trauma care. Through the OTC Research Grant Program funding support is provided on topics such as:

- Promotion of fracture healing, including treatment and enhancement of fracture repair
- Treatment of fractures in osteoporotic bone
- New technologies in fracture fixation, including computer-assisted surgery
- Prophylaxis and treatment of infections in fracture
- Prospective clinical trials in fracture care
- Numerical methods in trauma surgery
- Translational, pre-clinical and experimental research
- Biomechanical studies

The focus of program activities is reviewed and updated at the annual RECO meetings, and the area of research grants adjusted accordingly.

The work of RECO was recognized and appreciated by the General Assembly of all OTC Chapter Presidents at their session in Lisbon, June 2014. They provided Prof. Peter Patka with an honorary award for his long and dedicated service and leadership of the committee

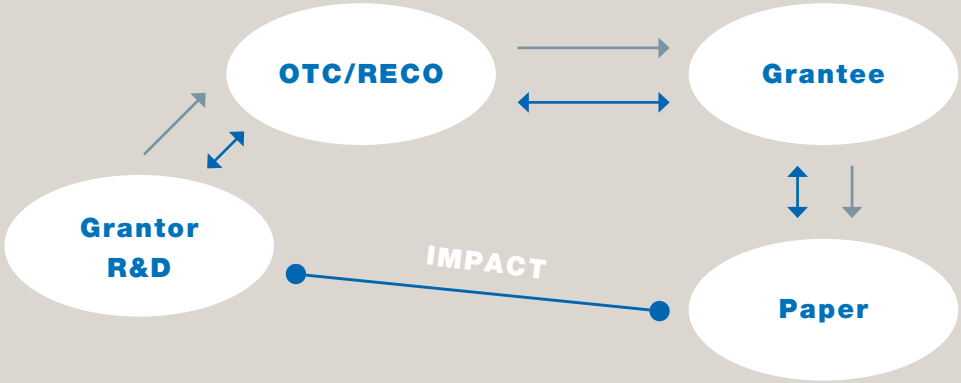
OTC Research Committee 2015

Research Grants Program
2005-2014

During the years **2005, 2006 and 2007** the Research Grants were administered by AIOD Strasbourg. With the transition from AIOD to the OTC Foundation at the beginning of **2008**, such grants are provided as OTC Research Grants. The essence of the program has been maintained, including the Research Committee. Due to a transitional period for the OTC Foundation administration and governance in **2012** there were no research grants awarded in that year. The grant program resumed in **2013** with the funding of three research projects per annum, and a streamlined application and review process.

Strategy: The objective of Research Grants is to encourage orthopedic trauma surgeons and basic scientists by providing seed and start-up funding for promising research projects in the field of orthopedic trauma surgery through Grants of up to US$ 50,000 for a research project extending over a maximum of two years. Both laboratory and clinical projects are suitable, but in either case clinical relevance is needed. The aim is to make the results of these grant projects available to a wider audience of surgeons with manifest research interests and of active scientists. Thus a feedback loop between all involved, from Research & Development (R&D) at Stryker to open literature and back is achieved.

GENERAL STRATEGY



Research Grants Program
2005-2014

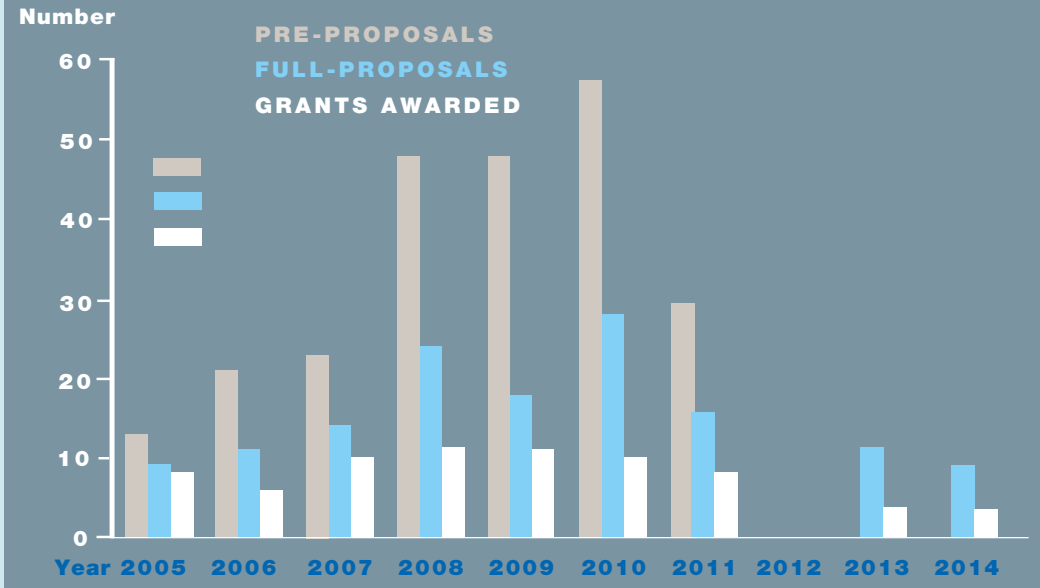
Pre-proposal applications
(2005 to 2011 grant cycles):
Preliminary screening of application was based on a pre-proposal application, containing a brief description of the research idea. Pre-proposals are reviewed in a blinded fashion by all research committee members, and are rated and ranked based on scientific merit and orthopaedic trauma impact. Proposals receiving an average rate of three or higher (on a scale of 1 to 5) were invited to submit a full-length proposal.

Full-length proposals
(direct submission as of 2013 grant cycle):
Full-length proposals are evaluated in a non-blinded fashion for their scientific merit, orthopaedic trauma impact, methodology, feasibility, experience of the research team, and the budget requirements. For each application, three appointed RECO reviewers provide an in-depth review, which is discussed with all research committee members. The best-rated applications are offered a Grant contract.

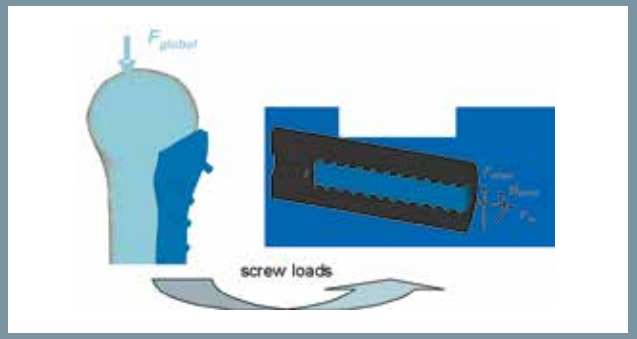
Results of the Research Grants
Details on all grants awarded during the period 2005 to 2014 are summarized in three brochures covering the grant cycles 2005 to 2008; 2009 and 2010; and 2011 to 2014. Also, the publications and presentations which resulted out of the investigators work are listed in these brochures. These brochures can be read as eBooks on the **OTCF website www.otcfoundation.org under >Publications.**

In summary, the program resulted during the ten-year period 2005 to 2014 in:
- 237 Pre-proposal reviews
- 147 Full proposal review
- 70 Grants awarded
- 2.5 million total USD grant amount awarded
- 277 Abstracts presented based upon grant projects
- 106 Publications based on grant projects

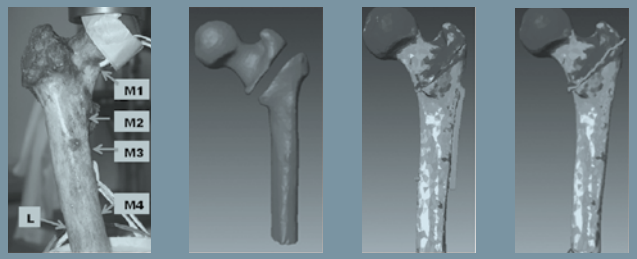
More abstract presentations and publications are expected from unfinished grants of the last years.



Research Grants Program
2005-2014



DR. T. WEHNER (2010) Global nonlinear FE model (left) for determing the screw loads as boundary conditions for a nonlinear elastoplastic micro FE model (right) of the bone-screw interface.



E. PELEG (2011) Patient specific quantitative analysis of fracture fixation in the proximal femur implementing principal strain ratios.

RESEARCH SYMPOSIA

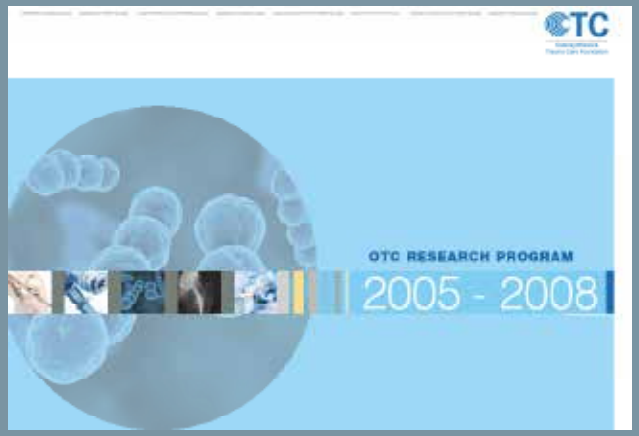
Results of research grant projects were presented and discussed at Research Symposia in conjunction with annual OTC Leadership Fora. The first one took place in Amsterdam, 23 June 2010 where the following research reports were presented:

1. **C. COLNOT** Role of BMP-2 in Stem Cell Recruitment and Differentiation during Fracture Repair
2. **D. LEVINSON** Bone Regeneration in Critical-size Gap induced by Endothelial Progenitor Cells
3. **A. BADHWAR** A Novel Animal Model for Compartment Syndrome: Pathophysiology and Therapeutics
4. **T. BLOKHUIS** Fracture Healing in Osteoporosis
5. **T. WEHNER** Optimization of Locked Screw Devices
6. **T. VAN RAAIJ** Same Level Fibular Plating versus Not Plating in Distal Metaphyseal Tibia Fractures treated with Intramedullary Nails: a Randomized Trial

A second symposium took place at the Leadership Forum in Madrid, 24 June 2011 where the following research reports were presented:

A.-R. LAWENDY Treatment of unstable lateral malleolus fractures
P. KUZYK Treatment of segmental tibial bone defect in a canine model
B. LI Effect of IL-12 on healing in preventing open fracture infection
M. BOTTLANG Can multi-planar fixation improve the strength of locked plating constructs?
E. PELEG Fracture fixation in the proximal femur implementing principal strain loss

Research Grants Program
2005-2014



The activities and results of the work of the OTC Research Committee were summarized and published grouping several years together. The three brochures followed about a common presentation:

- Research Program History
- Research Committee Members
- Supporting Researchers Worldwide
- Research Grant Application and Review Process
- Young Investigator Grants Awarded
- Research Grants Awarded
- Research Symposia
- Research Fellowships
- Research Courses
- Research Workshops
- Textbooks published
- Publications on Grant Projects
- Presentations of Grant Projects
- Announcement of Research Grants

The three brochures can be read and download as eBooks on the OTC website **www.otcfoundation.org**

Further information on the Research Grants Process can be obtained from **research.grants@otcfoundation.org**

Research Grants Program
2005-2014

STATISTICAL OVERVIEW OF RESEARCH GRANTS 2005 TO 2014

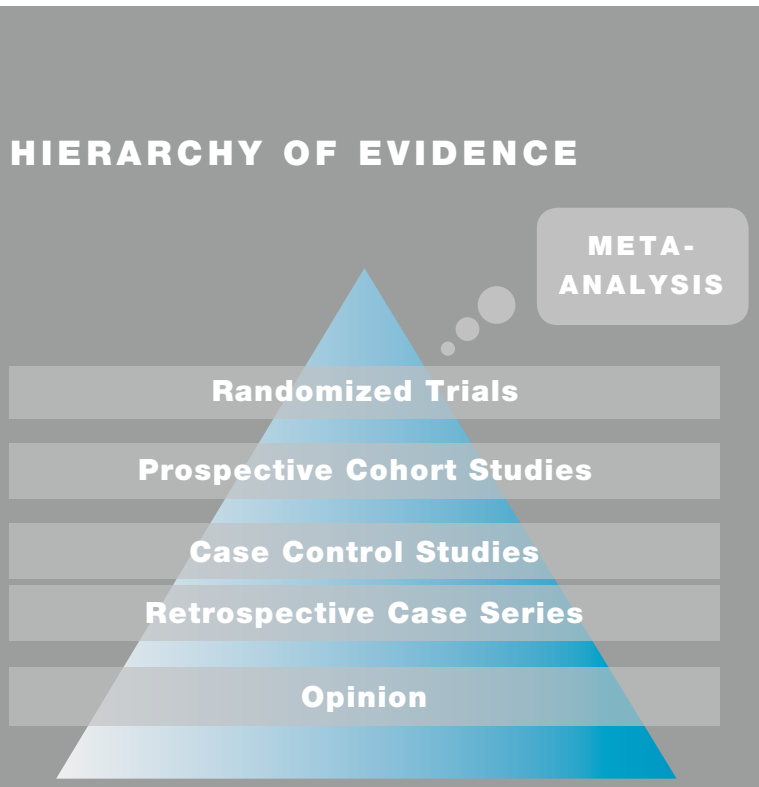
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Preproposals	13	21	23	48	48	55	29		0	0	**237**
Full proposals	11	10	14	28	18	27	16		13	10	**147**
Grants	8	6	10	11	11	10	8		3	3	**70**
%granted of pre	62	29	43	23	23	18	28				**30**
%granted of full	73	60	71	39	61	37	50		23	30	**48**
Grants amount	**145.000**	**300.000**	**364.200**	**386.965**	**421.089**	**331.733**	**270.722**	**0**	**150.000**	**150.000**	**2.519.709**
Presentations	16	18	43	38	42	54	19	17	20	10	**277**
Publications	5	11	14	12	14	14	14	5	10	7	**106**

Clinical Research Program
Evidence

Under the leadership of Dr. Mohit Bhandari the methodology of clinical research has been developed in a systematic fashion and disseminated worldwide in a series of courses. Starting in January 2006, ten courses were held across France, Japan, United States, Canada and India, attended by over 650 interested surgeons and researchers.

While Evidence Based Medicine (EBM) is sometimes perceived as a blinkered adherence to randomised trials it more accurately involves informed and effective use of all types of evidence, but particularly evidence from the medical literature, in patient care. With the ever-increasing amount of available information, surgeons must consider a shift in paradigm from traditional practice to one which involves question formulation, validity assessment of available studies and appropriate application of research evidence to individual patients.

The paucity of practical resources for surgeons led to the OTC's development and ongoing leadership in research education. Systematic methodology was developed to present options for clinical studies. This was described in detail in a series of three books which emanated from the work of Mohit Bhandari and others.



Strategic approach to clinical research studies

Clinical Research Program
Courses

Nice: where it all started in 2007

Amsterdam City Center. Course Venue

Course Faculty with Key Attendees

Drs. Emil Schemitsch and Mohit Bhandari

During the development phase of the OTC Foundation in 2007, a course was held in **October 2007 at the Trauma Care Institute (TCI) in Nice,** still under the auspices of AIOD Strasbourg. Then, **April 16-18, 2008, the first OTC Course on The Principles and Practice of Clinical Research was held in Amsterdam** with Mohit Bhandari MD, MSc, as chairman.

On the same basis such a course was held in **Athens, March 28, 2009,** organized jointly with OTC Hellas. Four international faculty members taught more than 100 national participants.

The research program held its 3rd Canadian course on **September 16-18th, 2009 in Toronto, Canada** with course Co-Chairs Mohit Bhandari and Emil Schemitsch. The most significant change was the addition of a basic science educational component led by a number of experts including Professor Hamish Simpson, OTC/RECO, who provided a guest lecture on “Good Experimental Technique”. With over 100 participants, 18 faculty and 2 guest lecturers, the 2009 principles of research course was a milestone of the OTCF research program in that it expanded the spectrum from clinical research to basic research.

Clinical Research Program
Courses

HAVANA June 2-3, 2010: Forum Internacional de Investigaciones Clinicas en Ortopedia
Organized jointly with Centro de Investigaciones Medico Quirurgicas (CIMEQ)
Five international faculty members; More than 140 national participants

LONDON September 23-25, 2010: Principles of Clinical and Experimental Research
Organized jointly with British Orthopaedic Trainee Association (BOTA)
Nineteen international and national faculty members
Twenty-eight national and international participants

PUERTO VALLARTA November 1-2, 2010: Seminario de Investigaciones Clinicas
Organized jointly with Asociación Mexicana de Ortopedia y Traumatologia (AMOT)
Five international faculty members; More than 75 national participants

HAVANA June 1-2, 2011: Forum Sobre las Investigaciones Clinicas en Ortopedia
Organized jointly with the Centro de Investigaciones Medico Quirurgicas (CIMEQ), Ciudad de La Habana, Cuba
Two national and four international faculty members
More than 100 participants

SAN FRANCISCO 2011: OTI and IGOT Second International Annual Flap Course and Clinical Pre-Course
Organized jointly with the San Francisco General Hospital Foundation
Faculty drawn from Orthopaedic Trauma Institute San Francisco General Hospital
Participants from developing countries were trained to appropriately manage injuries requiring wound coverage

Havana course 2010

London Course 2010

London Course 2010

Clinical Research Program
Courses

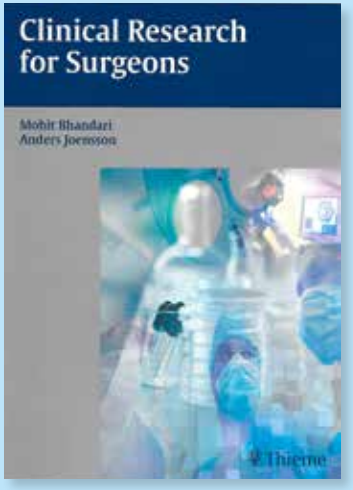
MURNAU November 7-8, 2011: Principles of Clinical Research
Organized jointly with the Trauma Center (BGU) Murnau, Germany
Eight faculty members were teaching this OTC course on how to design, analyze and participate in skeletal trauma research
39 participants from various European countries attended this course

AARHUS September 3-4, 2012: Principles of Clinical Research
Organized jointly with the Aarhus University
Hospital, Denmark
Eight faculty members were teaching this OTC course on how to design, analyze and participate in skeletal trauma research
More than 30 participants from Scandinavian countries attended this course

Aarhus Course at Helnan Marselis Hotel 2012

Murnau Course at BGU Trauma Center 2011

Clinical Research Program
Books



ADVANCED CONCEPTS IN SURGICAL RESEARCH

Editors: Mohit Bhandari and Bernd Robioneck

Advanced Concepts in Surgical Research is a practical, reader-friendly guide to planning, conducting, and evaluating solid, evidence-based research that leads to high-quality results. Geared to the investigator who has already mastered basic principles, this book focuses on more advanced topics such as randomized controlled trials, survey design, observational studies, meta analysis, statistical concepts, reporting of data, and much more.

CLINICAL RESEARCH FOR SURGEONS

Editors: Mohit Bhandari and Anders Joensson

Clinical Research for Surgeons is a practical guide for understanding, planning, conducting, and evaluating surgical research. It covers the principles of evidence-based surgery, the standard benchmark guiding clinical practice, and applies these principles to the design of suitable research studies. The reader will come to fully understand important concepts such as case-control study, prospective cohort study, randomized trial, and reliability study. The book provides valuable discussions of the critical appraisal of published clinical studies, allowing the reader to learn how to evaluate the quality of such studies with respect to measuring outcomes and to make effective use of all types of evidence in patient care.

Clinical Research Program
Books

BOOKS PUBLISHED UNDER THE AUSPICES OF THE CLINICAL RESEARCH PROGRAM

GETTING YOUR RESEARCH PAPER PUBLISHED – A SURGICAL PERSPECTIVE

Editors: Mohit Bhandari and Anders Joensson

Getting Your Research Paper Published is written from the perspective of experienced surgeons and veteran researchers. This succinct, how-to manual provides readers with everything they need to prepare, publish, and present a scientific research paper. The expert authors address every aspect of the publication process, including quality and ethics in academic writing, the rules of authorship, grammar, formatting, style, and much more. Each consistently organized chapter begins with a brief summary and introduction and ends with up-to-date references and carefully selected suggestions for further reading.

Biomechanics Research Program
Coordination

This program was founded already under the auspices of AIOD Strasbourg, prior to the creation of OTCF, with the objective of "Improvement of dynamical fracture fixation by initiation, coordination and funding of biomechanical studies." The transition from AIOD to OTCF took place during 2007. During the course of 2008 the biomechanical program was merged with the basic and clinical research components into a comprehensive OTC Research Program lead by the OTC Research Committee (RECO).

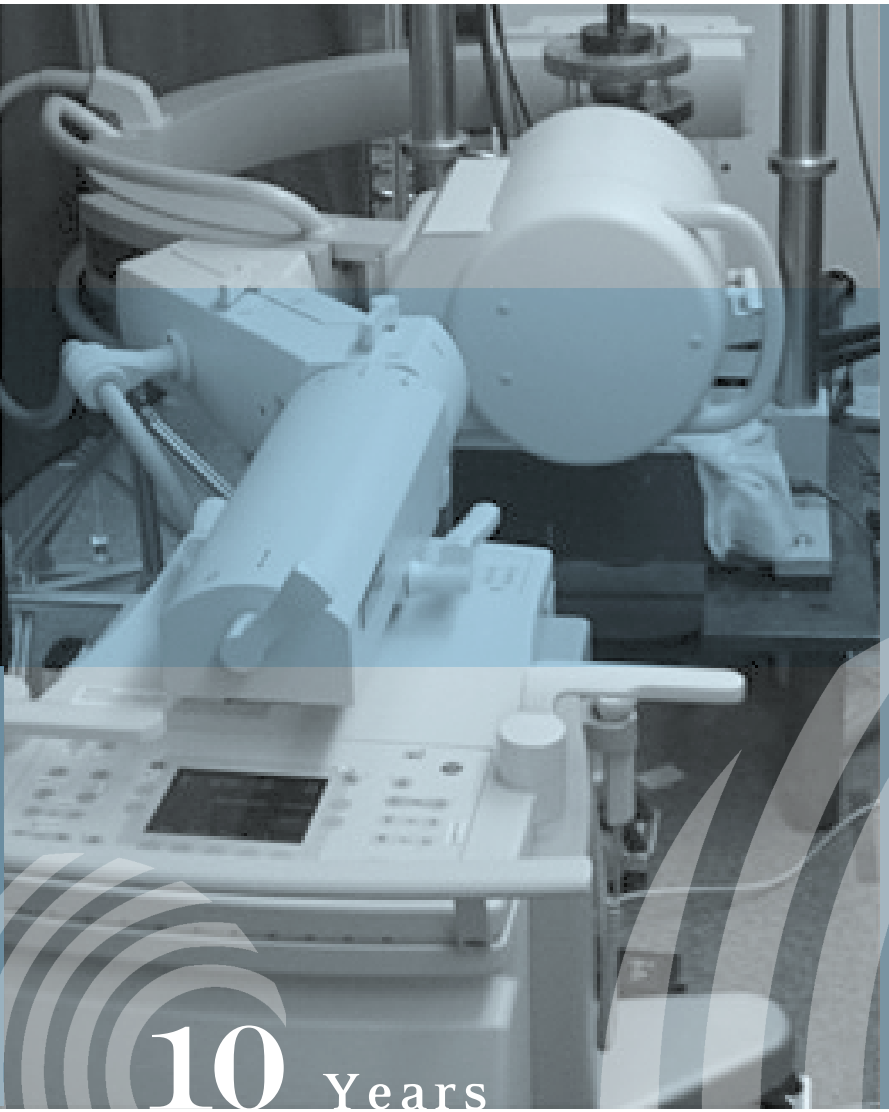
CHAIR
PETER AUGAT
Murnau, Germany

CO CHAIR
MICHAEL BOTTLANG
Portland Oregon

The initial program aims under the chairmanship of Prof. Peter Augat and Dr. Michael Bottlang were:

- Encourage and support biomechanical studies for the improvement of fracture fixation and bone healing.
- Coordinate biomechanical activities in trauma research.
- Create a trauma related AIOD Biomechanical Network.
- Organize dedicated expert forums and workshops.

Biomechanics Research Program
Coordination



BIOMECHANICAL RESEARCH WORKSHOPS

The OTC Research Program includes a special focus on the biomechanics of fracture fixation. Each year a “hot topic” is identified on which biomechanical researchers, engineers, and clinicians are invited to share their views at a research symposium. As a result, problems are identified which can be addressed by performing a biomechanical study. To this end such issues were included into the OTC Research Grants Program as of the 2008 cycle.

BIOMECHANICAL RESEARCH GRANTS

OTC Research grants in the area of biomechanics were awarded throughout the ten year period. They are included in the section on research grants.

Biomechanics Research Program
Fellowships

BIOMECHANICAL RESEARCH FELLOWSHIPS

Since its inception the biomechanical research program accompanied the hot topic process with research grants and research fellowships. This started with the topic of biomechanics of hip fractures already in 2006/2007. Examples of fellowship reports are included in the brochure “OTC Research Program 2009/2010”. Biomechanical research fellowships were awarded to:

JULIA KOERBER (2008) at Biomechanics Institute, BGU Murnau
Topic: Finite Element Analysis of a Human femur from Computed Tomography Data.

JOSEF DOORNINK (2008) at Biomechanics Institute, BGU Murnau
Topic: Post-mortem Analysis of Ovine Tibiae after Callus Healing of a Gap Osteotomy.

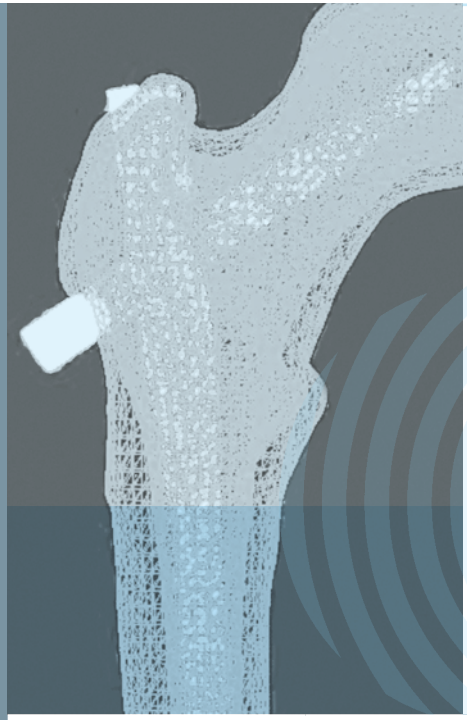
ASMAA MALOUL (2008/2009) at Orthopaedic Biomechanics Laboratory, Toronto
Topic: Biomechanical Characterization of Complex Thia Bone Structures in the Human Craniofacial Skeleton.

ERAN PELEG (2009) at Orthopaedic Biomechanics Laboratory, Sunnybrook Health Centre
Topic: Patient Specific Quantitative Analysis of Fracture Fixation in the Proximal Femur Implementing Principal Strain Ratios.

SEBASTIAN DECKER (2010) at Laboratory for Skeletal Regeneration, San Francisco General Hospital
Topic: The Role of Angiogenesis and Hypoxia on Bone Healing and Bone Development. Does Lactate Influence Angiogenesis?

DANIEL STEPHAN (2011) at Institute of Biomechanics, BGU Murnau
Topic: Analysis of the Intra-individual Differences of the Joint Surfaces of the Calcaneus.

Biomechanics Research Program
Fellowships

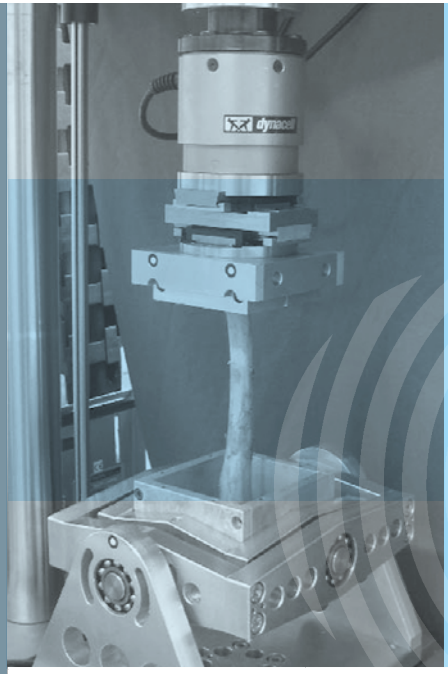


JULIA KOERBER

Fellowship Period:	2008
Host Location:	Biomechanics Institute, BGU Murnau

FINITE ELEMENT ANALYSIS OF A HUMAN FEMUR FROM COMPUTED TOMOGRAPHY DATA

Abstract: A method was developed to generate finite element (FE) models from computed tomography (CT) data. This FE model was validated by mechanical tests of cadaveric femurs. These FE results are highly sensitive to the material laws chosen for the model.



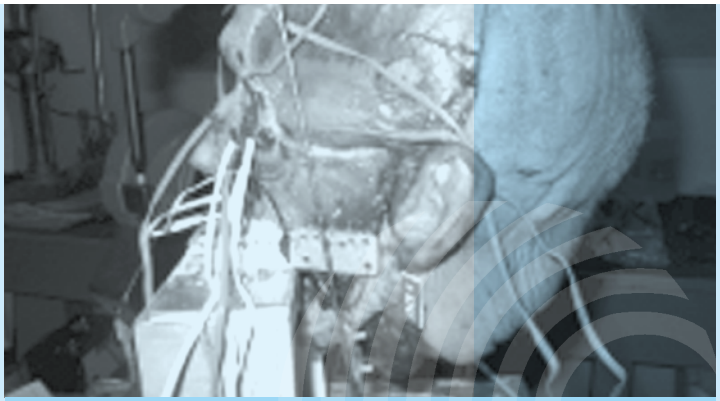
JOSEF DOORNINK

Fellowship Period:	2008
Host Location:	Biomechanics Institute, BGU Murnau

POST-MORTEM ANALYSIS OF OVINE TIBIAE AFTER CALLUS HEALING OF A GAP OSTEOTOMY

Abstract: The specific goal for this research fellowship was to establish and execute protocols for the mechanical analysis of ovine tibiae after callus healing of a gap osteotomy. Testing was conducted under axial compression, torsion and 4-point bending. Results were compared to contralateral tibiae for healing assessment.

Biomechanics Research Program
Fellowships

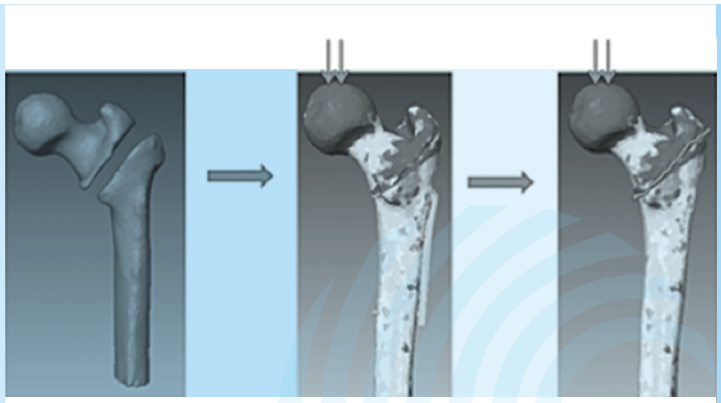


ASMAA MALOUL

Fellowship Period:	2008-2009
Host Location:	Orthopaedic Biomechanics Laboratory, Toronto, Canada

BIOMECHANICAL CHARACTERIZATION OF COMPLEX THIN BONE STRUCTURES IN THE HUMAN CRANIOFACIAL SKELETON

Abstract: To understand the biomechanical behavior of thin bone structures in the human skeleton 6 fresh-frozen heads were mechanically tested through mastication muscles to measure strain in the facial bones. The results of all these studies will help in the characterization of the mechanical behaviour of the craniofacial skeleton which will provide an understanding of the impact of muscles on load distribution and strain patterns.



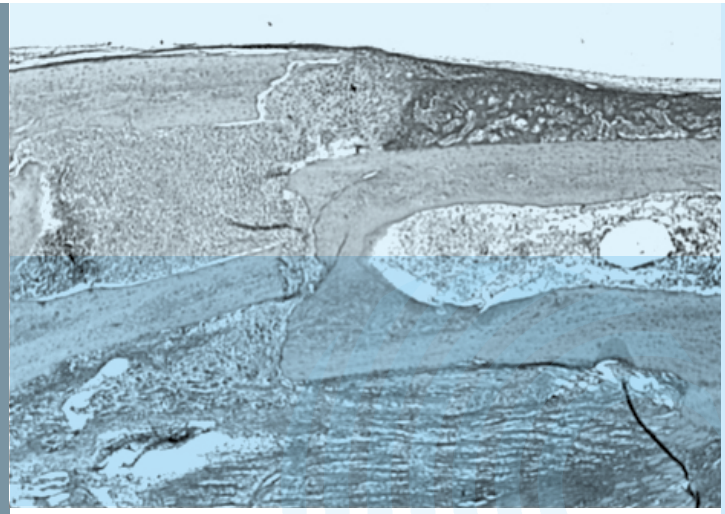
ERAN PELEG

Fellowship Period:	2009
Host Location:	Orthopaedic Biomechanics Laboratory, Sunnybrook Health Centre

PATIENT SPECIFIC QUANTITATIVE ANALYSIS OF FRACTURE FIXATION IN THE PROXIMAL FEMUR IMPLEMENTING PRINCIPAL STRAIN RATIOS.

Abstract: Computational patient-specific modeling has the potential to yield powerful information for selecting and planning of fracture treatments if it can be developed to yield results that are rapid, focused and coherent from a clinical perspective. A combined experimental and numerical study was performed with cadaveric proximal femora intact and following fracture fixation to quantify the per of the SR variable performance.

Biomechanics Research Program
Fellowships

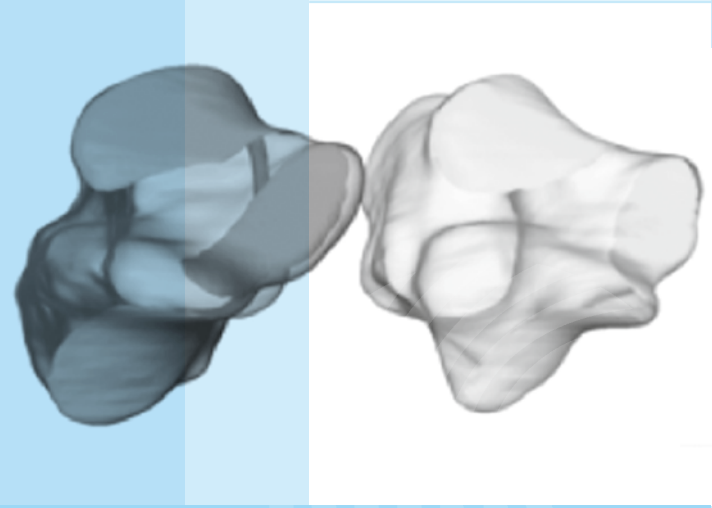


SEBASTIAN DECKER

Fellowship Period:	2010
Host Location:	Laboratory for Skeletal Regeneration, San Francisco General Hospital

THE ROLE OF ANGIOGENESIS AND HYPOXIA ON BONE HEALING AND BONE DEVELOPMENT. DOES LACTATE INFLUENCE ANGIOGENESIS?

Abstract: The main study purpose was the role of angiogenesis and hypoxia on both fracture healing and skeletal development. To analyze the effect of hypoxia on fracture healing, externally stabilized tibiae fractures were created in 10 mice. In vivo assays were done on the chicken chorioallantoic membrane (CAM). Evaluation showed a decrease of vessels compared to control.



DANIEL STEPHAN

Fellowship Period:	2011
Host Location:	Institute of Biomechanics, BGU Murnau

ANALYSIS OF THE INTRA-INDIVIDUAL DIFFERENCES OF THE JOINT SURFACES OF THE CALCANEUS.

Abstract: Currently, the degree of reconstruction is visually determined by computer tomography (CT) or X-ray. The hypothesis of this study< is that for individual patients only small differences between the 3D orientation and the articular surface of the calcaneus exists. The results show that only small intraindividual differences within the anatomy exist.

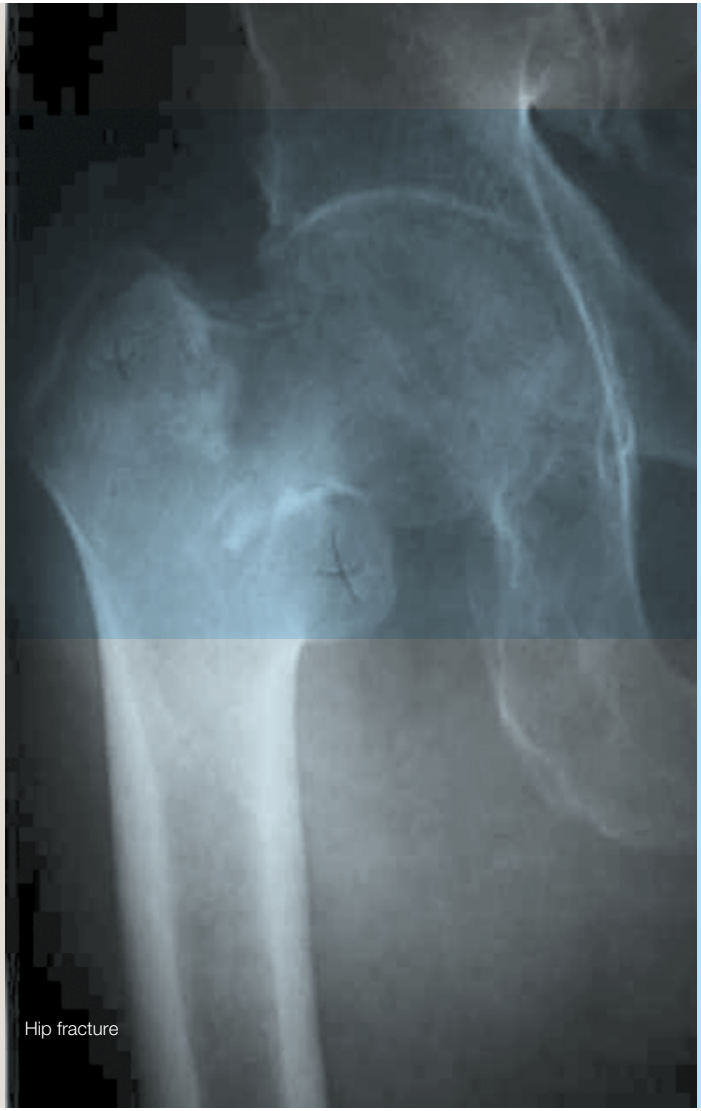
Hot Topic Workshops
Biomechanics of Hip Fractures 2006/2007

Today the overall OTC research program is based upon the concept of "Hot Topics", i.e. dealing with burning issues in the area of biomechanical and related scientific questions, emanating from advances in research or from problems faced by surgical practitioners. Each topic is dealt with over a biennium, including workshops, fellowships and research grants which are solicited in the areas defined at the hot topic workshops.

HOT TOPIC I

BIOMECHANICS OF HIP FRACTURES (2006/2007)

This topic was initiated by an AIOD Expert Workshop **in 2006** at the Trauma Center (BGU) Murnau, Germany, on Biomechanics of Hip Fractures. The purpose was: (a) to understand state-of-the-art clinical treatment methods, outcomes and constraints of hip fracture treatment; and (b) to summarize state-of-the-art knowledge on hip fracture bio-mechanics and biomechanical structures and testing. With this input to identify biomechanical knowledge gaps and to agree on first guidelines for future biomechanical testing. This workshop led to two experimental studies and a biomechanical fellowship.



Hip fracture

2006/07 Workshop Murnau, program

Hot Topic Workshops
Biomechanics of Locked Plating 2007/2008

2007 Workshop Mahwah

2008 Workshop Nice, Hotel Meridien

Workshop
Chairman's Birthday

10 Years

HOT TOPIC II
BIOMECHANICS OF LOCKED PLATING (2007/2008)

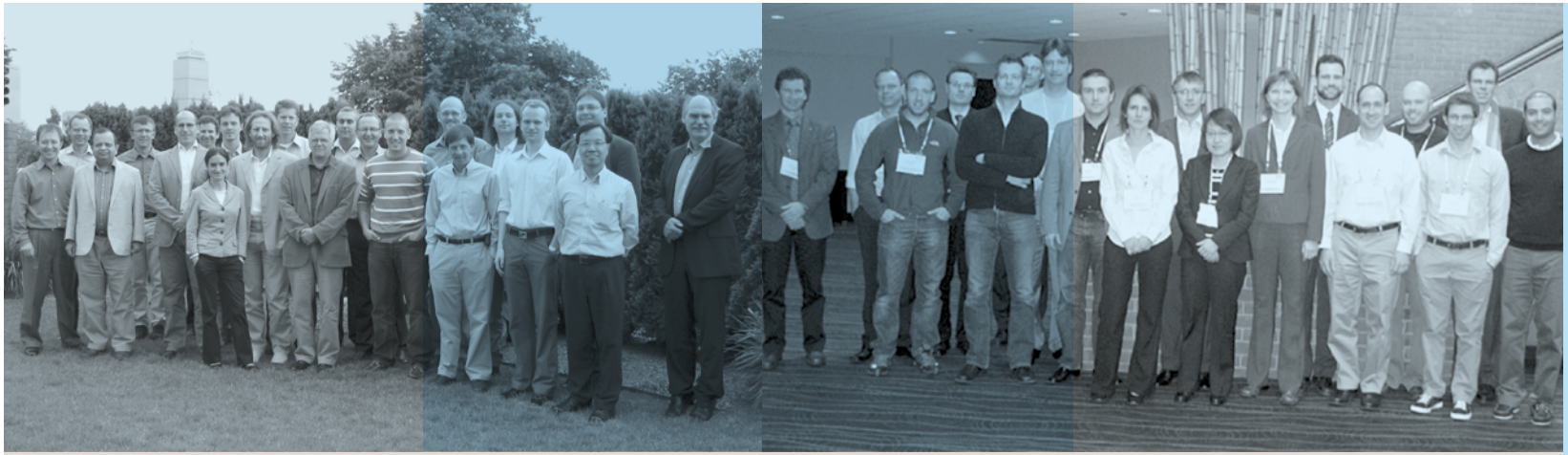
In **September 2007** a workshop on the topic of locked plating was held in **Mahwah, NY,** launching several activities on the problems identified during the workshop. The need to discuss their outcomes led to convening an OTC symposium on the biomechanics of locked plating, held on **May 5th 2008 at the Trauma Care Institute in Nice.** Thirteen scientists and clinicians from Germany, Austria and the United States, plus several invited guests, came together under the chairmanship of Prof. Peter Augat.

Subjects ranged from the biomechanical differences between locking and nailing, and experiences with locked plating in different situations, to guidelines for locked plating in cases of fragility fracture. Finally, potential biomechanical study areas in locked plating were identified by the participants, such as the choice between locked plating and nailing, patients' demands for stability, screw fixation, or the use of intelligent implants using modern micro-electronics.

2007 Workshop Mahwah

2008 Workshop Nice

Hot Topic Workshops
Numerical Modelling in Trauma Care 2009/2010



June 2009 Boston workshop

December 2010 Boston workshop

HOT TOPIC III
NUMERICAL MODELLING IN TRAUMA CARE (2009/2010)

June 14th and 16th, 2009, the OTC organized an expert workshop on the topic of Numerical Modeling and Trauma Care which was held in Boston, MA. Twenty five experts from various specialties including orthopedic surgery, trauma surgery, biomechanics, computer science, and biomedical engineering were invited to share their view on the future of numerical modeling in the field of trauma care. During the 3 day workshop clinicians and researcher discussed the visions and realisms of how computer science and modeling could influence the treatment of trauma patients. The most promising areas were identified as the prediction of mechanical properties of osteosynthesis constructs, and the tools for complex surgical interventions.

December 5th and 6th 2010, the OTC Biomechanics Program invited 18 researchers from around the globe to Boston MA, for a second think tank workshop on how to incorporate numerical modeling into trauma care. Orthopaedic surgeons, biomechanical engineers and computer scientists presented numerical models for fracture prediction, fracture treatment and fracture healing assessment. Following one and a half days of high quality scientific debates, discussions concentrated on numerical modeling tools to support decision making in fracture treatment and early inclusion of numerical biomechanics in education and teaching.

Hot Topic Workshops
Assessment of Fracture Healing 2011/2012

2011 Barcelona

HOT TOPIC IV
ASSESSMENT OF FRACTURE HEALING (2011/2012)

Two workshops on “Functional Assessment of Fracture Healing” were held in consecutive years; one to define the scope of the problem, and one to come to conclusions on future work needed in this area.
The workshop topic was selected to address the persistent subjectivity and variability in clinical assessment of fracture healing. The consequential uncertainty continues to hinder efforts to evaluate clinical outcomes in studies that investigate the effect of osteosynthesis constructs on fracture healing.
The goals of these interdisciplinary workshops were three-fold:

1. Define clinical methods and challenges in fracture healing assessment.
2. Share innovative approaches to improve fracture healing assessment.
3. Discuss strategies to implement novel approaches in clinical trials and practice.

2011 Barcelona Workshop

FIRST OTC WORKSHOP ON FUNCTIONAL ASSESSMENT OF FRACTURE HEALING
BARCELONA, SPAIN, OCTOBER 21-22, 2011

Under the chairmanship of Peter Augat, Murnau, and Michael Bottlang, Portland, a total of 30 invited participants attended the workshop and made presentations.

Hot Topic Workshops
Assessment of Fracture Healing 2011/2012

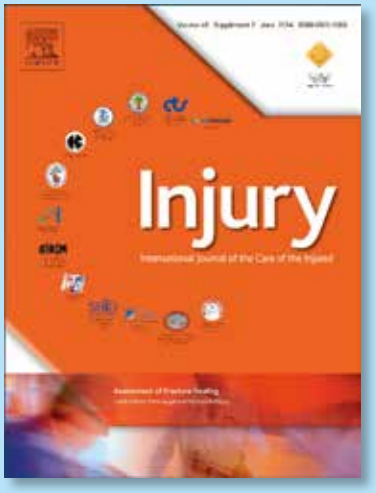
SECOND OTC WORKSHOP ON FUNCTIONAL ASSESSMENT OF FRACTURE HEALING
BOSTON, DECEMBER 3-4, 2012

Under the chairmanship of Peter Augat, Murnau, and Michael Bottlang, Portland, a total of 22 participants attended and made presentations. This second meeting was called to take the subject from problem identification in Barcelona to an analysis of potential solutions and listing of promising approaches

2012 Boston

2012 Boston Workshop

Hot Topic Workshops
Assessment of Fracture Healing 2011/2012



PRESENTATION OF CONCLUSIONS AND RECOMMENDATIONS OF THE TWO WORKSHOPS ON ASSESSMENT OF FRACTURE HEALING

The presentations prepared by 19 clinicians and 20 scientists with distinguished expertise pertinent to fracture healing assessment were summarized in a supplement to the journal INJURY. Three broad categories were addressed: **(1)** clinical aspects of fracture healing assessment; **(2)** technologies for fracture healing assessment and simulation; and **(3)** outcome assessment for clinical trials.
The full text of this INJURY supplement can be seen in eBook form on the OTCF website **www.otcfoundation.org under Publications,** or obtained in paper form by contacting **research@otcfoundation.org**

ASSESSMENT OF FRACTURE HEALING

EDITORS: PETER AUGAT & MICHAEL BOTTLANG

The bottleneck of evidence-based fracture care
Michael Bottlang, Peter Augat

Delayed union and nonunions: Epidemiology, clinical issues, and financial aspects David J. Hak, Daniel Fitzpatrick, Julius A. Bishop, J. Lawrence Marsh, Susanne Tilp, Reinhard Schnettler, Hamish Simpson, Volker Alt

Biological perspectives of delayed fracture healing
K.D. Hankenson, G. Zimmerman, R. Marcucio

Imaging techniques for the assessment of fracture repair
P. Augat, E.F. Morgan, T.J. Lujan, T.J. MacGillivray, W.H. Cheung

Computational techniques for the assessment of fracture repair Donald D. Anderson, Thaddeus P. Thomas, Ana Campos Marin, Jacob M. Elkins, William D. Lack, Damien Lacroix

Biomechanical methods for the assessment of fracture repair P. Augat, M. Faschingbauer, K. Seide, K. Tobita, S.A. Callary, L.B. Solomon, J.H. Holstein

Gait and function as tools for the assessment of fracture repair – The role of movement analysis for the assessment of fracture healing Dieter Rosenbaum, Felipe Macri, Fernando Silva Lupselo, Osvaldo Cristiano Preis

Patient – important outcome for the assessment of fracture repair A. Hoang-Kim, T. Miclau, J. Goldhahn, T.H. Nijman, R.W. Poolman

Can we enhance fracture vascularity: What is the evidence?
Ippokratis Pountos, Michalis Panteli, Elias Panagiotopoulos, Elena Jones, Peter V. Giannoudis

Hot Topic Workshops
OTCF Workshops

HOT TOPIC V

OSTEOPOROTIC FRACTURES (2013/2014)
OTCF WORKSHOP ON OSTEOPOROTIC FRACTURES – THE BIOLOGICAL PERSPECTIVE, LONDON, NOVEMBER 14-15, 2013

Under the chairmanship of Theodore Miclau and Volker Alt, a total of 23 participants attended and made presentations.

The workshop dealt with the following key subject areas:

1. Experimental Approaches: Animal models for fracture healing and osteoporosis
2. Systemic osteoporosis treatment and its effects on bone metabolism and fracture healing
3. Local treatment for enhancement of osteoporotic fracture healing
4. Fragility fracture programs: Are they effective?

The presentations and discussions will be published in a supplement to INJURY in 2015.

2013 London Workshop Participants

2013 Workshop Dinner at London's Sarastro

Hot Topic Workshops
Osteoporotic Fractures 2013-2014

OTCF WORKSHOP ON OSTEOPOROTIC FRACTURES – THE MECHANICAL PERSPECTIVE, BOSTON, NOVEMBER 17-18, 2014

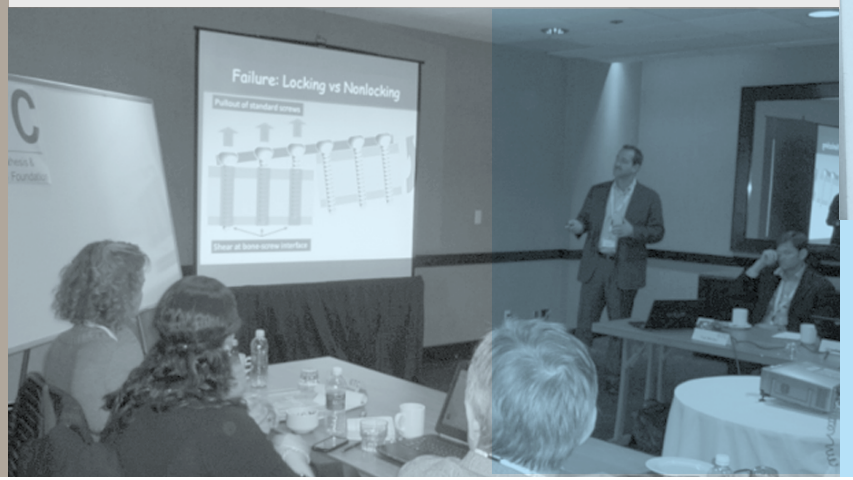
Under the chairmanship of Peter Augat and Jörg Goldhahn a total of 25 participants attended and made presentations under the main headings:

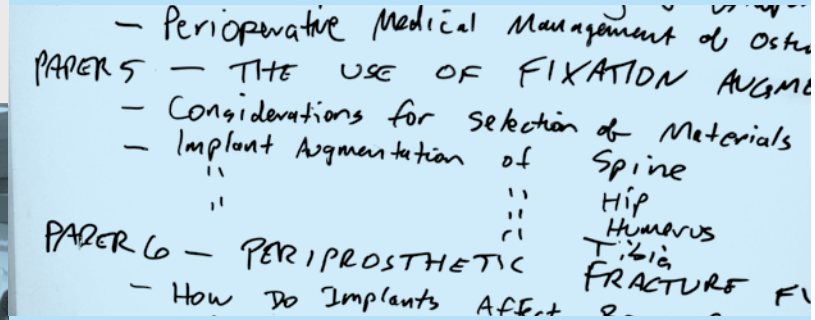
- Osteoporotic bone, is it different from normal bone?
- Fracture fixation in osteoporotic bone
- Is augmentation the solution?
- If fracture fixation fails in osteoporotic bone

The presentations and discussion results will be published in a supplement to the journal INJURY in 2016.

Chairmen Peter Augat and Jörg Goldhahn

2014 Boston Workshop Presentation





Intensive Brainstorming Results

Hot Topic Workshops
Evolution of Treatment 2015/2016

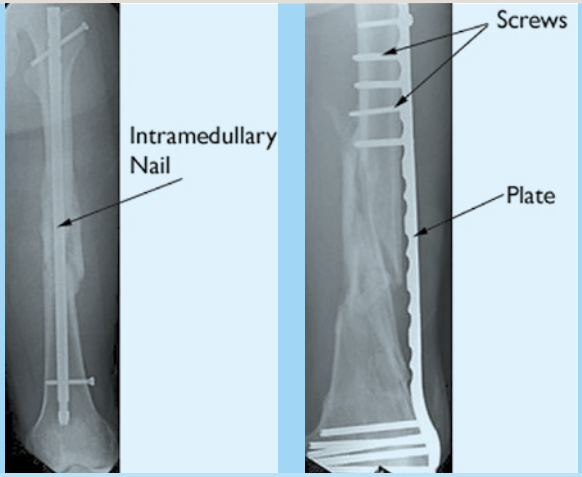
HOT TOPIC WORKSHOP VI
OTCF WORKSHOP ON COMPLICATIONS OF IM NAILING-EVOLUTION OF TREATMENT, ZURICH, NOVEMBER 2-3, 2015

The series of Hot Topic workshops on a biennial basis will be continued in 2015 and 2016. RECO decided to deal with IM Nailing in 2015, and then with “Complications of Plating-Evolution of Treatment” in 2016.

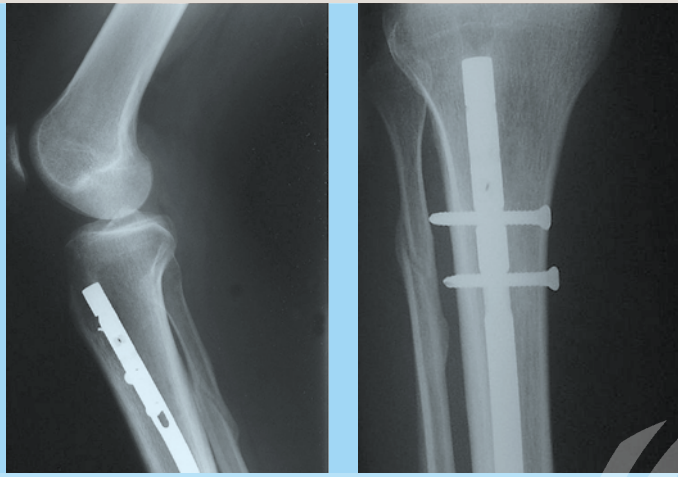
The 2015 Zurich workshop will deal with the following aspects:
- Infection
- Malalignment
- Systemic
- Technique-related complications
- Non-Union
- New applications for IM nailing

It is foreseen that the presentations and discussion results will be published in a supplement to the journal INJURY in 2017.

Exhibit at OTCF Lisbon 2014: 75 Years of IM Nailing



Femur Fracture – Nail vs Plate


Tibia Fracture – Nail vs Plate

Translational Research Program
From Science to Practice 2012-2014

NEW OTCF FOCUS: TRANSLATIONAL RESEARCH

With the completion of the methodology basis for clinical research in 2012 and the transfer of training courses to country chapter level, and a newly focused orientation of the grantor, emphasis in the three-year plan 2012-2014 shifted to translational research. The key component will be research projects on subjects of interest ("hot topics").

The closely interlinked activities include:
- research literature reviews
- symposia in the form of "hot topic" workshops
- research grant projects on selected topics in areas identified by the workshops
- stimulation of publications summarizing the deliberations and results of the workshops

The key role of RECO was expanded from evaluation of open proposal submissions for research grants to proactive shaping and guiding of the translational research process, with advice and involvement in these four activity areas.

The process of integrating basic research with clinical research was first initiated at the **Toronto course in September 2009.** This was followed up at the **Clinical and Experimental Research Course in London, in September 2010.** The introduction of experimental subjects started with clinical and computational biomechanics, then imaging techniques and models for in vivo studies, as well as research at cellular and molecular level.

EXPERIMENTAL RESEARCH METHODS IN ORTHOPEDICS AND TRAUMA

This **textbook project of RECO** aimed at developing a comprehensive and authoritative methodology compendium for basic, experimental and pre-clinical research. RECO members became actively involved as editors of book sections and as chapter authors.

Editors, section editors and most authors have been contracted under 2011 grantor funding with additional authors identified in 2012. Draft chapters were received in 2013 and the editorial review process took all of 2014. The book will be published by mid-2015 by Thieme Verlag, Stuttgart, who also issued the first three books on clinical research methodology.

This book spans from bioinformatics to nanotechnology, with advances in basic research ultimately driving improvements in clinical care. The book provides a comprehensive summary of all current research methodologies for translational and pre-clinical studies in biomechanics and orthopaedic trauma surgery. With this "roadmap" at hand, specialists and trainees will have the tools to conduct nigh-quality experimental research in any area of musculoskeletal science, with a solid understanding of how the findings can be applied in patient care.

Translational Research Program
From Science to Practice 2012-2014

EXPERIMENTAL RESEARCH METHODS IN ORTHOPEDICS AND TRAUMA
Editors: Hamish Simpson, Peter Augat

In particular, the book:

- Utilizes the principles and methodology of modern, evidence-based medicine in pre-clinical musculoskeletal research
- Offers a comprehensive analysis of in vivo models for studying different components of the musculoskeletal system
- Demonstrates how principles of structural, functional, and numerical biomechanics can be utilized in well-defined experimental research studies – spanning topics from fracture fixation to gait analysis to bone remodeling
- Covers the role of new macroscopic CT and ultrasound imaging techniques for assessing bone and cartilage functions
- Explores cutting-edge developments in cell culture research, molecular testing, and tissue engineering
- Provides practical advice, a glossary of key terminology, and hundreds of illustrations to familiarize clinicians with every aspect of designing and interpreting an effective research study.

With **54 chapters** by orthopedic surgeons, physicians, biologists, bioengineers, physicists, and mathematicians, Experimental Research Methods in Orthopedics and Trauma is intended to become the authoritative reference on this topic.

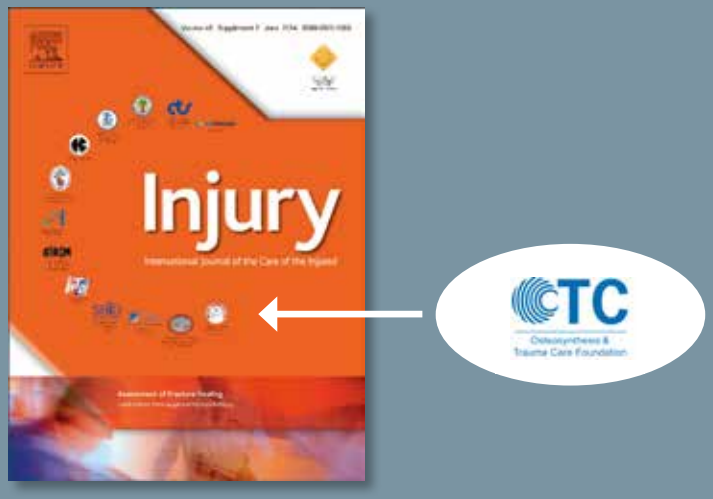
The OTC Foundation, it's Research Committee, and OTC Chapters with research interests will use this textbook as the basis for workshops, training courses, and other educational events. This program was started at the Congress of the German Society for Biomechanics, Bonn, 6-8 May 2015, where chapter authors presented material from biomechanics chapters of the book to a workshop of 90 participants.

Translational Research Program
From Science to Practice 2012-2014

AFFILIATION BETWEEN OTC FOUNDATION AND THE JOURNAL INJURY

The **publications program of the OTC Research Committee (RECO)** was put on a continuous and sustainable basis in March 2015 through formal affiliation with the journal **INJURY** issued by Elsevier publisher. Under this agreement RECO will be responsible for coordinating the publication of one extra issue of the journal INJURY as a supplement every year. This will allow to publish the results of the annual hot topic workshops on a corresponding schedule. Furthermore, INJURY has thus become the "house journal" of the **OTC Foundation.**

One such supplement has been published already emanating from the 2011 and 2012 workshops. The next supplements will address fragility fractures, first biological aspects then biomechanical aspects. Cooperation on research-related issues with other organizations include also The International Society for Fracture Repair (ISFR), the Fragility Fracture Network (FFN), and the Foundation for Orthopedic Trauma (FOT).

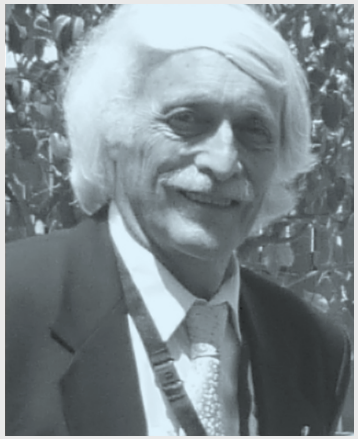


Research at OTC Foundation
Outlook into the Future

HISTORY AND FUTURE OF THE OTCF RESEARCH PROGRAM
Publication of the textbook on experimental research in 2015 constitutes the most prominent milestone in the lifetime of the Research Committee (RECO). All members have contributed substantively and together shaped this work over the years 2012 to 2014, marking the **Ten-Year Anniversary of Research at OTC Foundation.** At the same time the new chapter of translational research, ranging from basic science and biomechanical experiments to pre-clinical studies, is being opened on a sound scientific basis by providing the much awaited methodology guidance. The OTC Foundation, its research arm RECO, and the R&D colleagues at the grantor, will continue jointly to shape and support scientific advances in orthopaedics and trauma care research.

Congratulations to the Research Committee for the twenty-fifth session in its ten years history!

Athens, June 10th 2015



RICHARD HELMER
General Manager
OTC Foundation

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Research at OTC Foundation
Outlook into the Future

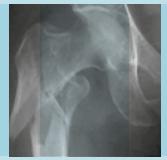
25th Session of the Research Committee at Hilton, Athens, 10th June 2015

CELEBRATING TEN YEARS RESEARCH AT OTC FOUNDATION ON LYCABETTUS HILL, ATHENS, 9TH JUNE 2015

10 Years

www.otcfoundation.org

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