



Ludwig Boltzmann Institute
Clinical Forensic Imaging

ANNUAL REPORT

2013

1. OVERVIEW OF THE LUDWIG BOLTZMANN INSTITUTE FOR CLINICAL-FORENSIC IMAGING.....	3
1.1 AIMS.....	3
1.2 QUANTITY STRUCTURE	4
1.3 INSTITUTIONAL PARTNERS.....	5
1.4 SUPERVISORY BOARD UND SCIENTIFIC ADVISORY BOARD.....	7
1.4.1 <i>Supervisory Board</i>	7
1.4.2 <i>Scientific Advisory Board</i>	8
1.5 HUMAN RESOURCES AND DEVELOPMENT	8
1.5.1 <i>Human resources</i>	8
1.5.2 <i>Career development</i>	12
1.5.3 <i>Team events</i>	15
1.6 INFRASTRUCTURE	15
1.7 HIGHLIGHTS OF THE YEAR.....	16
1.8 PUBLIC RELATIONS.....	17
1.8.1 <i>Media contacts and reports</i>	17
1.8.2 <i>Public presentations</i>	18
2. RESEARCH PROGRAM AND RESULTS	20
2.1 PROJECTS.....	20
2.1.1 <i>Hematomas and other soft tissue injuries</i>	20
2.1.2 <i>Forensic aspects of traumatic brain injury</i>	22
2.1.3 <i>Radiologic evidence in forensic reconstruction and age estimation</i>	23
2.1.4 <i>Computer-aided tools for forensic case analysis: preparation and presentation</i>	27
2.1.5 <i>Juridical issues of radiological methods in clinical forensic medicine</i>	29
2.1.6 <i>Clinical Forensic Care Unit</i>	30
2.2 PUBLICATIONS	32
2.2.1 <i>Publication policies and intellectual property rights</i>	32
2.2.2 <i>Publications</i>	32
2.3 PARTICIPATION IN SCIENTIFIC CONFERENCES.....	33
3. OTHER ACTIVITIES	34
3.1 COOPERATIONS	34
3.1.1 <i>Scientific cooperations</i>	34
3.1.2 <i>Non-scientific cooperations</i>	36
3.1.3 <i>Third party projects</i>	37
3.2 MEMBERSHIP IN SCIENTIFIC ASSOCIATIONS.....	38
3.3 LECTURE SERIES AND WORKSHOPS.....	39
3.4 TEACHING AND TRAINING ACTIVITIES.....	40
3.4.1 <i>Teaching activities</i>	40
3.5 REVIEWING ACTIVITIES	43

4.	OUTLOOK.....	44
5.	LIST OF PUBLICATIONS	45
5.1	PEER-REVIEWED PAPERS	45
5.2	BOOKS, BOOK CHAPTERS AND OTHER PUBLICATIONS.....	45
5.3	ABSTRACTS AND CONFERENCE PRESENTATIONS	46
5.4	DIPLOMA, BACHELOR, AND MASTER THESES.....	48

1. Overview of the Ludwig Boltzmann Institute for Clinical-Forensic Imaging

1.1 Aims

The main goals of the LBI-CFI are:

1. to undertake specific studies to form a scientific basis for the routine application of radiological methods in clinical forensic medicine; and
2. to establish a juridical basis for the implementation of clinical forensic imaging (CFI) in the routine forensic examination of living persons.

Ad 1)

Objectives regarding the establishment of a foundation for clinical forensic imaging are pursued relying on the dedication of all team members. Based on an interdisciplinary discussion of the studies and their current state at regular meetings, the different research areas constantly grow together to form a coherent entity.

Ad 2)

To ensure the interaction of juridical research with the routine forensic work of the Clinical-Forensic Care Unit (CFCU), one member of the law team is present at the daily meetings of the CFCU team where all examined cases are presented. Additionally, specific legal questions regarding clinical forensic examinations are discussed, helping direct the juridical research towards a focus on practical issues.

Generally, the research strategy of the LBI-CFI includes:

1. Daily case work in forensic medicine and, particularly, clinical forensic medicine as a basis for the definition of the areas of research and specific research questions
2. Logical and systematic approach to scientific questions aimed at increasing knowledge and understanding in the different areas of research
3. Hypothesis driven and mainly prospective study design with clear objectives regarding the methodology of data analysis
4. Ethical correctness at all study stages, and the approval of studies by the local ethics committee
5. Encouragement and promotion of the scientific and personal skills of young researchers concerning posing of scientific questions, study design, study performance, and data analysis, as well as in relation to scientific writing and presentation of results
6. Backflow of the achieved study results into routine forensic work and instructing institutions such as prosecution authorities

1.2 Quantity structure

Finances

Table 1 presents an overview of the 2013 finances. The income consisting of cash and in kind contributions from the LBG GmbH and institutional partners was approximately 1,59 Mio Euros. Expenses amounted to about 1,41 Mio Euros (cash and in kind contributions).

Finances	2013
Income	1,590,695
<i>Personnel</i>	1,005,866
<i>Material expenses</i>	156,516
<i>Research expenses</i>	247,229
<i>Assets</i>	4,417
Expenses in total (EUR)	1,414,028

Table 1: Financial overview 2013

Human resources

Table 2 shows an overview of the team at the LBI-CFI.

Staff (31.12.2013)	Head Count		Fulltime Equivalents	
	Total	Women	Total	Women
Management & Key Researchers	6	3	5,1	2,6
Medical Doctors	6	4	5,8	3,8
Law & Criminalistics	4	3	3,3	2,9
Computer Graphics & MR Physics	3	0	3	0
Administrative & Technical Staff	3	2	2,5	1,5
Total	22,0	12,0	19,7	10,8

Table 2: Overview of human resources 2013

1.3 Institutional partners



Medical University of Graz

The Medical University of Graz (MUG) is one of four medical universities in Austria. Their strategic interest in supporting the LBI-CFI is founded on aims to enhance the Institute of Forensic Medicine and to obtain new infrastructural possibilities in the field of forensic, pathologic and anatomic imaging, particularly for research purposes. Five years after its establishment, the LBI-CFI has acquired a wealth of technical expertise and project experience, and its staff works as a nucleus in the field of forensic imaging at the MUG.

The role of the MUG in the LBI-CFI is to offer availability of the research cases together with the Superior Court of Appeal of Styria and Carinthia, and to provide infrastructure.

SIEMENS

Siemens AG Österreich

Siemens AG is one of the world's largest suppliers of the healthcare industry. In helping reach research targets, Siemens is primarily involved in the technical and methodological aspects of the research. The main strategic interest of Siemens for the participation in the LBI-CFI is the chance to enhance creative and strategic solutions in a new and - to date - undeveloped field. By participating in and supporting the research of the LBI-CFI Siemens gets a unique opportunity in this market.

Their role in the LBI-CFI is to support research in the field of forensic imaging by contributing expertise in different areas.



Karl-Franzens-University of Graz

The Institute of Criminal Law, Criminal Law Procedure and Criminology of the Karl-Franzens-University of Graz (KFUG) provides the scientific background for a legal framework in which the validity and applicability of forensic radiological imaging as evidence in criminal procedures can be evaluated. A long-term accompanying study evaluates stepwise the expected advantages of modern imaging techniques as evidence in legal procedures. Therefore, the close cooperation between forensic medical doctors, prosecutors and judges from the Superior Court of Appeal of Styria and Carinthia (OLG) is of primary importance. One of the basic scopes of this partner is to participate in national and international scientific research and discussions about criminal law and criminal law procedures. The partnership

with the LBI-CFI allows this partner to influence the development and implementation process with respect to possible legal implications from the beginning.

Their role is to support the evaluation of the impact of clinical forensic imaging in routine juridical work in national and international legal systems, and to support the LBI-CFI in the evaluation of the advantages and disadvantages of imaging techniques in criminal proceedings.



Superior Court of Appeal of Styria and Carinthia

Commissioning forensic expert opinions weeks or months after an incident makes the forensic assessment difficult. The OLG and the BMJ support the LBI-CFI with the aim of ensuring that the LBI-CFI is commissioned and integrated as early as possible into clinical forensic cases in Styria and Carinthia to be able to conduct the planned studies. Their strategic interest is to improve the evidence situation based on a complete collection of findings and objective documentation. Moreover, their intention is to reduce the length of legal proceedings and revisions, and, therefore, to reduce costs.

Their role is to cover the users' perspectives, to provide knowledge of legal proceedings, to grant access to court files, and to support the application of clinical forensic imaging in the investigation procedure. The OLG and the BMJ do not dispose of funds to directly finance research.



UniversitätsKlinikum Heidelberg

Heidelberg University Hospital

The University of Heidelberg along with its Institute of Forensic and Traffic Medicine with its chair Professor Dr. Kathrin Yen, the former director of the LBI-CFI, is a partner of the LBI-CFI since 2012. It aims to cooperate with the LBI-CFI to implement its research program, particularly in post-mortem studies where a direct validation of imaging findings is possible. The results of these studies are invaluable as a basis of knowledge and experience in forensic imaging generally, and specifically for the implementation of radiological imaging in living victims.

Their role is to perform post-mortem forensic imaging studies in close cooperation with the LBI-CFI by taking advantage of its specific infrastructure.

Bundesministerium für Inneres

Since June 2013 the Ministry of Internal Affairs is a new partner of the LBI-CFI. Specifically, the support from the Ministry will allow a study concerning 'Injury Documentation' to be undertaken. Additionally, the Ministry will provide expert advice regarding digital communication and compliance with data protection legislation for the transfer of forensic and/or sensitive data. At a press conference on November 22nd 2013, the new partnership between the Ministry of Internal Affairs and the LBI-CFI was announced by the Minister herself, Mag. Johanna Mikl-Leitner and the Director of the Institute, Dr. Eva Scheurer.



© BMI / A. Tuma

1.4 Supervisory Board und Scientific Advisory Board

1.4.1 Supervisory Board

The Supervisory Board of the LBI-CFI consists of representatives from the six partner institutions (MUG, Siemens, KFUG, OLG, University of Heidelberg and BMI) and the management of the LBG GmbH. The Board monitors the performance of the LBI-CFI, but also allows the partners to make suggestions, to decide together and to commission the director of the LBI-CFI with the implementation of the decisions. Equally, the director can submit proposals or change requests, which are then decided upon by the Board.

The members of the Supervisory Board are:

- Vizerektorin Univ.Prof. Dr. Irmgard Lippe (Medical University Graz) as chair
- Mag. Gerd Obetzhofer (Oberlandesgericht Graz)
- Vizerektor Univ.Prof. Dr. Martin Polaschek (Karl-Franzens University Graz)
- Prof. Dr. Kathrin Yen (Universitätsklinikum Heidelberg)
- Generalmajor Gerhard Lang (Bundesministerium für Inneres)
- Mag. Claudia Lingner (Ludwig Boltzmann Gesellschaft GmbH)
- Dr. Erich Heiss (Ludwig Boltzmann Gesellschaft GmbH)
- Dr. Peter Mayrhofer (Ludwig Boltzmann Gesellschaft GmbH)

Siemens AG Österreich has decided, temporarily not to be represented in the Supervisory Board.

Supervisory Board meetings took place on 13.03.2013 and 12.12.2013 at the Institute in Graz.

1.4.2 Scientific Advisory Board

The Scientific Advisory Board consists of 5 experts representing the different disciplines covered by the LBI-CFI and the management of the LBG GmbH.

The members of the Scientific Advisory Board are:

- Univ.Prof. Dr. Walter Bär (Institut für Rechtsmedizin der Universität Zürich) as chair
- Prof. Dr. Dorothee Auer (University of Nottingham, Queen's Medical Centre Campus)
- Univ.Prof. Dr. Hansjürgen Bratzke (Zentrum der Rechtsmedizin der Johann Wolfgang Goethe Universität Frankfurt am Main)
- Univ.Prof. Dr. Karl-Olof Lövblad (HCUG, Unité de Neuroradiologie, Geneva)
- Prof. Dr. Gustav Strijkers (Department of Biomedical Engineering, Eindhoven University of Technology)

The Scientific Advisory Board meeting took place on 11.12.2013 at the LBI-CFI in Graz.

1.5 Human resources and development

1.5.1 Human resources

Human resources of the LBI consist of a director and a deputy director, both acting also as key researchers in forensic medicine and law, respectively, four key researchers covering scientific management, radiology and computer graphics with responsibility for the work in their research areas, 12 researchers with various educational backgrounds (i.e. forensic medicine, radiology, biology, forensic sciences, chemistry, physics & engineering, law and

IT), two team assistants for the administrative support and one technologist for performing the radiologic scans. All employees are located in Graz.



© B. Bergmann

The staff is organized in four content-based teams:

1. The team Forensic Medicine I covers the two research areas “hematomas and other injury of soft tissues” and “traumatic brain injury” and consists of one key researcher (Eva Scheurer) and five researchers in forensic medicine, MR physics and criminalistics.
2. The team Forensic Medicine II is responsible for the research area “radiologic evidence in forensic reconstruction and age estimation” and consists of one radiological key researcher (Thomas Ehammer), one scientific key researcher (Sylvia Scheicher) as well as five researchers in forensic medicine and radiology.
3. The team Computer Graphics is responsible for the research area “computer-aided tools for forensic Case Analysis: Preparation and Presentation” and consists of two key researchers in computer graphics (Alexander Bornik und Martin Urschler) and one researcher in 3D modelling.



© B. Bergmann

4. The team Law is responsible for the research area “juridical issues of radiological methods in clinical forensic medicine” and consists of one key researcher (Reingard Riener-Hofer), one researcher and one expert in law.

The radiologic technologist and two team assistants do not belong to a specific research team, but support all teams by taking responsibility for efficient organizational and administrative processes.



© B. Bergmann

In 2013 the LBI-CFI consisted of the following 24 employees (see overview in Table 3).

	Function	Entrance date	Exit date	Remarks
Management & Key Researchers				
Scheurer Eva	Director, Key Researcher Forensic Medicine & Physics	09.05.2008		
Riener-Hofer Reingard	Deputy Director, Key Researcher Law	01.03.2010		
Dahlmann Felicitas	Key Researcher Forensic Medicine	23.04.2012	31.05.2013	
Ehammer Thomas	Key Researcher Radiology	01.11.2010		
Bornik Alexander	Key Researcher, Visualization Specialist	01.12.2008		
Urschler Martin	Key Researcher, Segmentation Specialist	01.12.2008		
Scheicher Sylvia	Senior Scientist / Scientific Editor Key Researcher	10.12.2013		
Medical Doctors				
Grassegger Sabine	Researcher Radiology	02.04.2012		
Kauderer Clemens	Researcher, General Practitioner	01.12.2012		
Klasinc Isabella	Researcher, General Practitioner	15.10.2012		
Krebs Nikolaus	Researcher, Resident Forensic Medicine	01.10.2008		Parental leave from 27.02.2013 to 26.04.2013
Ogris Kathrin	Doctoral Student, Resident Forensic Medicine	02.05.2012		
Tamegger-Jelinek Nathalie-Belin	General Practitioner	01.02.2010 30.09.2013	30.04.2013	Clinical-Forensic Care Unit, Maternity leave from 16.04.2012 to 31.01.2013
Law & Criminalistics				
Hesterberg Silja	Doctoral Student Biology	03.01.2013		
Kainz Simone	Doctoral Candidate Law	01.04.2011		
Schick Peter	Scientific Expert Law	01.10.2008		Em. Professor at KFU Graz
Webb Bridgette	Researcher Criminalistics	01.06.2013		
Computer Graphics & MR Physics				
Höller Johannes	Researcher, 3D Modelling	15.11.2010		
Neumayer Bernhard	Doctoral Student MR Physics	16.01.2012		
Petrovic Andreas	Doctoral Student MR Physics	06.07.2009		

Administrative and Technical Staff			
Brandl Elisabeth	Executive Teamassistant	01.08.2013	Maternity leave substitution
Habersatter Stefanie	Teamassistant	13.04.2010	Maternity leave since 16.09.2011
Reisner Evelyn	Executive Teamassistant	01.10.2008	Maternity leave since 11.10.2013
Schachner Silvia	Teamassistant	14.03.2011	Maternity leave substitution
Widek Thomas	Technologist, Radiology	03.05.2011	

Table 3: Overview of staff in 2013

- Nathalie-Belin Tamegger-Jelinek took her maternity leave from 16.04.2012 to 31.01.2013 with a subsequent minor employment at the Clinical-Forensic Care Unit until 30.04.2013. In October 2013 she came back for an 80% part time employment.
- Silja Hesterberg joined the LBI-CFI in January as a doctoral student at the MUG.
- Nikolaus Krebs was on parental leave from 27.02.2013 to 26.04.2013.
- Felicitas Dahlmann left the LBI-CFI at the end of May 2013 to work at the University Jena / Germany.
- Bridgette Webb was set as a fixed Associate from June 2013.
- Elisabeth Brandl joined the LBI-CFI in August 2013 as maternity leave substitution for Evelyn Reisner.
- Evelyn Reisner takes her maternity leave since October 2013.
- Sylvia Scheicher joined the LBI-CFI in December 2013 as a key researcher and senior scientist / scientific editor.

1.5.2 Career development

Internal education and training

Concerning continuing education and training of the researchers of the LBI-CFI, Journal club meetings of all researchers with presentations of current scientific papers and discussion (29.01.2013, 06.03.2013, 16.07.2013, 24.09.2013, 27.11.2013, 17.12.2013) were organized in 2013.

At the beginning of 2013 the director held review meetings with all employees to position and discuss individual career development.

In regular fortnightly meetings, the entire team of the LBI-CFI meets to exchange information regarding the current state and recent developments of their research, as well as for an interdisciplinary discussion of their studies to ensure optimal communication and cooperation between the researchers.

Daily morning meetings are held for all team members concerned with the Clinical Forensic Care Unit. Here, all examined cases are presented including the demonstration of photographs taken of characteristic morphologic findings. Additionally, any legal questions of the forensic medical doctors regarding clinical forensic examinations are discussed with the member of the law team present.

External education and training

Team members of the LBI-CFI regularly participate in educational lectures and meetings, PhD and diploma presentations as well as workshops of Graz University of Technology and Medical University Graz, and in the context of scientific conventions (e.g., at ISMRM, ISALM, ESMRMB).

Examples of externally organized activities with educational aspects, in which researchers of the LBI-CFI participated during 2013, are:

- “Medizinische Forschung am Menschen (Rechtliche Rahmenbedingungen), organized by ARS, Wien (18.03.2013)
- “15. Doktorandentraining der Deutschen Sektion der ISMRM e.V. – Translationale MR-Forschung – Von Mäusen und gesunden Probanden zum Patienten”, Münster (18.03. – 20.03.2013)
- Lecture on “DNA-Angelegenheiten”, organized by Landespolizeidirektion Steiermark, Graz (03.04.2013)
- “Aufbau Forschung: Statistik Grundlagen”, organized by the MUG, Graz (16.04.2013)
- “Basismodul: Lehren an der Med Uni Graz: Abläufe und AnsprechpartnerInnen”, organized by the MUG, Graz (07.06.2013)
- “Projektmanagement auf der methodischen Grundlage des Systems Engineering”, organized by Univ. Prof. Dr. Reinhard Haberfellner, Graz (17.06. – 19.06.2013)
- “Grundlagen effektiven Zeitmanagements”, organized by TU Graz (24.06. – 12.07.2013)
- Führungskräfteworkshop, organized by the LBG, Reichenau an der Rax (25.06. – 27.06.2013)



© LBG

- “Suggestionsfreie Gesprächsführung”, organized by Arbeitsgruppe Klinische Rechtsmedizin der DGRM, Saarbrücken (17.09.2013)
- “Aufbau Forschung: Statistik Aufbau”, organized by the MUG, Graz (30.09.2013)
- “Basismodul: Forschung an der MUG – Abläufe und AnsprechpartnerInnen”, organized by the MUG, Graz (16.10.2013)
- “Arbeiten mit Journal Clubs”, organized by the MUG, Graz (22.10.2013)
- “Aufbau Forschung: Good Scientific Practice”, organized by the MUG, Graz (23.10.2013)
- Workshop “Gefahren im Internet”, organized by Kriminalistische Studiengesellschaft, Graz (23.10.2013)
- “Unterweisung Biologische Arbeitsstoffe auf Grundlage der Verordnung biologischer Arbeitsstoffe”, organized by the MUG, Graz (28.10.2013)
- “Aufbau Lehre: Professionelle Hochschuldidaktik”, organized by the MUG, Graz (08.11.2013)
- Workshop “International Training for Radiographers in Forensic Radiology”, organized by Fumedita, Lausanne (11.11. – 12.11.2013)
- Lecture “Rechtliche Fallstricke für Gesundheitsberufe”, organized by the MUG, Graz (20.11.2013)
- “Medizinrechtlicher Nachmittag”, organized by Netzwerk Risikomanagement Österreich, Loipersdorf (20.11.2013)
- “Führen und Delegieren”, organized by TU Graz, Graz (24.11. – 29.11.2013)
- “Horizon2020-Infotag”, organized by the FFG, Graz (27.11.2013)
- Lectures at the Doctoral School of Electrical Engineering-Biomedical Engineering, organized by the TU Graz, Graz (during the year)

1.5.3 Team events

In 2013 the birthdays of the team members were celebrated at birthday lunches which took place every 3 months.

The habilitation of Eva Scheurer was celebrated at the LBI-CFI with prosecco and crisps in March 2013.



© MUG

The LBI-CFI Christmas dinner took place on 12.12.2013 at the Restaurant “Der Steirer” in Graz, where the team enjoyed an excellent traditional meal and celebrated the end of a successful and interesting year.

1.6 Infrastructure

The institute is located on the second floor of Universitätsplatz 4 neighbouring the Institute of Forensic Medicine of the Medical University Graz, with which it shares some rooms (e.g., kitchen, examination room, autopsy rooms). A second branch of the institute is located at Elisabethstrasse 27. This second office with workplaces for 5 team members is within walking distance (approx. 7 minutes) from the main office.

The scientific MR and CT scans are performed on scanners at the Department of Radiology, LKH Graz (MRI: 3T TimTrio, Siemens AG, Erlangen, Germany, CT: Sensation 64, Siemens AG, Erlangen, Germany), at the Technical University Graz (MRI: 3T Skyra, Siemens AG) and at the Privatklinik der Kreuzschwestern (CT/MR Zentrum Graz-Geidorf; MRI: 3T Skyra, Siemens AG), where also routine CT scans are performed in age estimation cases. X-rays (only for routine purposes) are performed at the Radiologiepraxis Dr. Uranitsch, Graz.

1.7 Highlights of the year

- 14.03.2013: FIRM-Aktuell event entitled “Klinische Rechtsmedizin – Gegenwart und Zukunft“



- 12.06.2013: Institute's 5 Year Anniversary Celebration
- 12.09.2013: Kick-off Event “Das klinisch-forensische Netzwerk Steiermark – CSI in Österreich?”



- 01.10.2013: Appointment of PD Dr. Eva Scheurer as a Board Member of the ESMRMB
- 22.11.2013: Official execution of the new partnership agreement with the BMI

Another highlight in 2013 was the LBI-CFI lecture series "The interdisciplinary world of forensic imaging" where we invited nationally and internationally renowned speakers to speak about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support. In 2013, the six lectures were given by Bakk. rer. nat. MSc. Vera Muschett (Graz, Austria), Prof. Dr. Gustav J. Strijkers (Eindhoven; Netherlands), Dr. Silke Grabherr (Lausanne, Switzerland), Prof. Dr. Richard Dirnhofer (Bern, Switzerland), Dr. Peter Schaden (Graz, Austria), Prof. Dr. Jürgen R. Reichenbach (Jena, Germany) (details see section 3.3). The lectures attracted an interdisciplinary and very interested audience. The series will be continued next year.

1.8 Public relations

1.8.1 Media contacts and reports

The Ludwig Boltzmann Institute for Clinical-Forensic Imaging received numerous requests for TV and radio interviews as well as for interviews for printed media reports. These requests were accepted whenever possible.

A selection of contributions released to the public is listed below:

- OTS press release about the event „FIRM-Aktuell Veranstaltung zum Thema „Klinische Rechtsmedizin – Gegenwart und Zukunft“ on 14.03.2013 entitled „Klinische Rechtsmedizin und Medizinrecht“, 11.03.2013
- Magazine article entitled „Spuren von Gewalt erkennen“ in „Salzburger Nachrichten“, 19.03.2013
- Magazine article entitled „Diskussion über klinisch-forensische Ambulanzen – Gewalt gehört richtig dokumentiert“ in Medical Tribune, 24.04.2013
- TV report about „5 Jahre Jubiläumsfeier des LBI-CFI“ at „Steiermark Heute“, ORF, 12.06.2013
- Magazine article about the anniversary celebration on 12.06.2013, entitled „5 Jahre Jubiläumsfeier des LBI-CFI“ in Kleine Zeitung, 12.06.2013
- TV report about „Klinisch-Forensisches Netzwerk Steiermark“ at „Steiermark Heute“, ORF, 14.09.2013
- Magazine article entitled „Totenruhe“ in „Profil“, 23.09.2013
- Magazine article entitled „Klinisch-Forensische Ambulanz Graz“, in „Öffentliche Sicherheit“, 30.09.2013

- Letter to the editor entitled „Tatzeitnahe Untersuchung zu: Wenn man schreien will, aber kein Ton kommt“ in „Die Presse“, 20.10.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „Magnetresonanz soll Gewalt nachweisen“, in „Die Presse“, 23.11.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „Grazer Institut soll Gewaltspuren sichtbar machen“, in „Kleine Zeitung“, 23.11.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „Hightech macht Gewalt sichtbar“, in „Kronen Zeitung“, 23.11.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „Gewaltdelikte bald länger nachweisbar“, in „Kurier“, 23.11.2013
- Magazine article about the partnership between BMI und LBI-CFI, entitled „Bessere Aufklärung von Gewalt-Verletzungen“, in „Österreich“, 23.11.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „3D-Modell überführt Gewalttäter“, in „Salzburger Nachrichten“, 23.11.2013
- Magazine article about the partnership between BMI and LBI-CFI, entitled „Verletzungen sichtbar machen“ in „BMI Kommunal“, Winter 2013

1.8.2 Public presentations

The scientific work and other activities of the LBI-CFI were presented to the non-scientific public at the following research exhibitions:

14.03.2013: FIRM-Aktuell Event zum Thema „Klinische Rechtsmedizin – Gegenwart und Zukunft“

12.06.2013: Institute's 5 Year Anniversary Celebration

28.06.2013: Family afternoon: 3D scan with Einstein junior in Graz:

The Einstein junior children's afternoon „3D-Scan with Einstein Junior“ took place in cooperation with the Kinderbüro in Graz. Children from 8-12 years were invited to solve a criminal case using different forensic methods, while their parents listened to the presentation of Eva Scheurer on forensic imaging. Additionally, the young researchers were given the opportunity to get a 3D-surface scan of themselves or of their favourite stuffed animal. By request this 3D scans were sent to the children and their parents. The children's afternoon was a great success amongst both young and old.

12.09.2013: Kick-off Event "Das klinisch-forensische Netzwerk Steiermark – CSI in Österreich?"



© M. Wiesner

22.11.2013: Family day: "Forensische Altersschätzung mit Einstein Junior" in Graz



2. Research program and results

2.1 Projects

The research program of the LBI-CFI during the year 2013 was conducted within five main key areas, each comprising different studies, which are briefly described in the following sections.

Across all studies, some of which were conducted in parallel, a total of 120 MRI scans of living and deceased subjects were made. Table 4 shows an overview of the studies in which MRI scans were performed.

MRI	2013
MRS subcutaneous fatty tissue	5
Correlation of internal and external findings (Marker)	12
Fracture dating using MRI	1
Traumatic brain injury	7
Strangulation study	12
MRS lumbal spine (Reproducibility / Age estimation)	66
Age estimation using MRI	17
Total	120

Table 4: Overview of research MRI scans 2013

2.1.1 Hematomas and other soft tissue injuries

Artificial hematomas in subcutaneous fatty tissue of living volunteers

First results showed that the contrast of hematomas in MRI could be used to obtain objective information on hematoma characteristics of injected blood volumes in the subcutaneous fatty tissue of healthy living volunteers longitudinally over 2 weeks. The aim of further data evaluation was to explore factors influencing the contrast of subcutaneous hematomas in order to date traumatic lesions for the forensic reconstruction of events using MRI.

In 20 healthy volunteers, 4 ml of freshly drawn autologous blood was injected into the subcutaneous fatty tissue of the thigh after a preliminary MRI scan. The artificial hematoma was scanned repetitively at different points in time (directly after the injection and 3h, 24h,

3d, 7d and 14d after the injection). All measurements were performed on a 3T scanner. A visual evaluation of the artificial hematomas and lobular structure of the fatty tissue was performed, and the thickness of the subcutaneous fatty tissue was measured.

The outcome will be further investigated in a larger group of volunteers (planned 1st half 2014), however, these results already suggest that influential factors, such as hematoma shape, fatty tissue structure and hematoma regeneration must be taken into account in order to reliably assess the age of bruises for forensic reconstruction.

Peer-reviewed journal papers

- Neumayer B, Hassler E, Petrovic A, Widek T, Ogris K, Scheurer E. Age determination of soft tissue hematomas. *NMR Biomed*, under revision

Currently in work:

- Hassler E, Ogris K, Petrovic A, Neumayer B, Widek T, Yen K, Scheurer E. Characterization of artificial subcutaneous hematomas using MRI. *Int J Legal Med*

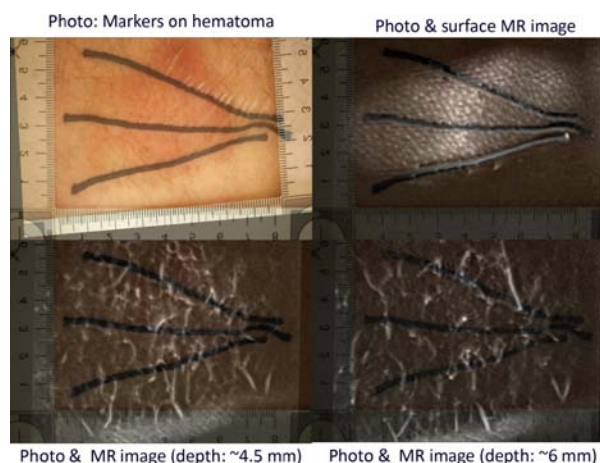
Abstracts / Proceedings:

- Neumayer B, Hassler E, Widek T, Ogris K, Scheurer E. Age Estimation of Soft Tissue Hematomas. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, Proc Intl Soc Mag Reson Med (2013). [E-Poster]
- Petrovic A, Diwokoy C, Hassler E, Ogris K, Scheurer E. IDEAL fat-water separation for the detection and characterization of soft tissue hematomas. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, Proc Intl Soc Mag Reson Med (2013). [Poster]
- Petrovic A, Schweser F, Deistung A, Scheurer E, Reichenbach JR. Longitudinal investigation of diffuse hemorrhagic lesions using Quantitative Susceptibility Mapping (QSM). 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, Proc Intl Soc Mag Reson Med (2013). [Poster]

Correlation of photographs and MRI data using fiducial markers

This completed study was undertaken in two consecutive phases, an *ex vivo* phase followed by an *in vivo* phase.

The objective of the *ex vivo* study was to investigate the visibility of a strand-shaped fiducial marker in MRI, macroscopic photography and histopathology with the aim of correlating images across these modalities. Eight samples of porcine tissue were examined and the correlation of a specific MR image with a given histology slice was possible. This study demonstrated that the



markers examined are visible in macroscopic photography, histology and MRI, providing a way in which results from these modalities can be combined. This has a possible application in the registration of histology results and MR images in the post-mortem investigation of subcutaneous hematomas. Additionally, this study provided guidance for the subsequently undertaken *in vivo* study.

The objective of the *in vivo* study was to improve the detection and documentation of subcutaneous hematomas in living persons by developing and evaluating a set of external strand-shaped markers. Ten volunteers with at least one bruise on their upper leg were examined. Cotton-oil based markers were secured by a transparent medical patch, and were documented using photography and 3T MRI in oblique and transversal orientations. Results demonstrated the excellent visibility of markers and lesions in both modalities as well as an absence of artefacts for all volunteers. Photographs and oblique MR images obtained at the skin surface were registered to MR images which had been acquired deeper in the subcutaneous tissue. The overall accuracy of the technique was evaluated by examining the root-mean-square error (RMSE) of the registration across all volunteers. An accurate co-visualisation of external characteristics such as the size, colour and contours of the bruise in addition to the internal characteristics including depth and the extent of underlying tissue damage was possible.

Conferences

- Webb B, Petrovic A, Scheurer E. Correlation of Macroscopic and Histopathologic Findings with MRI in Forensic Examinations, BMT 2013, Dreiländertagung der Deutschen, Schweizerischen und Österreichischen Gesellschaft für Biomedizinische Technik, Graz, 19.-21. Sept. 2013. [oral presentation]

2.1.2 Forensic aspects of traumatic brain injury

Postmortem study of blunt head trauma findings using MRI and macro- and microscopic analysis

Introduction:

The aim of this study is to detect specific differences in terms of MRI-detectable traumatic lesions between a group of subjects with blunt head trauma and a control group without. This project is based on diffusion weighted (DWI) and susceptibility weighted (SWI) MRI. DWI and diffusion tensor imaging (DTI) are used as a means to probe myelin integrity and, therefore, seem especially useful to gain information about the nerve fibre status in traumatic brain injury (TBI). SWI is suited for detecting very small intracerebral hemorrhages (<3 mm) with high resolution and, thus, can be used for imaging contusional bleedings. The rupture of nerve fibers leads to a rapid loss of white matter tissue which may even be paralleled by iron deposition. Abnormally high iron deposition in the human brain has been shown to play a role in several neurological disorders and is linked to the process of neurodegeneration.

However, to date this has barely been investigated as a possible consequence of traumatic brain injury.

Materials and Methods:

In situ 3T MR brain scans of deceased subjects are performed. Thereafter, whole brains are fixed in formalin and are then investigated again by MRI. Tissue specimens are taken from prespecified white and gray matter regions for microscopic examination and chemical determination of trace element concentrations (iron, calcium, zinc and others). In 2013, high resolution DWI was implemented into the scan protocol.

Results / state of research:

Results show significant differences of mean diffusivity values and the magnetization transfer ratio in all sub-cortical white matter regions in the TBI group. Quantitative measurements revealed that iron is the dominant contributor to magnetic susceptibility in gray matter tissue. In white matter regions myelin content and iron are negatively correlated. However, both myelin and iron impact the effective transverse relaxation rate $R2^*$ significantly. Preliminary data analysis demonstrates a better detection rate for local contusion findings and microbleedings by macroscopic examination but a larger range and a higher number of clinically relevant findings by radiologic evaluation.

The pilot study for estimating magnetic relaxation ($T1$, $T2$, $T2^*$) using a Superconducting Quantum Interference Device (SQUID) in combination with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was approved by the review board of the Medical University Graz. Reference measurements of solutions with different iron concentrations resulted in divergent concentration values and did not show sufficient reproducibility. Therefore, measurements with human brain samples were not performed, and the study was terminated. Currently, additional corpses need to be recruited to complete the intended number of subjects and ensure statistically powerful conclusions. Additionally, the department of pathology has now been included in the recruiting process particularly for the control cases.

2.1.3 Radiologic evidence in forensic reconstruction and age estimation

Detection and forensic interpretation of soft tissue findings in living and post-mortem subjects after strangulation using MRI

Introduction

The diagnosis of strangulation in surviving victims based on objective findings is important in criminal proceedings relating to the assault. The gold standard is an external examination which often shows no signs of injury, despite a credible history of strangulation. The aim of this study is to evaluate the diagnostic performance of a native MRI scan when considering

strangulation and to investigate the value of MRI findings in addition to external injury for the reconstruction of the strangulation incident.

Materials & Methods

Living and deceased victims of strangulation incidents as well as of control groups of living and deceased persons without injury undergo external forensic examination with photo documentation and a native MRI scan of the neck on a 3T scanner. To enhance the informative value of the study the persistence of pathologic findings in living victims are investigated by performing a second MRI scan approximately 1 week after the initial examination. In deceased persons a forensic autopsy with a focus on the neck is performed.

Results / Progress 2013

Initial results showed that the most frequent radiological findings are subcutaneous and intramuscular bleedings or edema. These findings offered additional evidence in cases with only slight external findings. The radiological findings in combination with the external findings led to a high sensitivity and specificity for the diagnosis of strangulation (sensitivity 97%, specificity 100%), but the radiological findings also added important information on the attack and the assailant.

From September 2012 until now, new data from 10 subjects who survived a manual strangulation incident were collected, resulting in a cohort of 32 injured living victims. Furthermore, data collection in non-injured living controls (10) and in deceased non-injured controls (5) was completed. Beyond this, MRI data of 5 subjects deceased due to strangulation were radiologically evaluated and the results compared with autopsy findings. To date, only one victim underwent the second MRI scan. It seems to be difficult to motivate patients to come for a second MRI investigation.

To evaluate the diagnostic potential of MRI in a larger collective of living strangulation victims a multicenter study is planned to be performed. Therefore, an application in cooperation with institutes in Heidelberg (Universitätsklinikum Heidelberg), Hamburg (Universitätsklinikum Hamburg) and Maastricht (Academisch Ziekenhuis Maastricht) was made to the DAPHNE III Funding Programme (EU-wide) in October 2013.

Validation study: forensic age estimation of living persons using MR imaging of wrist, clavicles and wisdom teeth

In addition to an external examination of a person, the gold standard in forensic age estimation is based on the evaluation of an OPG (orthopantomogram, a panoramic dental X-ray), a radiograph of the hand and wrist, and a CT of the clavicles. These methods are associated with radiation exposure - a recurrent issue of public and political debate. An adequate or even better alternative using MRI would be highly appreciated.

The aims of this ongoing study are 1) to investigate all of the information currently used for forensic age estimation in living adolescents in the same individuals and 2) to determine statistically relevant reference values for middle European males which can be used for

forensic age estimation by performing an MRI examination of three body regions in a single session.

Participants undergo a 3T MRI examination of the wisdom teeth, the collar bones and the hand and wrist. The study was approved by the ethics committee. For the evaluation, internationally recognized standards are used. From a long-term point of view, MRI examinations might replace the use of ionizing radiation for the purpose of age estimation.

Results

To date the data of 247 male subjects between 13 and 24 years were collected. Data acquisition for the older age groups is complete. Currently, we are recruiting subjects in the lower age range (13-16 years), where recruiting is more complicated due to informed parental consent required.

Progress 2013

Preliminary results were presented at the 30th Annual Scientific Meeting of the European Society for Magnetic Resonance in Medicine and Biology (ESMRMB) in Toulouse, France, in October 2013.

- Grassegger S, Ehammer T, Widek T, Petrovic A, Baumann P, Scheurer E. Comparison of two methods for the assessment of skeletal age using MRI of the hand. 30th Annual Scientific Meeting of the ESMRMB, Toulouse, 3.-5. Okt. 2013, Proceedings of the 30th Annual Scientific Meeting ESMRMB (2013). [Oral Communication].

In this study the accuracy of two methods of age estimation of the hand and wrist, the Greulich-Pyle method and the Dvorak method, were compared. Data of 60 subjects aged 14 to 19 years (10 subjects/year) were used, and results showed that the Greulich-Pyle method is quite accurate for age estimation while the Dvorak method cannot be recommended due to a great systematic error.

Age Estimation using Magnetic Resonance Spectroscopy of Human Lumbar Vertebrae

The fat content of a human lumbar vertebra increases with age due to a well-established conversion of red to yellow bone marrow which can be measured in vivo using non-invasive magnetic resonance spectroscopy (MRS). In adults, skeletal and dental development used in adolescents for age estimation is completed. However, it may be possible to use the fat content in vertebrae for age estimation at pension age. Thus, the goals of this study are to investigate 1) the reproducibility of MRS measurements within and between individuals and 2) whether the fat content of lumbar vertebrae can be inversely used to determine the age of a person.

The spectroscopy protocol comprises measurements in vertebral bodies L2 and L3 with varying repetition and echo times. Eighteen healthy volunteers between 21 and 43 years were examined 3 times in supine position to investigate reproducibility of the measurements; this measurement was repeated at least one week later for 3 subjects to determine possible

scanner dependent variations. For the age estimation, so far, 3 male volunteers (59.0, 56.3, 67.9 years) were examined. The measured spectra were fit using jMRUI software and corrected for T_1 and T_2 relaxation.

The reproducibility of the results corrected for relaxation decay is very high. The age dependence of the fat fraction, however, is not linear as was expected on the basis of previous studies. Additional parameters like a person's BMI or the relaxation times (a result of the relaxation correction) are expected to increase the accuracy of the age determination. This, of course, will require a higher number of volunteers to evaluate the importance of these additional parameters.

Publications:

- Neumayer B, Petrovic A, Widek T, Boesch C, Scheurer E. Reproducibility of 1H MR Spectroscopy of Human Lumbar Vertebrae at 3 Tesla. 30th Annual Scientific Meeting of the ESMRMB, Toulouse, 3.-5. Okt. 2013, Proceedings of the 30th Annual Scientific Meeting ESMRMB (2013). [e-poster]

Fracture dating using MR-based methods

Especially in cases of suspected physical abuse in children, multiple fractures occur often. In order to differentiate between accidental and inflicted fractures, various characteristics, such as the localization and the type of the fractures need to be considered. Additionally, the time of emergence of a fracture can be decisive in determining a possible perpetrator. To date, fracture dating is based on features of secondary fracture healing visible in X-ray, e.g., the hard callus at the fracture site, which allow a rather rough estimation of the time since the fracture occurred.

The aim of this study is the identification of qualitative and quantitative criteria, which can be seen using MRI during the process of fracture healing and which can possibly be used to determine the age of fractures. Compared to conventional radiology, soft tissues like bone marrow, periosteum, muscle and fat can be better evaluated by radiation-free MRI.

An MRI protocol is currently being finalized in cooperation with Prof. Fritz Schick, Dept. of Experimental Radiology, University of Tübingen. To date the protocol was used for three volunteers with different fractures to test its applicability and to optimize measurement parameters on a 3T scanner (TimTrio, Siemens AG).

The assessment of the different stages during fracture healing is expected to provide a diagnostic scheme to guide forensic radiologists in accurately estimating the date a fracture was caused. Later the study will be expanded to fracture dating in children, adopting the MRI protocol to the needs of younger patients. The outcome of this study is expected to help in investigating child abuse and violence against minors from a forensic point of view in the field of medical imaging and legal medicine.

2.1.4 Computer-aided tools for forensic case analysis: preparation and presentation

Introduction

In accordance with the research program of the past years we have established a number of basic algorithmic techniques and software applications for the planned forensic software toolbox. Our main concern is the processing of forensic findings from photographic and volumetric (MRI/CT) data, and the visualization of forensic findings in the context of easy-to-understand reference models.

Current State & Results

1. Visualization & Interactive Segmentation for Analysis & Presentation

The prototype of the software toolbox, i.e. the generic, interactive segmentation and visualization application has been continuously extended and improved based on feedback and knowledge gained when applying the tool to various cases and datasets. The system has also been introduced to the forensic community at the annual meeting of the German Society of Forensic Medicine in September 2013, based on a number of cases reconstructed using the tool. A journal publication is work in progress.

User feedback and the general trend in user interface design toward touch input devices led to the development of new multi-touch interaction techniques for the forensic software toolbox. These techniques allow users to explore 3D datasets and to perform the most important tasks in reconstruction of comprehensible 3D scenes of the course of events – spatial placement of 3D objects like datasets or 3D models of e.g. weapons – just by using one or multiple fingers on a touch display. Feedback obtained from radiologists and forensic experts is positive. As a long term goal we plan to provide touch based interaction for all tasks demanding it.

Case preparation and presentation leading to integrated 3D visualizations of all the digital data available is very useful in displaying injuries and their connections to the course of events. However, this does not imply that these 3D visualizations are self-explanatory. 3D labels can greatly help in that sense, if they can be automatically placed in a way that supports understanding of the data while avoiding occlusion of important other details. We have come up with a novel method that supports dynamic label placement in our reconstructions.

The work package towards automatic transfer function design was addressed in form of an extended literature survey of transfer function types and design techniques carried out by a Bachelor student (Marlene Vukmanic). This work also resulted in an implementation of one promising method (visibility histograms), which is now available in the software toolbox.

2. Medical Image Analysis

As a part of the interactive segmentation tool, we have continued to improve and refine the interactive image processing tools that are required for the extraction of forensically as well as clinically relevant anatomical structures from MRI and CT data. An important topic that was dealt with in 2013 is machine learning based computer vision approaches for medical image analysis. Machine learning allows supervised and unsupervised modelling of arbitrary

nonlinear input-output functional relations, and may be used for a multitude of applications, e.g. as a feature channel in our interactive 3D segmentation, for automatically learning transfer functions from examples, or for detecting wrist bones in MR images of the hand, as well as estimating the age of subjects from MRI data. One of our research goals is to successfully apply machine learning techniques to 3D data, which requires a lot of computational effort and memory consumption. Therefore, we pursue research in the direction of parallel implementation of these approaches using NVidia CUDA and graphics adapters. A paper on 3D memory efficient integral volumes, which are a basic building block of such methods, has been accepted as a full paper at the Big Data in 3D Computer Vision workshop of the International Conference on Computer Vision in Sydney and was presented there in December 2013.

Our cooperation with the Ludwig Boltzmann Institute for Lung Vascular Research, which has the extraction and analysis of vascular structures as a topic, led to a master thesis of our student Michael Helmberger finished in summer 2013. Our joint work on the implications of the lung vascular structures for pulmonary hypertension lead to a number of conference contributions and full papers including a journal paper for PLOS One. A best paper award was achieved at the MIUA 2013 conference. Currently another master student (Christian Payer) is working on the separation of vascular structures into arterial and venous trees.

Following the suggestions of the previous board meetings, in 2013 we established a project concerning the automatic software based age estimation from MRI data. Dr. Darko Stern has started his employment as a post-doc at the Institute for Computer Graphics and Vision in may 2013, working full-time on the two-year project "YOUTH", funded by the European Union Marie Curie exchange program, which aims at a software based automated age estimation from MRI images of the wrist, clavicle and wisdom teeth. Technically, this work makes heavy use of state of the art machine learning approaches (see above). In addition to the post-doc funding, we have also successfully written a proposal for the city of Graz that allows us to fund a master student (Thomas Ebner), who helps on the software development in this project. A first full paper with results of this project has been accepted for the International Symposium on Biomedical Imaging in Beijing 2014.

3. Patient-specific & Generic 3D Reference Models for Case Presentation & Database

We have continued to work on refining our creation of patient-specific 3D models using structured light scanning. Our Microsoft Kinect setup was heavily used for constructing patient test scans, and we are working on a fixed installation that can be used to scan patients who undergo routine clinical forensic examinations at the clinical forensic care unit. In an evaluation of six software tools for reconstructing models with the Kinect setup, we found that the ReconstructMe software still serves our purposes best in this context. We currently use the Kinect to create scans of humans and a more sophisticated projector/camera structured light setup for detailed scans of small objects. In a first attempt we created a 3D model of a murder weapon from an actual case with this projector/camera setup. A journal paper on the topic of presenting forensic data using 3D models was written and submitted to Forensic Science International, it is currently under revision.

A user survey on the acceptance of 3D models in the forensic environment was established and sent to different parties in legal medicine & law. A first outcome of this survey, which included questions about the acceptance of 3D model based illustrations of forensic findings versus standard 2D drawings, the difference between anonymous and user specific model presentations, as well as the opinion about protection against forgery, was presented at the DGRM 2013.

2.1.5 Juridical issues of radiological methods in clinical forensic medicine

Using the results from the medical and technical studies of the other key areas as a starting point, juridical research examines the implementation of radiological methods and evidence in the Austrian criminal procedure framework. The research activities in this area are inseparable from the forensic routine casework performed by the Clinical-Forensic Care Unit and the results of the other research areas of the LBI-CFI. For advisory purposes, a representative of the juridical team takes part in the daily meetings of the team of doctors responsible for the clinical forensic out-patient clinic.

Based on the interdisciplinary approach of the LBI-CFI there is a close collaboration with our partners, the Institute of Criminal Law, Criminal Law Procedure and Criminology of Graz University and the Superior Court of Appeal of Styria and Carinthia and also with our new partner the Ministry of Internal Affairs. This is reflected in the performed studies as well as in the subjects of the theses performed at the LBI-CFI.

Regular Jour Fixe meetings with representatives from the hospital, police and prosecution helps encouraging the practice oriented analysis of cases. This cooperation between the Medical University of Graz, State Criminal Police, Prosecution Graz and the LBI-CFI delivers interesting starting points for legal research. The cooperation with judges and public prosecutors helps achieve an analysis of court proceedings and demonstrates the progress in the field of clinical forensic methods.

Study „Standortbestimmung der Gerichtsmedizin in Österreich“

In cooperation with the Austrian Ministry of Justice (BMJ) the state of forensic medicine in Austria has been evaluated. Judges and prosecutors had the possibility to fill out an online questionnaire prior to the 16th November 2012. The results are presented in the October issue 2013 of “Österreichische Richterzeitung” (*Kainz/Scheurer/Schick/Riener-Hofer, Standort-bestimmung der Gerichtsmedizin in Österreich, RZ 10/13, 210ff.*)

Vergleichsstudie 2009 – 2012 (LBI Comparative Study 2009 – 2012)

In 2010, the Ludwig Boltzmann Institute for Clinical Forensic Imaging (LBI-CFI) in Graz undertook a study regarding the ‘Significance of forensic medical expert reports in legal adjudication’ at the Graz Regional Criminal Court. The most important outcome from this study was that in 76% of cases concerning bodily harm, the legal judgment was decided without a medical expert opinion. In the framework of this study, a follow-up study had already been planned to investigate if the number of cases involving a clinical forensic expert

changes due to the establishment of the LBI-CFI. Currently, this study which will review the role of clinical forensic experts in legal proceedings concerning bodily harm between 2009 and 2012 is being performed.

2.1.6 Clinical Forensic Care Unit

The first Austrian Forensic Care Unit was established in October 2008 by the Ludwig Boltzmann Institute for Clinical-Forensic Imaging in Graz as a facility of the LBI-CFI together with its institutional partner the Medical University of Graz. The Clinical-Forensic Care Unit offers medico-legal examinations of living persons after incidents of suspected physical or sexual violence, as well as forensic age estimations in living persons, which is a traditional duty of clinical forensic medicine. The medico-legal documentation of injuries after acts of violence helps to improve not only the quality of the medico-legal expert opinion, but also the quality of the juridical decision-making in court by providing a greater legal security.



© B. Bergmann

The service of the Clinical-Forensic Care Unit is available to all persons having suffered physical violence including accidents or sexual violence at no personal costs and independent of whether a report to the police has been made. An on-call service available 24/7 guarantees the availability of a medico-legal examination in the greater Graz area (hospitals, police stations, detention centres, and organizations offering help to victims, etc.) within 35 to 45 minutes. In relation to examinations outside this geographical radius, medico-legal assistance can be given by phone and email to ensure a successful examination by other physicians. Examinations in cases with suspected sexual assault or maltreatment of

adults and children are usually conducted in the corresponding hospital departments in cooperation with a gynaecologist or specialized paediatrician. Additionally, a medical doctor of the LBI is a member of the clinical child protection groups of the Department of Paediatric Medicine and the Department of Paediatric Surgery with weekly meetings and interdisciplinary discussions of suspected child abuse cases. Selected persons examined at the Clinical-Forensic Care Unit, who match the inclusion criteria of current studies of the LBI-CFI are asked if they are willing to participate in the respective study.

The LBI-CFI regularly performs forensic age estimation examinations based on the guidelines issued by the German Working Group on Age Diagnostics (AGFAD). These examinations are an excellent example of applying clinical forensic imaging as a modern tool in forensic medicine. For the enhancement of communication between prosecution, police, clinical and forensic medicine, the Jour Fixe meetings (see section 1.7) provide substantial progress with respect to the optimization of processes for victims of violence. This cooperation between Medical University of Graz, State Criminal Police, Prosecution Graz and the LBI-CFI delivers interesting starting points for the key area of legal research.

Table 5 presents an overview of the cases which have been seen at the Clinical-Forensic Care Unit in 2013. Most age estimations are performed on behalf of the Federal Office for Migration and Refugees; the other cases are examined by order of the Office of Public Prosecution or on a consultation basis for clinicians. In total, for 22% of all cases no financial contributions were received.

Clinical-Forensic Care Unit	2013
Physical violence (against adults > 18 years)	31
Sexual violence (> 18 y)	38
Physical child abuse (< 18 y)	46
Sexual child abuse (< 18 y)	29
Forensic age estimation in living persons	193
Other cases	2
<i>Cases in total</i>	339

Table 5: Overview of the cases seen at the Clinical-Forensic Care Unit 2013



© B. Bergmann

2.2 Publications

2.2.1 Publication policies and intellectual property rights

Regarding publications, rules for the regulation of authorship have been defined according to good scientific practice. These are supervised and executed for each study by the key researcher or the responsible researcher of the corresponding team. Authorships are regulated under consideration of the general principles for author contributions as outlined in the “instructions for authors” of main scientific journals.

The acquired radiological scanning data are owned by the LBI-CFI which is responsible for its acquisition and has to comply with national legal regulations. Requests for the usage of these data for purposes other than scientific or those outlined in the research program are evaluated and decided upon by the Supervisory Board of the LBI-CFI. The whole output of the research activities is published in scientific journals of the various involved scientific areas, complying with the main target of the LBI-CFI to implement clinical forensic imaging in legal practice. The IPR of the institutional partners are handled according to the contract of 2008.

2.2.2 Publications

The scientific output in the form of publications, proceedings and abstracts as well as book chapters (see the complete list of publications in section 5) was positive in 2013. The effort put into evaluation and manuscript preparation will be pursued in 2014.

2.3 Participation in scientific conferences

As a portrayal of the interdisciplinarity of the LBI-CFI, numerous contributions to international scientific meetings and conferences within the scientific communities of forensic medicine, magnetic resonance in medicine, and computer graphics have been made. Overall in 2013, 8 oral presentations and 7 poster presentations were given by researchers of the LBI-CFI.

An overview of the contributions to the different scientific communities 2013 is given here:

Forensic medicine

- Annual Scientific Meeting of the German Association of Forensic Medicine (DGRM), 17.09. – 21.09.2013, Saarbrücken, Germany
4 oral presentations
- XIII. Forensische Gespräche Lübeck, 29.11. – 30.11.2013, Lübeck, Germany
1 oral presentation (invited lecture given by PD Dr. Eva Scheurer)

Magnetic resonance in medicine and biomedical engineering

- Annual Scientific Meeting of the International Society of Magnetic Resonance in Medicine (ISMRM), 20.04. – 26.04.2013, Salt Lake City, Utah (USA)
7 poster presentations
- Dreiländertagung der Deutschen, Schweizerischen und Österreichischen Gesellschaft für Biomedizinische Technik (BMT), 19.09. – 22.09.2013, Graz, Austria
1 oral presentation
- Annual Scientific Meeting of the European Society for Magnetic Resonance in Medicine and Biology (ESMRMB), 03.10. – 05.10.2013, Toulouse, France
1 oral presentation and 1 poster presentation

Computer graphics:

- International Conference on Computer Vision 2013 (IEEE Computer Society), 01.12. – 08.12.2013, Sydney, Australia
1 oral presentation

Additionally, the following meetings and symposia were attended by team members of the LBI-CFI:

23.01.2013	Book Presentation “Korruption und Amtsmissbrauch”, Vienna
25.01.2013	“Die Einrichtung einer Europäischen Staatsanwaltschaft unter Berücksichtigung des gerichtlichen Rechtsschutzes”, Event of the Österr. Gesellschaft für Europäisches Strafrecht, Vienna

12.02.2013	Workshop / Pilot-Training "Bekämpfung des Menschenhandels", Krems
15.03.2013	AGFAD-Meeting, Berlin
15.03.2013	Meeting "Das Kindschafts- und Namensrechts-Änderungsgesetz 2013", Graz
23.05.2013 and 30.10.2013	Club Scientifica Meetings, Graz
17.10. – 19.10.2013	Interdisciplinary Congress "Die Vermessung der Seele – Geltung und Genese der Quantifizierung von Qualia", Graz
02.12.2013	1. LBG Health Sciences Kongress
Quarterly	SIDS-Meeting (Sudden infant death syndrome), Univ. Kinderklinik Graz

3. Other activities

3.1 Cooperations

3.1.1 Scientific cooperations

Scientific collaborations with national and international institutions have been established in the different fields and areas of research of the LBI-CFI. These cooperations are beneficial for both the LBI-CFI and the cooperating institutions, as the conjointly performed studies result in the enhancement of scientific output and in an increase of knowledge in the different fields.

Cooperations with a focus in forensic medicine

In addition to an institutional partnership, a scientific cooperation has been established with the *Institute of Forensic and Traffic Medicine, University of Heidelberg*, directed by Prof. Kathrin Yen, during the past years. This cooperation is intended to support the LBI-CFI particularly for the performance of post-mortem imaging studies. Embedded in this cooperation is a scientific collaboration with the Department of Radiology of the University and University Hospital of Heidelberg.

For the research in dental MRI, a cooperation has been established with Prof. Norbert Jakse, *Department for Oral and Maxillofacial Surgery, Medical University Graz*, Dr. Julian Boldt, *Department for Oral and Maxillofacial Surgery, University of Würzburg*, and Andreas Hopfgartner, *Department for Experimental Physics, University of Würzburg*, as well as with *Dr. Heiko Merkens*, dentist with a private practice in Aachen. The main benefit for all collaborators in this field is the facilitated representation of wisdom teeth and other dental structures by MRI.

Within the research area “traumatic brain injury”, analyses of trace elements in human brain are performed in cooperation with Prof. Walter Goessler, *Department of Chemistry, University of Graz*. The neuroimaging research unit of the *Department of Neurology, Medical University Graz* under the direction of PD Dr. Stefan Ropele and supported by the head of Department, Prof. Franz Fazekas, is specialized in quantitative MRI for assessing brain tissue changes. Myelin integrity, blood and iron are the most notable factors impacting MR relaxation behaviour and MRI contrast and, thus, have to be differentiated when drawing conclusions about the origins of blunt force.

PD DDr. Johannes Haybäck, *Department of Pathology, Medical University Graz*, is our collaborator for the examination of microscopic traumatic changes of white matter tracts and for the detection of iron deposits for the correlation with MRI.

Further good and long standing scientific cooperations exist with:

Prof. Gerhard Ranner and Dr. Gerlinde Komatz, *CT/MR Zentrum Graz*, Prof. Michael Fuchsjäger, *Department of Radiology, Medical University Graz*, who support the LBI-CFI with radiologic reading and interpretation.

Prof. Andrea Berghold and Dr. Franz Quehenberger, *Institute for Medical Informatics, Statistics and Documentation, Medical University Graz*, who support and cooperate with the LBI-CFI in relation to data analysis and statistical training of the researchers.

MR physics

In the field of MR spectroscopy we cooperate with Prof. Chris Boesch, *AMSM, Department of Clinical Research, University Bern, Switzerland*, who supports us in the investigation of human lumbar vertebrae for age estimation.

For the dating of fractures we established a cooperation with Prof. Fritz Schick, *Section of Experimental Radiology, Department of Diagnostic Radiology, Eberhard Karls University of Tübingen* who supports us in the optimization of MR protocols as well as the quantitative analysis of the acquired data.

Further good and long standing scientific cooperation exists with Prof. Rudolf Stollberger, *Institute of Biomedical Engineering, Technical University Graz*, who supports the LBI-CFI in all arising technical problems and acts as a supervisor in many bachelor, master and doctoral theses performed at the LBI.

Computer graphics

Our main cooperation is with Prof. Horst Bischof and Prof. Dieter Schmalstieg, *Institute for Computer Graphics and Vision (ICG), Graz University of Technology*. Through a set-up financing two post-docs via the ICG, a knowledge transfer in both directions is optimally established. Martin Urschler works together in depth with two other post-docs from ICG, Michael Donoser, an expert in image segmentation, and Thomas Pock, an expert in variational methods for low-level image processing. Alexander Bornik works together with a team of post-docs and PhD students on volume visualization techniques. This tight collaboration is also visible in the co-authorships of methodological computer vision and

computer graphics papers (see publication list in section 5). Since May 2013 Dr. Darko Stern, working as a post-doc at the ICG financed via a Marie Curie International Exchange Fellowship grant works on an automatic software method for age estimation from MR hand images in close cooperation with LBI-CFI, together with a master student (Thomas Ebner). In the course of this project, we have also established a cooperation with Rene Donner, who is a medical computer vision expert, from Medical University of Vienna.

Another ongoing cooperation is with *RISC Software GmbH in Hagenberg*, with its research unit for medical informatics around Dr. Michael Giretzlehner. Johannes Höller is working in tight collaboration with this research unit, who are the developers of BurnCase3D, a software used for the documentation of burns. Their concepts of generic 3D surface models of different genders, ages, and obesity levels as well as their methods for displaying injuries on this 3D model are also important aspects in our 3D reference manikin model.

Our cooperation with the *Ludwig Boltzmann Institute for Lung Vascular Research, Graz* (Dr. Zoltan Balint, DI. Michael Pienn) was continued, where we work together on the extraction and analysis of vascular structures from pulmonary CT images. This topic was the focus of a master thesis by Michael Helmberger under the supervision of Martin Urschler. In 2013, after finishing this master thesis, we established a follow-up master thesis project on the topic of separation of lung vascularity into arterial and venous trees, performed by Christian Payer. Furthermore, we are working together with the *Clinical Department for Prosthodontics of the Medical University Graz* (Dr. Susanne Vogl) on the topic of registration and segmentation of jawbone images, a project done by Kerstin Hammernik and supervised by Martin Urschler. Another cooperation is with the *Department DIGITAL of JOANNEUM Research, Graz* (Dr. Martina Uray, Dr. Heinz Mayer) in the form of supervision of a master thesis by Martin Urschler. Here, the master student Michael Schneeberger is working on wound simulation software. Finally a cooperation with the Medical University of Vienna (Philipp Aichinger) on the topic of segmentation of the glottis from high-speed videos of the larynx has been started, here the student Fabian Schenk is working towards his master's degree.

3.1.2 Non-scientific cooperations

Valuable cooperations in relation to the Clinical Forensic Care Unit exist with the *Departments of Pediatric Medicine and Pediatric Surgery* and their child protection groups, as well as with the *Department of Obstetrics and Gynecology*, both at the *Medical University Graz*.

As a practical interdisciplinary basis for the research at the LBI-CFI, regular Jour Fixe meetings with representatives from the hospital (LKH Graz), police and prosecution are held. The aim of these meetings is to optimize communication and cooperation between the institutions concerned with incidents of violence. Five meetings have been held in 2013 and several issues concerning processes and cooperation as well as real cases have been discussed and analysed. The results from these discussions have been incorporated into the activities of the Clinical Forensic Care Unit and will also be a central part in the juridical key area of research.

3.1.3 Third party projects

Klinisch-forensisches Netzwerk Steiermark (KfN Steiermark)

(Simone Kainz, Eva Scheurer, Johannes Höller, Isabella Klasinc, Reingard Riener-Hofer)

In July 2013 the project “Klinisch-forensisches Netzwerk (KfN) Steiermark” sponsored by the „Zukunftsfond Steiermark“ of the Land Steiermark started. The objective of the project planned for a period of 18 months is the comprehensive buildup of a network of medical institutions in Styria being capable and willing to offer clinical forensic services. With this clinical forensic network model Styria would be able to take on a pioneering role in Austria, and could subsequently serve as a prototype for other Austrian states. In particular, partner hospitals and clinics with specific infrastructural opportunities, i.e. having an emergency service and gynecological expertise at their disposal, are expected to participate. A Styria-wide hotline and a secured online platform exclusively accessible to network members is intended to support the Styrian medical and nursing professionals for the investigation of physical and sexual violence.



© B.Bergmann

TechforMed: Standardization for the computer-aided analysis of MRI data (Standard_MRI)

(Martin Urschler, Alexander Bornik, Andreas Petrovic, Bridgette Webb, Eva Scheurer)

In December 2013, the application for funding made to the Land Steiermark under the call ‘HTI:Tech_for_Med’ was accepted for sponsoring. The call focused on further strengthening expertise and generating sustainable benefits in the domain of human technology in Styria. The LBI-CFI proposed a joint project entitled “Standardization for the computer-aided analysis of MRI data” in cooperation with the TU Graz (Institute for Computer Graphics &

Vision and Institute of Medical Engineering). The project aims to work towards the standardization of MRI data using an internal or an external standard (phantom) and to further enable the customization of a 3D analysis using visualization techniques. This would enhance a computer-aided analysis of MRI data and an efficient treatment of data in the framework of both, clinical and forensic medicine.

In view of the application, a preliminary investigation of candidate calibration phantom materials and their T1-values was undertaken. Further investigation of materials more closely resembling the tissues of interest (e.g. fat/muscle), of additional properties and of the stability of such phantoms is still required.

One of the expected outcomes of this project is to improve the signal standardization of MRI data to enable improved visualization and segmentation on the basis of reference values, similar to Hounsfield Units in CT. This will have an impact for the computer-aided tools for forensic case analysis from key area IV. We expect to develop MRI protocols that lead to simplified transfer function design based on the per-protocol reference, which can be used to automate the visualization of forensic findings from MRI, together with the proposed methods for signal inhomogeneity reduction. This inter-disciplinary project, which involves experts from image processing, MR physics and legal medicine, will help in improving the currently used MRI protocols in forensic practice as well as in the clinical context.

3.2 Membership in scientific associations

Team members of the LBI-CFI are members of the following scientific associations:

- DGRM – Deutsche Gesellschaft für Rechtsmedizin
- ÖGGM – Österreichische Gesellschaft für Gerichtliche Medizin
- AGFAD – Arbeitsgruppe für Forensische Altersdiagnostik der DGRM
- Berufsverband Deutscher Rechtsmediziner
- ISMRM – International Society of Magnetic Resonance in Medicine
- ESMRMB – European Society of Magnetic Resonance in Medicine and Biology
- ESR – European Society of Radiology
- RSNA – Radiological Society of North America
- ÖRG – Österreichische Röntgengesellschaft
- ISFRI – International Society of Forensic Radiology and Imaging
- Kriminalistische Studiengemeinschaft Steiermark
- FIRM – Forschungsinstitut für Recht in der Medizin
- Forschungsfeld Neurowissenschaften der Medizinischen Universität Graz
- SIDS (sudden infant death syndrome)-AG Austria
- Eurographics
- FIRS – Forensic Imaging Society of the Americas
- IEEE – Institute of Electrical and Electronics Engineers

LBI-CFI team members actively participated in the following working groups of scientific associations:

- AGFAD (Eva Scheurer)
- Arbeitsgruppe Klinische Rechtsmedizin der DGRM (Nikolaus Krebs)
- ESMRMB – European Society for Magnetic Resonance in Medicine and Biology (Eva Scheurer)
- ESR - European Society of Radiology (Thomas Ehammer)
- FIRM - Forschungsinstitut für Recht in der Medizin (Peter Schick)
- ÖRG - Österreichische Röntgengesellschaft (Thomas Ehammer)

3.3 Lecture series and workshops

In 2013 the LBI organized the annual lecture series “The interdisciplinary world of forensic imaging” which is open to the public and for which nationally and internationally renowned speakers are invited to give a talk about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support. In 2013, the following lectures took place:

- MSc. Vera Muschett, „DNA bei forensischen Fragestellungen“, 06.03.2013
- Prof. Dr. Gustav J. Strijkers, „Diffusion Imaging in Skeletal Muscle“, 05.06.2013
- Dr. Silke Grabherr, „Die postmortale Angiographie – Anwendungen und aktuelle Entwicklungen“, 19.06.2013
- Prof. Dr. Richard Dirnhofer, „Der Befund steht im Zentrum – In der rechtsmedizinischen Praxis und in der Wissenschaft“, 04.09.2013
- Dr. Peter Schaden, „Der gerichtsmedizinische Sachverständige – Fragen des Rechtsanwalts“, 16.10.2013
- Prof. Dr. Jürgen R. Reichenbach, „Suszeptibilitätsgewichtete Magnetresonanzbildgebung und ihre Anwendungen“, 20.11.2013

Additionally, the LBI-CFI organized a visit to the prison “Justizanstalt Jakomini“ on 22.01.2013, an event, which was also open to the public.

3.4 Teaching and training activities

3.4.1 Teaching activities

Academic teaching

- Appointment of Martin Urschler at Graz University of Technology, as a lecturer in „Medical Image Analysis” as a part of the computer science and biomedical engineering curricula, since SS 2008
- Appointment of Eva Scheurer at Medical University Graz, as a lecturer for the course “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt”, since WS 2010, with lectures given by Felicitas Dahlmann, Nikolaus Krebs, Kathrin Ogris, Isabella Klasinc and Clemens Kauderer.
- Appointment of Eva Scheurer at Medical University Graz, as a lecturer for the interdisciplinary course “Basiswissen Gerichtsmedizin”, since WS 2013, with lectures given by Nikolaus Krebs, Isabella Klasinc, Clemens Kauderer, Kathrin Ogris and Reingard Riener-Hofer as well as some colleagues from the Institute of Forensic Medicine, Medical University Graz (Peter Leinzinger, Manfred Kollroser, Barbara Reichenpfader).
- Appointment of Reingard Riener-Hofer at the FH Joanneum Graz, as a lecturer for the course “Rechtsgrundlagen für klinische Studien”, SS 2013
- Laboratory Tutorials „Optische Grundlagen”, “Herzschrittmacher”, and “MR-Messung und -Auswertung” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Bernhard Neumayer, SS and WS 2013, respectively
- Laboratory Tutorial “Atmung/Gasaustausch” and “Fluorooptische Bildgebung” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Andreas Petrovic, SS and WS 2013, respectively

Non-academic teaching

Teaching and training topics of clinical forensic medicine to different kinds of trainees, e.g., police officers, social workers, kindergarten teachers, is considered important for the implementation of clinical forensic knowledge in Austria. It is thus, a strategic policy of the management to support such activities and, particularly, to encourage the residents in forensic medicine to acquire experience in teaching. Table 6 shows the numbers of lectures given in the different fields; and below, some examples of individual presentations are given.

Number of lectures	2013
Hospitals, Clinical Units, Medical Doctors	3

Victim Support Institutions, Child Protective Services	0
Police, Prosecution authorities, Court, Jurists	1
Training (kindergarten, medical care, social work, etc.)	2
Total	6

Table 6: Number of non-academic lectures given by team members 2013

Examples of non-academic teaching:

- Lecture on “CSI Forschung: Forensische Bildgebung – Vision und Wirklichkeit” for teachers given by Eva Scheurer and Reingard Riener-Hofer, 10.01.2013
- Lecture on „Klinische Rechtsmedizin“ given by Eva Scheurer at a training event for attorney candidates, Hotel Weitzer, 31.01.2013
- Lecture on “Vorstellung der klinisch-forensischen Ambulanz“ given by Felicitas Dahlman for the employees of the “Reha Klinik Maria Theresia, Bad Radkerbsurg, 07.03.2013
- Lecture on “Vorstellung der klinisch-forensischen Ambulanz“ given by Kathrin Ogris for the employees, social workers and medical doctors organized by “Eltern-Beratungs-Zentrum des Landes Steiermark, Fernitz, 17.05.2013
- Lectures on “Spurensicherung und gerichtsverwertbare Dokumentation” given by Clemens Kauderer for medical personnel of the Salzburger Landeslinik, 22.10.2013
- Lecture on „MRT in der klinischen Rechtsmedizin“ at “XIII. Forensische Gespräche Lübeck” given by Eva Scheurer, Lübeck, 29.11.2013

Ongoing student projects

- Mag. Simone Kainz: „Die rechtsmedizinische Beurteilung von Körperverletzungsdelikten – Eine medizinrechtliche Studie“.
Dissertation (Supervision by Peter Schick).
- Mag. Elisa Florina Ozegovic: „Die Rechtfertigung medizinischer Eingriffe aus Forschungs- und Lehrzwecken“.
Dissertation (Supervision by Peter Schick).
- Mag. Oliver Neuper: „Patientensicherheit und Risikomanagement – Rechtliche Grundlagen und Verantwortung in Krankenanstalten“.
Dissertation (Supervision by Peter Schick).
- Dr. Kathrin Ogris: „Characterization of subcutaneous soft tissue injuries“.
Dissertation (Supervision by Eva Scheurer).
- Silja Hesterberg, MSc: „Fracture dating using MR based methods“.
Dissertation (Supervision by Eva Scheurer).

- DI Bernhard Neumayer: „Quantitative Analysis of Selected Contrasts in Magnetic Resonance Imaging“.
Dissertation (Supervision by Rudolf Stollberger, TU Graz)
- DI Andreas Petrovic: „Methodological improvements of quantitative MR imaging“.
Dissertation (Supervision by Rudolf Stollberger, TU Graz)
- Stefanie Christina Reumüller: „Einwilligung in die klinisch-forensische Untersuchung“.
Diploma thesis (Supervision by Peter Schick).
- Alexandra Wohlfahrt: „Schweigepflicht versus Informationspflicht: Zufallsbefunde in der klinischen Gerichtsmedizin“.
Diploma thesis (Supervision by Peter Schick).
- Simon Tucek: „Die rechtsmedizinische Untersuchung an urteils- oder einsichtsunfähigen Personen; Zustimmung von Sachwalter und Obsorgeberechtigtem“.
Diploma thesis (Supervision by Peter Schick).
- Ingo Wieser: „Die Befangenheit des rechtsmedizinischen Sachverständigen in den verschiedenen Verfahrensarten“.
Diploma thesis (Supervision by Peter Schick).
- Stefan Ozlberger: „PID und embryopathischer Schwangerschaftsabbruch – ein Rechtfertigungsproblem“.
Diploma thesis (Supervision by Peter Schick).
- Margot Kauderer: „Schulmedizin vs. Alternativbehandlung: medizin- und strafrechtliche Probleme“.
Diploma thesis (Supervision by Peter Schick).
- Michael Schneeberger: *Master thesis* at Joanneum Research on the topic of synthetic wound simulation. Martin Urschler supervises this thesis to deepen relationships with the group for human centered image analysis at the DIGITAL institute of Joanneum Research which is headed by Dr. Heinz Mayer.
- Kerstin Hammernik: *Diploma thesis* together with Dr. Susanne Vogl from the Clinical Department for Prosthetics at Medical University Graz. Her topic is the segmentation of dental bone implant material for the analysis and tracking of absorption of jawbone implants. The work is jointly supervised by Martin Urschler, LBI-CFI and Thomas Pock, ICG, Graz University of Technology.
- Thomas Ebner: *Diploma thesis* on the topic “Detection of wrist and hand bones from MR images. This topic is a necessary pre-processing step for enabling automatic bone age estimation from MRI. He works closely together with Dr. Darko Stern from ICG, Graz University of Technology and is supervised by Martin Urschler, LBI-CFI.
- Christian Payer: *Diploma thesis* together with Michael Pienn and Zoltan Balint from the Ludwig Boltzmann Institute for Lung Vascular Research. Building on the work of Michael Helmberger on vessel segmentation, his topic is the separation of lung vascularity in venous and arterial trees, to investigate the effect of both trees on the recently established non-invasive method for quantification of pulmonary hypertension.
- Fabian Schenk: *Diploma thesis* together with Philipp Aichinger from the Medical University Vienna. His topic is the localization and segmentation of the glottis from high-speed larynx videos. He is supervised by Martin Urschler, LBI-CFI.

- Andreas Lesch: Diploma thesis “Quantification of T1, T2 and relative spin density using bSSFP with correction of non-ideal flip angle profiles” at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).
- Markus Stefan Menth: Bachelor thesis “Konzeption einer Meanderspule zur Darstellung des subkutanen Fettgewebes mittels MRT” at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Hermann Scharfetter, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).

3.5 Reviewing activities

Journals

International Journal of Legal Medicine (Eva Scheurer)

Journal of Forensic and Legal Medicine (Eva Scheurer)

Forensic Science International (Eva Scheurer)

European Radiology (Eva Scheurer)

American Journal of Neuroradiology (Eva Scheurer)

Journal of Magnetic Resonance Imaging (Eva Scheurer)

Computer Graphics Forum (Alexander Bornik)

Medical Physics (Alexander Bornik)

Computer Methods and Programs in Medicine (Alexander Bornik)

International Journal of Human-Computer Studies (Alexander Bornik)

IEEE Transactions on Medical Imaging (Martin Urschler)

Conferences

ISMAR (Alexander Bornik)

CVPR (Computer Vision and Pattern Recognition) (Martin Urschler)

ICCV (International Conference on Computer Vision) (Martin Urschler)

CVWW (Computer Vision Winter Workshop) (Martin Urschler)

4. Outlook

Institutional partners

Collaboration with our institutional partners Medical University Graz (MUG), Siemens AG Österreich, the Institute of Criminal Law, Criminal Law Procedure and Criminology at the Karl-Franzens University Graz (KFUG), the Institute of Forensic and Traffic Medicine at the University of Heidelberg, Germany, as well as the Superior Court of Styria and Carinthia (OLG) as well as the new partner Ministry of Internal Affairs is continued at least until the end of the current period of the LBI-CFI, i.e., the end of May 2015. The combination of these institutions is an exceptional opportunity for the LBI-CFI and its interdisciplinary areas of research, and is essential in achieving its challenging goals. Similarly, there are scientific and strategic benefits for these partners.

Evaluation of the LBI-CFI

In the next year the main challenge will be to prepare the structural and scientific evaluation of the institute which will take place in autumn. This includes on one hand strong interaction with the current institutional partners and initial talks to potential new partners for a next 7 years-term. On the other hand a strategic concept has to be written in order to plan and define the possible future of the LBI-CFI concerning the long term cooperation with and the integration into existing structures.

Scientific program

In the next year the scientific program will be continued in form of the five defined key areas. However, the main task in 2014 will be to intensify the current activities of data evaluation, manuscript preparation and publication of results. Additionally, a tentative research program has to be defined for a potential next term.

Teaching and training

In the next period, the LBI-CFI lecture series "The interdisciplinary world of forensic imaging" for which nationally and internationally renowned speakers are invited to give talks about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support, will be continued. The lecture series for 2014 has been planned with presentations by the following speakers: PD DDr. Christian Bachhiesl (Stv. Leiter der Universitätsmuseen, Graz), DI Ursula Buck (Institute of Forensic Medicine, University Bern), Prof. Andreas Berg (Center for Medical Physics and Biomedical Engineering, Medical University Vienna), PD Dr. med. Tanja Germerott (Institute for Forensic Medicine, Hannover Medical School), Prof. Dr. med. Stefanie Ritz-Timme (Institute of Forensic Medicine, University Hospital Düsseldorf), Mag. Gerd Obetzhofer (President of the Regional Court for Criminal Matters, Graz), and Prof. Dr. med. Dirk Petersen (Institute of Neuroradiology, UKSH Campus Lübeck).

Similarly, the lectures on “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt” and “Basiswissen Gerichtsmedizin” at the Medical University Graz are planned to be held next year.

5. List of publications

5.1 Peer-reviewed papers

Malli N, Ehammer T, Yen K, Scheurer E. Detection and characterization of traumatic scalp injuries for forensic evaluation using computed tomography. *Int J Legal Med*, 127 (1):195-200 (2013).

Schuh P, Scheurer E, Fritz K, Pavlic M, Hassler E, Rienmüller R, Yen K. Can clinic CT data improve forensic reconstruction? *Int J Legal Med*, 127 (3):631-638 (2013).

5.2 Books, book chapters and other publications

Helmberger M, Urschler M, Pienn M, Balint Z, Olschewski A, Bischof H. Pulmonary Vascular Tree Segmentation from Contrast-Enhanced CT Images. In: *Proceedings of the 37th Annual Workshop of the Austrian Association for Pattern Recognition (ÖAGM/AAPR)*; Piater J and Rodríguez-Sánchez A. (Eds), Innsbruck (2013).

Helmberger M, Urschler M, Pienn M, Balint Z, Olschewski A, Bischof H. Tortuosity of Pulmonary Vessels Correlates with Pulmonary Hypertension. In: *Proceedings Medical Image Understanding and Analysis 2013*; (Eds), Birmingham (2013).

Kainz S, Fischer F, Scheurer E. Forensische Altersdiagnostik bei Lebenden in Österreich. In: *Klinisch-forensische Medizin - Interdisziplinärer Praxisleitfaden für Ärzte, Pflegekräfte, Juristen und Betreuer von Gewaltopfern*; Grassberger M, Türk E and Yen K (Eds), Springer Wien, NewYork:483-486 (2013).

Kainz S, Scheurer E, Schick P, Riener-Hofer R. Standortbestimmung der Gerichtsmedizin in Österreich - Die Auswertung einer wissenschaftlichen Umfrage. In: *Österreichische Richterzeitung*; (Eds), 10/13:210-213 (2013).

Riener-Hofer R. Bildgebung und Forensik: Forensigraphie. In: *Kriminalistik - Unabhängige Zeitschrift für die kriminalistische Wissenschaft und Praxis*; Verlagsgruppe HJR GmbH Kriminalistik Verlag (Eds), 11/2013:701-705 (2013).

Riener-Hofer R, Schick P. Klinisch-forensische Begutachtung im Österreichischen Strafrecht aus juristischer Sicht. In: *Klinisch-forensische Medizin - Interdisziplinärer Praxisleitfaden für Ärzte, Pflegekräfte, Juristen und Betreuer von Gewaltopfern*; Grassberger M, Türk E and Yen K (Eds), Springer Wien, NewYork:59-71 (2013).

Schick P. Die körperliche Untersuchung als (straf-)prozessuale Maßnahme. Ein Abgrenzungsversuch zwischen Medizin- und Strafrecht. In: *FS-H H Kühne*; Esser R et al (Eds), C F Müller Verlag Heidelberg:459 -476 (2013).

Schick P. Die strafrechtliche Verantwortung des Sachverständigen. In: *Der medizinische Sachverständige. Rechtsgrundlagen und Beispiele guter Praxis medizinischer und pflegerischer Sachverständigengutachten*; Kröll W, Schewpe P and Neuper O (Eds), NWV Wien - Graz:119-140 (2013).

Urschler M, Bornik A, Donoser M. Memory Efficient 3D Integral Volumes. In: *International Conference of Computer Vision 2013 Workshop: Big Data in 3D Computer Vision*; (Eds), Sydney, Australia DEC 1-8 (2013).

Yen K, Hassler E, Scheurer E. Klinisch-forensische Bildgebung. In: *Klinisch-forensische Medizin - Interdisziplinärer Praxisleitfaden für Ärzte, Pflegekräfte, Juristen und Betreuer von Gewaltopfern*; Grassberger M, Türk E and Yen K (Eds), Springer Wien, NewYork:149-156 (2013).

5.3 Abstracts and conference presentations

Baumann P, Widek T, Merckens H, Boldt J, Petrovic A, Urschler M, Kirnbauer B, Jakse N, Scheurer E. Dental age estimation of living persons: Comparison of dental MRI with conventional orthopantomogram. International Congress of I.O.F.O.S., Firenze, 29.-31.08.2013, *Journal of Forensic Odontostomatology* (2013). [Oral Communication].

Bornik A, Urschler M, Scheurer E. Integrierte computerunterstützte Analyse und visuelle Aufbereitung forensischer Fälle basierend auf multimodaler 3D Bildgebung. 92. Jahrestagung der DGRM, Saarbrücken, 17.-21. Sep. 2013, *Rechtsmedizin* 23 (4):312 (2013). [Oral Communication].

Grassegger S, Ehammer T, Widek T, Petrovic A, Baumann P, Scheurer E. Comparison of two methods for the assessment of skeletal age using MRI of the hand. 30th Annual Scientific Meeting of the ESMRMB, Toulouse, 3.-5. Okt. 2013, *Proceedings of the 30th Annual Scientific Meeting ESMRMB* (2013). [Oral Communication].

Helmberger M, Pienn M, Kovacs G, Kullnig P, Urschler M, Olschewski A, Olschewski H, Bálint Z. Fractal dimension of lung vessels negatively correlates with hemodynamics of patients. European Congress of Radiology, Wien, 7.-11. März 2013, (2013). [E-Poster].

Hoeller J, Urschler M, Scheurer E. Erhebung der Akzeptanz von anonymisierten und patienten-spezifischen 3D-Modellen zur Dokumentation klinisch-forensischer Befunde für rechtsmedizinische Gutachten. 92. Jahrestagung der DGRM, Saarbrücken, 17.-21. Sep. 2013, *Rechtsmedizin* 23 (4):325 (2013). [Oral Communication].

Kainz S, Scheurer E, Schick P, Riener-Hofer R. Das Bild der Rechtsmedizin in Österreich - Die Auswertung einer wissenschaftlichen Studie. 92. Jahrestagung der DGRM, Saarbrücken, 17.-21. Sep. 2013, *Rechtsmedizin* 23 (4):305 (2013). [Oral Communication].

Krebs N, Langkammer C, Ehammer T, Lövlblad KO, Komatz G, Ropele S, Fazekas F, Yen K, Scheurer E. Direct validation of MRI findings in postmortem brain. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].

Krebs N, Langkammer C, Ehammer T, Lovblad KO, Komatz G, Ropele S, Yen K, Scheurer E. Postmortale Validierung von MRT Befunden in Hirngewebe. 92. Jahrestagung der DGRM, Saarbrücken, 17.-21. Sep. 2013, *Rechtsmedizin* 23 (4):292 (2013). [Oral Communication].

- Kruisz J, Petrovic A, Stollberger R, Scheurer E. Investigation of temperature dependence of tissue relaxation parameters for post-mortem imaging. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Langkammer C, Krebs N, Goessler W, Scheurer E, Fazekas F, Ropele S. Iron and Myelin Induced Contrast Variations in the Corpus Callosum. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Marterer R, Krauskopf A, Scheurer E, Sorantin E. MRI-based bone age assessment. 50th Annual Meeting and 36th Postgraduate Course of the European Society for Pediatric Radiology, Budapest, 3.-7. Juni 2013, *Abstract Book* (2013). [Oral Communication].
- Neumayer B, Hassler E, Widek T, Ogris K, Scheurer E. Age Estimation of Soft Tissue Hematomas. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [E-Poster].
- Neumayer B, Petrovic A, Widek T, Boesch C, Scheurer E. Reproducibility of 1H MR Spectroscopy of Human Lumbar Vertebrae at 3 Tesla. 30th Annual Scientific Meeting of the ESMRMB, Toulouse, 3.-5. Okt. 2013, *Proceedings of the 30th Annual Scientific Meeting ESMRMB* (2013). [E-Poster].
- Ogris K, Widek T, Pivec S, Ehammer T, Komatz G, Grassegger S, Yen K, Scheurer E. Comparison of MRI of the neck with external findings in survived manual strangulation. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Petrovic A, Diwokoy C, Hassler E, Ogris K, Scheurer E. IDEAL fat-water separation for the detection and characterization of soft tissue hematomas. 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Petrovic A, Schweser F, Deistung A, Scheurer E, Reichenbach JR. Longitudinal investigation of diffuse hemorrhagic lesions using using Quantitative Susceptibility Mapping (QSM). 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Scheurer E, Widek T, Baumann P, Petrovic A, Merkens H, Grassegger S. Forensic age estimation of living adolescents using MRI of wisdom teeth, wrist and clavicles 21st Annual Meeting ISMRM, Salt Lake City, 20.-26. Apr. 2013, *Proc. Intl. Soc. Mag. Reson. Med.* (2013). [Poster].
- Storck C, Hofer M, Neumayer B, Stollberger R, Gogos B. The closure of the posterior glottis: true or a geometric condition? Pan European Voice Conference PEVOC, Prag, 21.-24. Aug. 2013, (2013). [Poster].
- Webb B, Petrovic A, Scheurer E. Correlation of Macroscopic and Histopathologic Findings with MRI in Forensic Examinations. BMT 2013 - Dreiländertagung der Deutschen, Schweizerischen und Österreichischen Gesellschaft für Biomedizinische Technik, Graz, 19.-21. Sep. 2013, *Abstractband BMT2013:801* (2013). [Oral Communicaton].

5.4 Diploma, bachelor, and master theses

- Michael Helmberger (2013): *Diploma thesis* on the topic of "Segmentation and analysis of lung vascular structures from CT images" under the supervision of Martin Urschler, LBI-CFI. In this work the analysis of lung vascularity is used to detect pulmonary hypertension at an early stage in patients. Collaboration with the Ludwig Boltzmann Institute for Lung Vascular Research in Graz.
- Barbara Kölbl (2013): *Bachelor thesis* with the title "Bildgebende Verfahren in der Rechtsmedizin" at FH Joanneum Radiologietechnik Graz (Supervision by Manfred Tropper, FH Joanneum, and Thomas Widek, LBI-CFI).
- Julia Kruisz (2013): *Diploma thesis* with the title "Temperature dependence of relaxation parameters and optimization of contrast for post-mortem MRI" at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).
- Irma Mujkic (2013): Bachelor thesis "Forensische Gesichtsweichteilrekonstruktion in der Computertomographie" at University of Applied Science Joanneum AG, Radiologietechnologie (Supervision by Eva Scheurer and a professor from Joanneum AG).
- Bettina Pucher (2013): Bachelor thesis "IR Photography of subcutaneous hematomas", at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Hermann Scharfetter, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).
- Marc Steiner (2013): Master thesis dealing with statistical shape models to represent strong prior shape knowledge for 3D image segmentation, which is an important part of our interactive real-time segmentation software (Institute for Computer Graphics and Vision, Graz University of Technology, in cooperation with the LBI-CFI).
- Christof Sirk (2013): Bachelor thesis "Fast GPU implementation of advanced fitting algorithms for MRI" at the Institute for Medical Engineering, Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic, LBI-CFI).