



Ludwig Boltzmann Institute
Clinical Forensic Imaging

ANNUAL REPORT 2015



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

The Ludwig Boltzmann Institute for Clinical-Forensic Imaging (LBI CFI) was founded in May 2008 and was intended to operate for a period of seven years. Due to positive evaluations in November 2011 and October 2014 the LBI CFI was rewarded with a 2nd period, which started in June 2015 and goes till May 2022. The main goal of the LBI CFI is the formation of a scientific fundament according to the juridical basis for the implementation of clinical-forensic imaging into the clinical-forensic routine casework. In line with the research policy of the Ludwig Boltzmann Gesellschaft, the institute focuses on interdisciplinary research and its research programme requires strong emphasis on applicable results. Moreover the institute is characterized by an applied scientific workflow.

The interdisciplinarity at the LBI CFI is represented by four scientific teams focused on forensic medicine, forensic technology, forensic natural sciences, and forensic law. The communication between the different fields of forensic sciences is mandatory, the researchers benefit from the expertise of their own discipline as well as from the others. Disciplinary as well as interdisciplinary meetings are of great importance for the spreading of ideas and the scientific output. In weekly team meetings the disciplinary scientific progress is discussed, every two weeks the key researchers of the LBI CFI meet for an update of the scientific progress in the teams and in a monthly seminar to the whole institute, called the "Studienpräsentation", the researchers are encouraged to present their work. The Studienpräsentation helps every member of the institute to keep track of the ongoing studies and is of great importance for the scientific output, communication, mutual learning and spreading of ideas.

The interdisciplinarity is also reflected by the disciplines of the LBI CFI partner consortium. The partners of the LBI CFI come from the field of medical sciences and juridical sciences, especially in relation to proceedings in criminal matters. The academical partners are the Medical University of Graz with the Institute of Forensic Medicine, the Institute of Forensic and Traffic Medicine of the University of Heidelberg and the Karl-Franzens-University of Graz with its Institute of Criminal Law, Criminal Law Procedure and Criminology. By the Ministry of Internal Affairs, the Superior Court of Appeal of Styria and Carinthia the practical relevance of the research is guaranteed. In 2015 the annual budget of the LBI CFI funded by the Ludwig Boltzmann Gesellschaft (LBG) and institutional partners was 1.3 Mio Euro.

1.1 Aims

Clinical-forensic medicine, i.e. forensic examinations of living persons, has become an important part of the forensic routine casework. To date, the standard for these examinations following e.g. domestic violence, strangulation or child maltreatment is the external inspection of the body, which is subjective and also misses internal findings. Therefore, there is a need for objective and all-embracing examination alternatives. The use of clinically established cross section methods such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) additionally to the external inspection could provide an objective basis for the forensic evaluation. However, the aim of forensic imaging is completely different compared to clinical radiology. Clinical radiological imaging has a diagnostic and therapeutic purpose while forensic imaging is targeting on the reconstruction of events, dating of injuries as well as the interpretation of severity of injuries. Therefore, clinical radiological studies can only serve as a basis for clinical-forensic imaging, while it is necessary to perform systematic MRI and CT studies to get a scientific basis to implement these methods into the forensic routine.

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. The interaction of juridical research with routine forensic work is ensured by the interdisciplinary meetings of the Clinical-Forensic Care Unit (CFCU). Here examined cases are presented and specific legal questions regarding clinical forensic examinations are discussed, which helps to direct the juridical research towards a focus on practical issues.

The research strategy of the LBI CFI is characterized by the daily case work in clinical forensic medicine as a basis for the definition of the areas of research and specific research questions. It is focused on the backflow of the achieved study results into routine forensic work and instructing institutions such as prosecution authorities. The logical and systematic approach to scientific questions is aimed at increasing knowledge and understanding in the different areas of interdisciplinary research. Ethical correctness at all study stages and the approval of studies by the local ethics committee is an absolute prerequisite for the work of the institute. Moreover the 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 is one of the declared aims of the LBI CFI.

1.2 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. Since 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.



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 in which the applicability of forensic radiological imaging as evidence in criminal procedures can be evaluated. 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. Moreover the partnership between LBI CFI and Karl-Franzens-University of Graz allows an implementation process with respect to possible legal implications from the beginning. It supports the evaluation of advantages and disadvantages of imaging techniques in criminal proceedings as well as the evaluation of the impact of clinical forensic imaging in routine juridical work in national and international legal systems.



Superior Court of Appeal of Styria and Carinthia

Commissioning forensic expert opinions weeks or months after an incident makes the forensic assessment difficult. The Superior Court of Appeal of Styria and Carinthia OLG supports the LBI CFI with the aim of ensuring that the LBI CFI is integrated into clinical forensic cases in Styria and Carinthia and gets an insight into judicial practice. Its 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. Strategically the OLG is interested in improving the evidence situation based on a complete collection of findings and objective documentation.



Heidelberg University Hospital

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



Bundesministerium für Inneres

The Ministry of Internal Affairs is a partner of the LBI CFI since June 2013 and provides expert advice regarding the use of forensic imaging in police practice. One of the basic scopes of this partner is to participate in scientific studies and to support the LBI CFI with its practical experience in criminal investigations. Moreover the partnership between LBI CFI and the Ministry of Internal Affairs helps to focus the projects and publication of the institute with respect to the practical relevance from the beginning.



Siemens AG Österreich

Siemens AG, one of the world's largest suppliers of the healthcare industry, has decided to participate in the LBI CFI for an initial period of seven years. The main strategic interest of Siemens for the participation in the LBI CFI was the chance to enhance creative and strategic solutions in a new and undeveloped field. Their role in the LBI CFI was to support research in the field of forensic imaging by contributing expertise in different areas. The partnership ended with the end of May 2015 and we like to thank our former partner for the valuable cooperation.

1.3 Supervisory Board und Scientific Advisory Board

1.3.1 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 directors of the LBI CFI with the implementation of the decisions. Equally, the directors 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 Obezhofer (Oberlandesgericht Graz)
- Vizerektor Univ.Prof. Dr. Martin Polaschek (Karl-Franzens University Graz)
- Prof. Dr. Kathrin Yen (Universitätsklinikum Heidelberg)
- Generalmajor Gerhard Lang (Bundesministerium für Inneres)
- Dr. Peter Mayrhofer (Ludwig Boltzmann Gesellschaft GmbH)

Supervisory Board meetings took place on 12.05.2015 and 19.11.2015 at the Institute in Graz.

1.3.2 Scientific Advisory Board

The Scientific Advisory Board consists of five experts representing the various disciplines within the Ludwig Boltzmann Institute for Clinical-Forensic Imaging:

- 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 annual meeting of the Scientific Advisory Board took place on 21.10.2015 in Vienna.

Univ.Prof. Dr. Walter Bär, chairman of this SAB so far, has recently retired. In 2016 a new member will join the SAB. Once the board is completely occupied again, the members will

elect a new chairman. For us it was a great pleasure to be supported by the scientific expertise of Univ.Prof. Dr. Bär. We will miss his valuable advices and like to thank him for the fruitful cooperation during the last years.



Figure 1: Scientific Advisory Board on 21.10.2015 in Vienna. From left to right: Univ.Prof. Dr. Karl-Olof Lövblad, Univ.Prof. Dr. Walter Bär, Univ.Prof. Dr. Hansjürgen Bratzke, Prof. Dr. Gustav Strijkers, and Prof. Dr. Dorothee Auer

1.4 Human resources and development

1.4.1 Living Interdisciplinarity at the LBI CFI

Research work at the LBI CFI is characterized by interdisciplinarity, which is represented by the four scientific teams of the institute, covering the disciplines of forensic medicine, forensic technology, forensic natural sciences, and forensic law. All researchers benefit from the expertise in their own as well as from other teams, nonetheless, communication between the different fields of forensic sciences is mandatory. Therefore, internal team meetings as well as meetings comprising all members of the institute are of great importance for the scientific output, communication, mutual learning and spreading of ideas. The team members come together in weekly or two-weekly team meetings to discuss the scientific progress, publications, ideas for projects and administrative staff. Every two weeks, the key researchers of the LBI CFI meet for an update of the scientific progress in the teams and to discuss and organise the daily routine of the institute. Every researcher is encouraged to

present his/her work in a monthly seminar to the whole institute, called the “Studienpräsentation”, which helps every member of the institute to keep track of the ongoing studies. The “Studienpräsentation” is always followed by the “LBI meeting”, the monthly come-together of the LBI CFI, where the heads of the institute inform all members about upcoming tasks and plans. A further interdisciplinary meeting is organised by the PhD students of the institute, the MRI seminar, which takes place once a month. The radiographer of the LBI CFI together with PhD students from medical and technical disciplines come together to discuss current MR studies of the teams, new publications on MR approaches and novel ideas for further researcher concerning MRI. Finally, the “funding breakfast” is organised every three months on a Friday morning, where every member of the LBI CFI is invited for coffee and croissants whilst talking about open calls and strategies for third party funding of scientific projects. All together, the pronounced communication culture supports the interdisciplinary thoughts of science towards clinical-forensic imaging at the LBI CFI.

1.4.2 Human resources

The institute leadership is organized as a diarchy comprising two equal executive directors responsible for the juridical-administrative and the medical-scientific management. This form of management ensures the research’s consistent adaptation to legal and forensic requirements. Both directors are also acting as key researchers (forensic medicine and law).

The staff is organized in four content-based teams:

1. Within the Team Forensic Medicine (Key Researcher: Thorsten Schwark), the research area “radiologic evidence in forensic reconstruction and age estimation” is located, as well as the Clinical Forensic Examination Unit.
2. The Team Forensic Technology (Key Researcher: Alexander Bornik, Martin Urschler) is responsible for “image processing & computer graphics”, “crime scene & incident reconstruction”, as well as “magnetic resonance methodology”.
3. The Team Forensic Natural Sciences (Key Researcher: Sylvia Scheicher, Hanna Sprenger) covers besides natural science studies the interdisciplinary project management of the institute.
4. The Team Law (Key Researcher Reingard Riener-Hofer) comprises the legal research area as well as legal attendance to research concentrations & services.

The researchers of the LBI CFI have various educational backgrounds (i.e. forensic medicine, radiology, biology, forensic sciences, chemistry, physics & engineering, law and computer science). Furthermore, the LBI CFI team comprises two team assistants for the administrative support and one radiographer for performing the radiologic scans. All employees are located in Graz.



Figure 2: The LBI CFI team

In 2015 the LBI CFI consisted of the following employees

	Function	Discipline
Management & Key Researchers		
Riener-Hofer Reingard	Institute Director (co-directorate), Key Researcher	Law
Schwark Thorsten	Institute Director (co-directorate), Key Researcher	Forensic Medicine
Bornik Alexander	Senior Scientist, Key Researcher	Visualization & Computer Graphics
Scheicher Sylvia	Senior Scientist / Scientific Editor Key Researcher	Forensic Natural Sciences, Chemistry
Sprenger Hanna (Maternity leave substitution for Sylvia Scheicher)	Senior Scientist / Scientific Editor Key Researcher	Forensic Natural Sciences, Molecular Biology
Urschler Martin	Senior Scientist, Key Researcher	Image Analysis & Computer Vision
Team Forensic Medicine (Key Researcher: Thorsten Schwark)		
Grassegger Sabine	Researcher Radiology	Forensic Radiology
Kauderer Clemens	Researcher, General Practitioner	Forensic Medicine
Klasinc Isabella	Researcher, General Practitioner	Forensic Medicine
Krebs Nikolaus	Researcher, Resident Forensic Medicine	Forensic Medicine

Kalloch Andrea	General Practitioner	Clinical Forensic Medicine
Schaden Christoph	Student Assistant	Administration
Wieland Annemarie	General Practitioner	Clinical Forensic Medicine
Team Forensic Natural Sciences (Key Researcher: Sylvia Scheicher, Hanna Sprenger)		
Baron Katharina	PhD Student Medical Sciences, Researcher	Biological Anthropolgy, Forensic Physics
Kirchmeyr Daniela	FEMtech intern	Biomedical Engineering
Webb Bridgette	PhD Student Biomedical Engineering, Researcher	Forensic Sciences
Widek Thomas	Radiographer Researcher	Forensic Radiography
Team Forensic Technology (Key Researcher: Alexander Bornik, Martin Urschler)		
Ebner Thomas	Software Engineer	Machine Learning
Höller Johannes	Software Engineer	Software Engineering - Computer Graphics & Vision
Martinez Vera Naira Pilar	Doctoral Student	MR Physics
Neumayer Bernhard	Doctoral Student	MR Physics
Stern Darko	Post-Doc Researcher	Image Analysis & Computer Vision
Team Law (Key Researcher: Reingard Riener-Hofer)		
Kainz Simone	Researcher Doctoral Candidate Law	Law
Administrative Staff		
Brandl Elisabeth (Maternity leave substitution for Evelyn Reisner)	Executive Teamassistant	
Reisner Evelyn	Executive Teamassistant	
Schachner Silvia	Teamassistant	

Table 1: Overview of staff in 2015

1.4.3 Education and training

Internal education and training

- In line with the research policy of the Ludwig Boltzmann Gesellschaft, the institute focuses on interdisciplinary research. Its research program requires the cooperation of the disciplines of the LBI CFI. Monthly interdisciplinary study presentations of all researchers support the scientific exchange between the medical, the technical, the natural sciences and the juridical team.

- Weekly team-meetings serve for communication between Key researcher and Researcher and help to coordinate the scientific work.
- Regular meetings of the doctor's team of the clinical forensic care unit serve both training of junior doctors and juridical discussion.
- First aid refresher course by Dr. Andrea Kalloch on October 8th, organized by the LBI CFI, Graz



Figure 3: First aid refresher course at the LBI CFI

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, DGRM).

Examples of externally organized activities with educational aspects, in which researchers of the LBI CFI participated during 2015, are:

- “Aufbaumodul Presentation Skills in English” organized by the MUG, Graz (16.01. and 23.01.2015)
- “Einführung neuer Mitarbeiter”, organized by the MUG, Graz (28.01.2015)
- Instruction Magnetom Prisma by Siemens, organized by the LKH Graz (25.02.2015)
- “Statistik, Grund und Aufbau”, organized by the MUG, Graz (03.03. and 10.03.2015)

- “Writing Scientific Papers in English”, organized by the MUG, Graz (05.03. and 11.03.2015)
- “Basismodul Forschung”, organized by the MUG, Graz (15.04.2015)
- “Basismodul Lehre”, organized by the MUG, Graz (18.05.2015)
- FWF-Coaching Workshop, organized by the MUG, Graz (19.05.2015)
- Workshop “Forschungsprojekte erfolgreich managen”, Graz (22.06.2015)
- Meet the Expert-Workshop “Stimmige Selbstdarstellung”, organized by the LBG, Wien (23.06.2015)
- “Führungskräfteworkshop”, organized by the LBG, Gartenhotel Dürnstein (28.09. – 30.09.2015)
- W-fORTE “Lösungsorientierte Kommunikation in Konflikten”, Graz (15.10.2015)
- Prüfung/Begutachtung Dr. Schwark zur Eintragung in die Liste der allgemein beeideten und gerichtlich zertifizierten Sachverständigen, Graz (20.10.2015)
- Workshop „BioTechMed-Graz im europäischen Forschungsraum, organized by BioTechMed-Graz und FFG, Graz (29.10.2015)
- FFG-Workshop „Informationstechnologie im Gesundheitssektor – Förderungen in Horizon 2020“, organized by FFG, Wien (16.11.2015)
- „Humanpotenzial Förderinfotag“, organized by FFG, Wien (16.11.2015)
- „FEMtech Netzwerktreffen: Kulturwandel in der außeruniversitären Forschung?“, organized by FFG, Wien (16.11.2015)
- W-fORTE-Workshop „Organisation und Führungserfolg als Wechselspiel“, organized by FFG, Wien (17.11.2015)
- Ablegung des SV-Eides für das Fachgebiet 02.70 Gerichtsmedizin, Dr. Schwark, Graz (19.11.2015)
- Key-Researcher Training “Medientraining”, organized by the LBI CFI, Graz (30.11. – 01.12.2015)

1.4.4 Team events

A good atmosphere and team spirit are of vital importance, if targets and goals are to be achieved. Therefore, different team events, which help the team to grow professionally and socially were organized.

- On “Faschingsdienstag”, the members of the institute participated in the traditional carnival lunch with sparkling wine and doughnuts. It is a great fun every year.
- On the 29.05.2015 the 13th Styrian Leukämiehilfelauf took place. Four team members of the LBI CFI took the challenge and run 5 km for a good cause. They were actively supported by the Institute Director Dr. Reingard Riener-Hofer and her husband.



Figure 4: "Styrian Leukämiehilfelauf"

- In June the Teambuilding took place. The LBI CFI hiking-day was a good opportunity to strengthen team spirit and corporate feeling. Afterwards, we had delicious food at the "Gasthaus Stoffbauer".



Figure 5: The LBI CFI team at the hiking day

- The LBI CFI Christmas dinner took place on 16.12.2015 at the Restaurant "Weißes Kreuz" in Graz. The team was spoiled with Styrian delicacies and it was a cheerful and relaxed evening.

1.5 Infrastructure

The institute is located on the second floor of Universitätsplatz 4, directly adjacent to 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 6 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 (Magnetic Resonance Imaging (MRI): 3T Prisma fit, Siemens AG, Erlangen, Germany, CT: Definition AS and 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.



Figure 6: MR scanner at the University of Technology Graz with PhD students from the LBI CFI. From left to right: Katharina Baron, Bridgette Webb, and Naira Martinez

1.6 Highlights of the year

- *Youth Meets Science!* started in June

This project for young people from the Ludwig Boltzmann Institute for Clinical-Forensic Imaging (LBI CFI) invites students to learn more about the topic of clinical forensic science.

The project start was a great success and attracted a lot of media interest.



Figure 7: Blood stain analysis performed by a school class

- *Fame Project - Fully Automatic MRI-based age Estimation of adolescents*

Work on FAME starts with July, 1st 2015 and will last for three years. Dr. Darko Stern and MSc. Christian Payer will work on this project, together with master students at the Institute for Computer Graphics and Vision. Students interested in participating in this project with master projects, master theses or summer jobs are invited to get in contact.

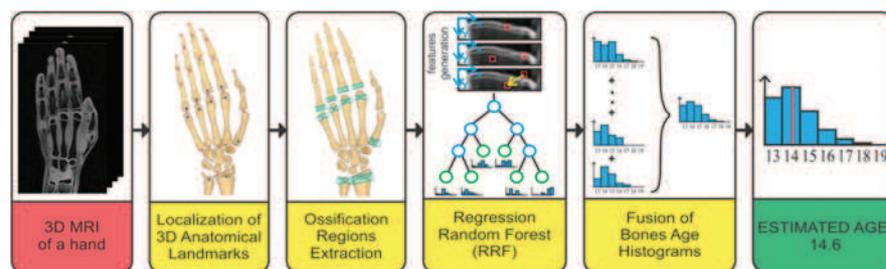


Figure 8: Work flow of the FAME project

- *Kiras CSISmartScan3D Kick off Meeting in November*

On November 18th the LBI hosted the CSISmartScan3D kick-off meeting. After a short presentation of LBI CFI about the topic and the projects aims, Christian Haas from crime site investigation unit (Tatortgruppe LKA Steiermark) delivered insight into the way crime site investigations are performed in Styria.

In the sequel representatives from all partner organizations presented their roles and planned contributions to the project. PD Christian Bachhiesl from the University of Graz presented the planned investigation of 3D methods in forensics starting with seminal work by Hans Gross towards the end of the 19th century.

Prof. Friedrich Fraundorfer (Graz University of Technology) presented 3D scanning sensors and ideas how to cope with open problems like abrupt camera motion. Dr. Matthias R  ther (Holistic Imaging) presented techniques to organize, store and visualize massive amounts of 3D data and ideas how to integrate crime site data. Dr. Bornik (LBI CFI) presented ideas how to master the transition from pure 3D model acquisition to computer-aided crime site investigation.

After the inevitable negotiations concerning organizational matters, the meeting concluded with lively discussions on the practical aspects of the collaboration.



Figure 9: CSISmartScan3D aims at the development of a 3D crime site documentation

- *Key Researcher Medientraining November 30th to December 1st 2015*

At the end of 2015, 12 Key Researcher and PR-persons from four Ludwig Boltzmann Institutes attended the very informative and intensive Key Researcher training with emphasis on media training. On two half-days the participants were introduced in the presentation of research results to the public and how to interact appropriate with media and journalists. Furthermore, the participants learned how to use their voice professionally when talking to an audience.

- *Club Scientifica on 14th December 2015*

The LBI CFI was the first non-university institution to host one of the Club Scientifica network meetings. Dr.ⁱⁿ Reingard Riener-Hofer and Dr. Thorsten Schwark gave in their keynote speeches interesting insights into the LBI CFI workaday life. The interuniversity discussion and the scientific networking confirmed the success of this event.



Figure 10: Dr. Reingard Riener-Hofer is introducing the interdisciplinary LBI CFI at Club Scientifica

- *MICCAI 2015 (the 18th International Conference on Medical Image Computing and Computer Assisted Intervention, was held from October 5th to 9th 2015 in Munich)*
Dr. Martin Urschler received a runners-up mentioning at MICCAI 2015 for being one of 18 most useful reviewers (out of roughly 700).
- *LBI CFI lecture series “The interdisciplinary world of forensic imaging”*
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 2015, the lectures were given by *Priv.-Doz.in Dr.in Nicole von Wurmb-Schwark* (Kiel); *Firma LayerLab.net GmbH* (Graz); *PhD Prof. Henning Müller* (Schweiz); *Dr. Michael Sandholzer* (UK); *Sara Kondert* (Graz); *Prof. DDr. Fritz Schick*, Sektion für Experimentelle Radiologie, Abteilung für Diagnostische und Interventionelle Radiologie, Universität Tübingen, Deutschland, „Magnetresonanztomographie: Von der diagnostischen Bildgebung zur quantitativen Gewebecharakterisierung“; *Univ.-Prof.in Dr.in Silvia Ulrich* (Linz); *PD ao. Univ.-Prof. Mag. Dr. Wolfgang Neubauer* (Vienna).



Figure 11: Dr.in Silvia Ulrich is giving a talk about "Das Europaratsübereinkommen zur Verhütung und Bekämpfung von Gewalt gegen Frauen und häuslicher Gewalt"

1.7 Public relations

1.7.1 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:

- Magazine article entitled "Klinisch-forensische Gewaltabklärung" in Medical Tribune, March 2015
- Magazine article entitled "Grazer Tätersuche besser als im Fernsehen" in Kleine Zeitung, April 2015
- Online article entitled "Initiative zur Berufsorientierung für Schüler/innen in Graz", OTS, September 2015
- Online article entitled "Grazer Gerichtsmediziner geben Schülern Einblick", ORF.at, September 2015
- Online article entitled "Zwölfjährige Einbrecher in Wirklichkeit 18 Jahre alt", ORF.at, November 2015
- TV coverage: Youth Meets Science!, servustv.at, November 2015, online available: https://youtu.be/iptJm_fr_f_E
- Report entitled "Forensische Untersuchungsstellen für gewaltbetroffene Frauen und Kinder in Österreich", bmbf.gv.at, December 2015

1.7.2 Public presentations

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

ELSA Graz on March 11th 2015

Dr. Thorsten Schwark was invited to give a talk entitled “Gerichtsmedizin hautnah” (“Forensics close-up”) within the series of lectures of the European Law Students’ Association ELSA.



Figure 12: “Gerichtsmedizin hautnah”

Symposium Sterbehilfe Frankfurt am Main on March 23th 2015

Dr. Reingard Riener-Hofer was invited to give a talk about “Euthanasia in Austria” within the Symposium Sterbehilfe, Frankfurt am Main.

3. IMAG Sitzung „Schutz von Frauen vor Gewalt“ on June 12th 2015

The invitation of the Federal Ministry for Women following the “Clinical-Forensic Network of Styria (CFN Styria)” and a concept of a “Clinical-Forensic Network for Austria” was presented by Dr. Riener-Hofer and Dr. Schwark.

Youth Meets Science! in June, November and December 2015

The concept of Youth Meets Science! was created in 2015. Its purpose is to give students an understanding of clinical forensic science on the one hand and to provide an overview of the many different occupations at the institute for career orientation on the other hand.

In 2015 classes of the institutions *Akademisches Gymnasium*, *Bischöfliches Gymnasium*, *NMS Eggersdorf*, and *GIBS* visited the LBI CFI in June, November and December. The visit on November 13th was also covered on TV.



Figure 13: Youth Meets Science! visit BRG Kepler

Workshop „Gerichtssaal der Zukunft“ Heidelberg on October 22nd 2015

Dr. Alexander Bornik was invited to give a talk entitled „Neue Möglichkeiten der Visualisierung von CT- und MRT-Befunden“ within the workshop „Gerichtssaal der Zukunft“ in Heidelberg.

„Kriminalistische Studiengesellschaft Workshop“ on November 11th 2015:

During the workshop entitled “Altersschätzungen am Lebenden: gestern – heute – morgen” (“Age estimation in living persons: yesterday – today – tomorrow”), Dr. Thorsten Schwark gave an overview on this topic. Thomas Widek presented the currently applied methods for age estimation in living persons, and Dr. Martin Urschler concluded the workshop with his talk on automated age estimation based on MRT data-

„16 Tage gegen Gewalt an Frauen“ 25th November until 10th December:

In this promotional period, violence against women is addressed throughout Austria in all its forms and it is intended to raise awareness of this serious form of violation of human rights. This year for the first time the Institute took part with its Clinical-Forensic Outpatient Center.

„100. Wiederkehr seines Todestages. Hans Gross – a 'father' of criminology. The centenary of his obit - Graz on December 10th 2015

Dr. Alexander Bornik was invited to give a talk entitled “Bildgebung in der Forensik. Anfänge, Gegenwart und Zukunft”.

Club Scientifica on 14.12.2015

The topic of the Club Scientifica – which in general aims to connect female researchers – in December 2015 was “Networking in an Interdisciplinary Context”. The LBI CFI was the first non-university institution to host one of these group network meetings.

In their keynote speeches institute heads Dr.ⁱⁿ Reingard Riener-Hofer and Dr. Thorsten Schwark gave an interesting insight into the workaday life at the LBI CFI and Dr.ⁱⁿ Nicole von Wurmb-Schwark presented the interdisciplinary field of DNA analysis.



Figure 14: Club Scientifica hosted by the LBI CFI at the Meerscheinschlössl, Graz

2 Research program and results

2.1 Projects

The research program of the LBI CFI during the year 2015 was conducted within four main key areas, each comprising different interdisciplinary studies, which are briefly described in the following sections.

Across all studies, some of which were conducted in parallel, a total of 165 MRI scans of living subjects were made. Table 4 shows an overview of the studies in which MRI scans were performed.

MRT	2015
Pedibrain	9
Subcutaneous hematomas	71
Fracture dating using MRI	23
Control measurements TU	5
Strangulation study	1
MRS lumbar spine (Reproducibility / Age estimation)	20
Age estimation using MRI	36
Total	165

Table 2: Overview of research MRI scans 2015

2.1.1 Forensic reconstruction and dating of injuries

Forensic reconstruction of traumatic brain injuries (TBI) in living children and adolescents (PEDIBRAIN)

After mild traumatic brain injury, the brain frequently appears unharmed on conventional imaging scans. Routinely performed imaging methods may not be sensitive enough to detect discrete trauma, such as diffuse axonal injury, which can in some cases lead to long-term disabilities. The diagnosis of mild cerebral trauma may be quite difficult, and often is based only on self-reported symptoms.

Especially in younger people (children and teenagers), traumatic brain injury has a high incidence because of leisure activities (sports, traffic accidents). Therefore, in fall 2015, the study titled "Forensic Reconstruction of Traumatic Brain Injuries in Children and Adolescents" started. The aim of this study is to evaluate specific MR characteristics of mild traumatic brain injuries in children and adolescents aged 10 to 18 years.

Up to December 2015, 9 volunteers were examined on a 3T scanner. A detailed documentation of external injuries and a comprehensive questionnaire about the circumstances of the accident were also included in the examination. The gained clinical data, together with the analysis of the collected MR data, are expected to provide better insight in mild TBI, and consecutively improve forensic reconstruction of traumatic incidents as well as for medical diagnosis and therapy.

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

The gold standard in forensic medicine for the diagnosis of strangulation is an external examination, which often shows no injury despite the credible description of such an event. The aim of this study is to evaluate whether radiological findings of internal lesions of the neck and throat allow to differentiate between subjects with and without strangulation, and to compare radiological findings of an MRI scan with external findings in strangulated subjects regarding the forensic reconstruction of the event.

The study includes living (group A) and deceased victims (group B) of strangulation incidents, and control groups of living (group C) and deceased persons (group D) without a history of strangulation, using MRI within 10 days of the event. All subjects undergo a forensic external examination with photographic documentation and a non-enhanced 3T MRI scan. The individuals of the deceased groups (B and D) additionally undergo an autopsy with a neck dissection performed by a forensic pathologist.

MRI data are evaluated by two blinded radiologists, according to a predefined diagnostic scheme.

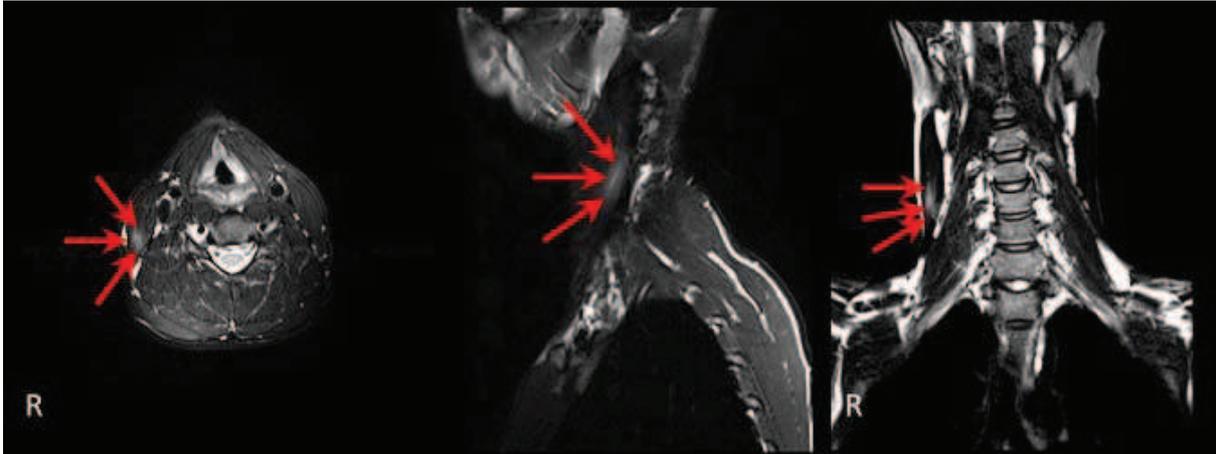


Figure 15: MR-images of the neck after survived strangulation (bleeding into the sternocleidomastoid muscle)

To date, data of 41 injured living victims and 5 subjects deceased due to strangulation were collected, and most of the data have been read and evaluated. Furthermore, both control groups, consisting of 15 living and 5 deceased subjects, have been completed.

Initial results show that the most frequent radiological findings are subcutaneous and intramuscular bleedings and/or edema. The findings offered additional evidence in cases with only slight or nonexistent external findings. MRI findings in addition to the external findings led to a high sensitivity and specificity for the diagnosis of strangulation. The analysis of the localization of the lesions added information on the attack and the assailant himself, which can facilitate the forensic reconstruction of the event.

Correlation study regarding traumatic injuries and their biomechanical origin in living subjects using clinically indicated radiography and CT

The aim of this study is the reconstruction of circumstances of an accident or a criminal incident on the basis of clinical radiography and CT data. The evaluation of CT data of trauma patients, including additional anamnesis using a questionnaire, should allow a reconstruction of the biomechanical mechanisms of injury and, therefore, lead to a better understanding of the sequence of impacts in incidents. We hypothesize that relevant forensic information for e. g. the reconstruction of events can be gained by evaluation of radiological (CT) examinations done for clinical purposes. In forensic routine work, such data frequently are part of an expert opinion. CT data are being adjudged by a radiologist and edited using the software developed at the LBI CFI. The mechanisms causing the injuries diagnosed will then be reconstructed, and compared with the information given by the patient. Injuries will be grouped by location (extremities, head, and thorax).

To date, 30 patients (of 100 patients planned) needing a CT scan have been recruited and have completed the questionnaire. The data have been transferred to the LBI CFI, and 3D reconstruction has been performed in some of these cases. An example is given below (fig. 1). A further reconstruction has not been done so far, a meeting of the involved scientists is scheduled for January.

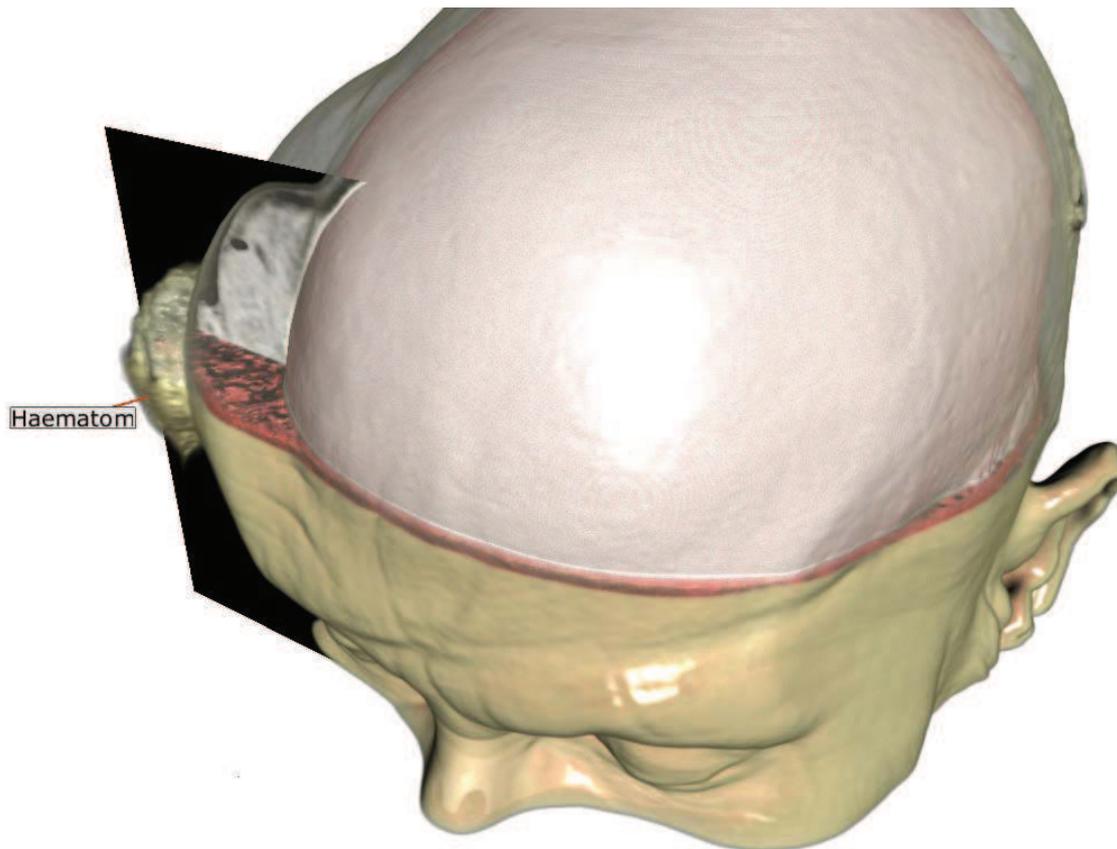


Figure 16: Example of a reconstruction of a scalp hematoma based on CT data

Subcutaneous hematomas: Experimental study of subcutaneous bruises and underlying muscle lesions in living volunteers

In clinical forensic medicine, it is often important to determine the time of origin of soft tissue injuries. As subcutaneous hematomas are usually not relevant for clinicians, only limited knowledge exists regarding the detection and dating of traumatic lesions in the subcutaneous fatty tissue using MRI. In contrast, blunt force injuries are of utter importance in forensic medicine, since dating of soft tissue injuries is frequently indispensable for the reconstruction of criminal acts.

First studies investigating injected blood volumes in the subcutaneous fatty tissue of healthy living volunteers longitudinally over 2 weeks have shown that the contrast of hematomas in MRI might be used to obtain objective information on hematoma characteristics.

Based on these initial results a subsequent study with real hematomas started in fall 2015.

The aim of this consecutive study is to evaluate the MRI characteristics of hematomas experimentally created by controlled application of an impact using a mechanical device in 30 healthy volunteers. The hematomas are scanned repetitively at different points in time (directly after the impact and after 3h, 24h, 3d, 7d and 14d) on a 3T scanner. Up to December 2015, 12 subjects were examined.

Fracture dating using MR-based methods

In forensic cases, experts have to deal with a vast amount of varying injuries. They have to examine the type of injury, origin, appearance, and the correlation of diverse bodily harm. Particularly challenging is the examination of fractures and the differentiation between inflicted and accidental ones. To enable a detailed assessment, various characteristics of the fracture have to be considered, including the type of fracture and the localization. In cases of inflicted fractures, the exact definition of the age of the fracture is crucial in follow-up criminal prosecutions, since this information enables the inclusion or exclusion of possible offenders. To date, fracture dating is performed using radiographic methods, allowing only for qualitative results and being strongly depending on the experience of the examiner. Magnetic resonance imaging, in contrast, allows for the investigation of bone and surrounding soft tissue structures without any exposure to radiation, therefore having the potential for a more precise analysis.

This ongoing study aims to investigate the possible usage of quantitative MR imaging for bone fracture dating by systematically investigating time-resolved changes in quantitative MR characteristics after a fracture event.

In early 2014, an MRI protocol was established in cooperation with Prof. Fritz Schick of the Department of Experimental Radiology at the University of Tübingen. Between May 2014 and December 2015, 50 MR scans of 23 subjects (♀:12 ♂:11; aged 19 – 65y; median: 30 y, scanned 1 to 6 times over a period of up to 300 days after fracture event), were acquired using the developed MR protocol. All subjects were treated conservatively for a fracture in either a long or collar bone. Changes of quantitative parameters were investigated using a customized MatLab GUI and evaluated by comparison between reference areas of muscle and bone and the fractured area by defined regions of interest (ROIs) (R2014a, ©MathWork Inc.; Figure 17 [1]).

First results indicated a very promising trend in time-dependent changes of quantitative MR parameters already in a small number of evaluated scans and were submitted for publication in June 2015, and accepted in January 2016 (Baron et al., 2016). All preliminary results were also presented at two international conferences in May and June 2015: the ISFRI/IAFR Joint Congress (oral presentation) and the ISMRM 23rd Annual Meeting (E-Poster)

The evaluation and incorporation of additional data from a greater number of subjects as well as further adaptation of the MR protocol is planned for the next years. This might allow for a more accurate determination of the correlation of quantitative MR characteristics with phases of bone healing.

This study will contribute to fracture dating with an increased accuracy in forensic investigations as well as better assessment of bone healing processes in a clinical perspective.

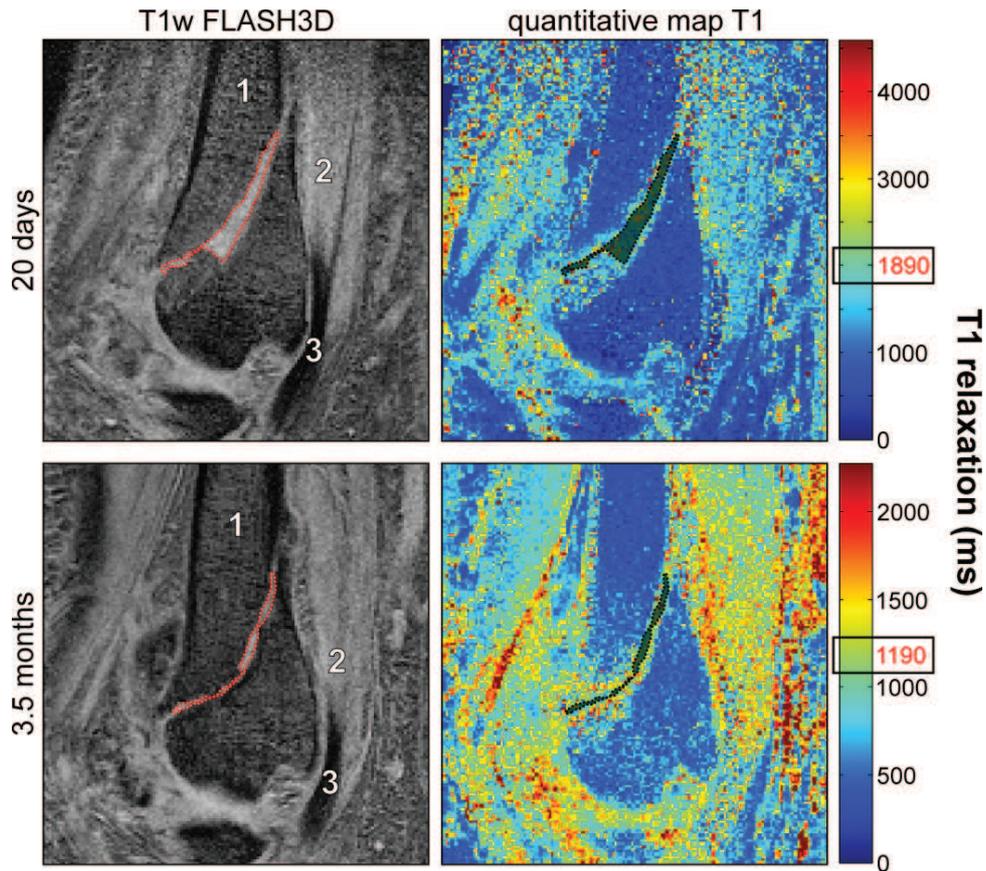


Figure 17: MR images of a Weber B fracture in a T1w FLASH3D sequence without preceding MT pulse 20 days (top) and 3.5 months (bottom) after the fracture event and corresponding quantitative T1 maps including the transferred ROIs (dashed lines). 1–3 specify the fibula, peroneus longus muscle, and peroneus longus tendon, respectively. [1]

[1] Baron, K., et al. (2016): Quantitative MR Imaging in Fracture Dating - Initial Results. *Forensic Science International, Volume 261*, 61 - 69.

2.1.2 Non-invasive age estimation based on radiologic evidence from MRI

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

Age estimation of living persons is required in different fields of public interest, including age fraud in youth sports competitions, asylum and criminal procedures as well as growth disorders in paediatric medicine. Radiological examinations using ionizing radiation are the current gold standard in the forensic age assessment procedure (X-ray of the hand, orthopantomography of the teeth, CT of the clavicles). The search for alternative, radiation-free radiological examinations, such as MRI or sonography, is currently one big topic in the forensic community. Our ongoing study investigates 500 young, healthy males from 13 to 24 years. They undergo MRI examinations of the hand, the clavicles and the wisdom teeth. The aim of the study is to obtain MR reference values for each of the regions, to understand the developmental differences between these 3 indicators of growth, and finally to establish age estimation using MR Imaging.



Figure 18: MR images of clavicles, wrist and teeth

Age estimation using magnetic resonance spectroscopy of human lumbar vertebrae

This study, which started in 2014, is based on the results of several studies reporting an increase of the fat content of lumbar vertebrae with chronological age, which is caused by a conversion of red to yellow bone marrow. Since current age estimation methods are based on skeletal and dental development and therefore not applicable to adults, the fat content in vertebrae is a potential marker for the estimation at pension age. The fat fraction can be determined non-invasively using magnetic resonance spectroscopy (MRS). The goals of this study are 1) the determination of the intra- and inter-individual reproducibility of this approach, and 2) the determination of the correlation of the fat fraction of human lumbar vertebrae with chronological age.

In 2015, recruitment of volunteers was continued. A publication of the results of the study is currently being prepared.

Novel anatomical structures for MRI age estimation

This research work focuses on the study of the anatomical structure of the manubrium and its potential for age estimation. We found a statistically significant correlation of volume, surface and shape with age. These results indicated that age estimation from MRI data of manubria is feasible. This work was published as an E-poster in June 2015 during the ISMRM congress in Toronto (Canada) and it was also awarded with a Trainee (Educational) Stipend. At the end of the year, new calculations started using a larger amount of training data.

The developmental stages of the clavicle and the manubrium led us also to explore the sternoclavicular joint space as a new potential age dependent parameter. Statistics showed that this new parameter correlates with age indicating that the sternoclavicular joint space can be included as a new candidate in MRI-based age estimation. As a conclusion, changes of the shape of the manubrium and ossification of the medial end of the clavicles lead to an age-dependent slow exponential decrease of the sternoclavicular joint space. This work was published as a lightning talk and as an E-poster in October 2015 during the ESMRMB congress in Edinburgh (UK).

Automatic age estimation from MRI data (FAME)

In our ongoing research work that deals with automatically estimating an age from 3D MRI data of left hands, wisdom teeth and clavicles of adolescents, we were able to increase our research team due to a successfully submitted FWF proposal. In the FWF project FAME (Fully automatic MRI-based age estimation of adolescents, P28078-N33), which has started in July 2015, we are planning to extend our previously published automatic age estimation methods given hand MRI data to the other investigated anatomical structures (wisdom teeth and clavicles). Under the lead of principal investigator Dr. Martin Urschler from LBI CFI, this project strengthens our collaboration with Graz University of Technology. Funding for this three-year project allows to employ a post doc, Dr. Darko Stern who has already been working on this topic since 2013, at LBI CFI, as well as a PhD student, DI Christian Payer, at the Institute for Computer Graphics and Vision at Graz University of Technology. The PhD thesis of DI Christian Payer is supervised by our collaboration partner Univ. Prof. Dr. Horst Bischof.

In 2015, a master's thesis from Walter Unterpinker has been finished, where he shows how wisdom teeth may automatically be localized in 3D MRI data. This work was published at the Medical Image Understanding and Analysis conference in Lincoln, UK, in July. Dr. Darko Stern presented results on this topic in a featured talk at the yearly conference of the Austrian Association for Pattern Recognition in Salzburg. In August, a journal paper for "Annals of Human Biology" was published, describing how our age estimation method is capable of automatically deriving age relevant features from hand MRI data. In the second half of 2015, we have presented several improved works on age estimation and localization of age relevant anatomical structures at workshop of the premier international computer vision, ICCV, in Santiago de Chile. Furthermore, two publications for the International Symposium on Biomedical Imaging (ISBI) were accepted, which will be presented in April 2016.

2.1.3 Computer-aided forensic reconstruction and documentation of injuries

Computer-aided tools for forensic case analysis and documentation

In the first LBI CFI period a number of basic algorithmic techniques and software applications for the planned forensic software toolbox were established in accordance with the research programme. The main goal of these efforts is to optimally support the processing of forensic findings from various digital information source ranging from photographs to volumetric (MRI/CT) data, and the visualization of forensic findings in the context of easy-to-understand reference models. The resulting software has undergone a number of development cycles resulting in different prototypes while it has been continuously extended and improved based on feedback and knowledge gained when applying the tool to various cases and datasets. Research in 2015 was focused on tools and techniques to interactively extract unnatural air aggregations in CT and MRI datasets and to visualize these findings especially for non-experts. The efforts towards automated and dynamic placement of text and image labels led to a diploma thesis, where the current placement functionality is enhanced, addressing limitations concerning the overall number of labels and allowed placement regions of the

current approach. The new algorithm also allows labels to be placed in regions, where they are partially included by e.g. semi-transparent portions of the dataset, thereby increasing the number of possible labels and the chance for placement close to their anchor points.



Figure 19: Visualization of air enclosed in stab wound (left). Reconstruction of a murder case based on post-mortem CT data, a 3D surface model of the weapon and multiple images showing weapon injury details

In 2015, the software toolbox has been repeatedly and increasingly applied to pending cases in Graz as well as to cases supplied by other forensic institutes. Annotated illustrations and videos documenting injuries were taken to the files and presented in court during the summary trials.

Systematic development of post-mortem MR angiography (PMMRA)

This study, funded for three years by a DOC-fellowship from the Austrian Academy of Sciences, commenced in May 2015. Cooperation partners for the project are Fumedica AG (Muri, CH) and the Centre Universitaire Romand de Médecine Légale (Lausanne, CH). The study aims to improve the radiological evaluation of coronary arteries and myocardium, and generally supports minimally-invasive autopsy procedures in the investigation of suspected cardiac deaths. In recent years, such minimally-invasive procedures using state-of-the-art imaging techniques have gained importance when ascertaining internal and external findings, even prior to autopsy. A systematic investigation of the various aspects relevant in an MR-based approach to address current weaknesses in the radiological evaluation of cardiac causes of death is the focus of this doctoral thesis.

In the already completed phase of this project, the physical and relaxation properties of liquids potentially appropriate for targeted perfusion of post-mortem vasculature were characterised. Given the significant role of temperature in post-mortem MRI examinations, the temperature dependence of these properties was also modelled. These results formed the basis for the evaluation of the investigated liquids and the selection of liquids for use in the following phases of the project. Initial results were presented at the ESMRMB in October 2015 [1] and an additional abstract summarising the final results and simulating potential

contrast using a common MRI sequence will be presented at the ISMRM in May 2016 [2]. Work has already commenced on the development of an MR protocol to optimise perfusate visualisation in post-mortem tissue. Preliminary results comparing various MR sequences and parameters were summarised in an abstract submitted at the end of January 2016 for the ISFRI [3].

Following the selection of appropriate perfusates, the practical aspects for the targeted and consistent delivery of liquid into the heart and coronary arteries were examined. This phase was undertaken using a porcine-cannula model to define and measure pump parameters (Figure 20). These examinations, in addition to MR protocol development, are ongoing.

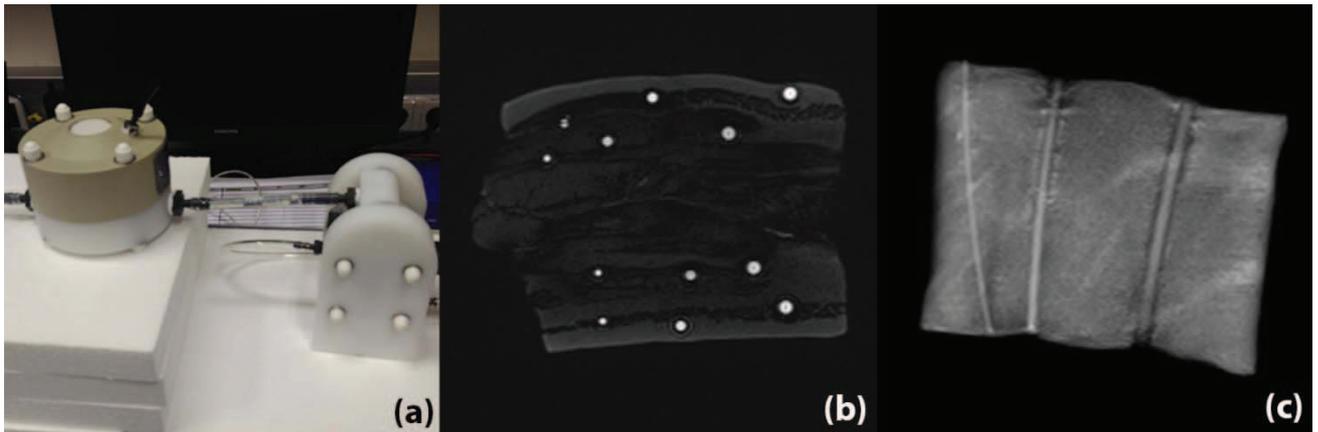


Figure 20: (a) Developed pump system (b) MR image of the porcine-cannula phantom (4 x perfusates, 3 x various cannula diameters (2, 3 & 4mm) (c) MR image of cannula filling

Accepted abstracts:

1. Webb, B., et al. *Temperature-dependent characterisation of relaxation parameters (T_1 , T_2) of potential perfusates in post-mortem MR angiography (PMMRA)*. In *Proceedings of the 32nd Annual Scientific Meeting of the ESMRMB*. 2015. Edinburgh.
2. Webb, B., et al. *Post-mortem reperfusion of the vascular system and examination in MRI: Temperature-dependent characterisation of perfusates and contrast simulations*. In *Proceedings of the 24th Annual Scientific Meeting of the ISMRM*. 2016. Singapore.
3. Webb, B., et al. *Evaluation of MRI sequences and liquids potentially suitable for post-mortem vascular perfusion*. In *Proceedings of the 5th Annual Meeting of the International Society of Forensic Radiology and Imaging*. 2016. Amsterdam.

Digital forensic documentation

This continuously ongoing efforts aims at the investigation and evaluation of the utility of various imaging technologies and devices in the forensic context.

In 2015 this has been done for so-called action cameras to fully document autopsies. These cameras are lightweight, waterproof, offer a huge field of view and the achievable image resolution is comparable to conventional digital cameras. Moreover, a software tool for 3D distance measurements has been developed. It allows to retrospectively measure arbitrary 3D distances based on given user-defined corresponding points in two images in the video stream an automated computation of the relative camera motion.

Moreover, cheap thermography devices, namely the FLIR One and the ThermalSeek sensor have been evaluated for various forensic applications including the detection of liquids on clothes, detection of blood traces, and time of death estimation based on the post mortem surface temperature gradation.

CSISmartScan3D – integrated crime site scanning and documentation

The project CSISmartScan3D aims at the development of a 3D crime site documentation device with the potential to establish 3D documentation as routine procedure in crime site investigation and to lay the basis for integrated case analysis based on crime site 3D data and 3D datasets from CT or MRI scanners used in legal medicine.

Circumstances currently preventing 3D scans are manifold. Besides technical limitation of particular scanner types and acquisition principles, the actual availability at the crime site when the scanner is needed plays an important role. Expensive scanners and consequently a low number of devices induce long distances to the place of action and unacceptable delays for other investigation tasks.

In CSISmartScan3D these problems are addressed using a combination of multiple cheap 3D sensors, robust algorithms for sensor data fusion and a user interface unifying 3D scanning and site documentation.

The project is a cooperation between LBI CFI (project leader), the TU Graz (Institute for Computer Graphics & Vision and Institute of Medical Engineering), the University of Graz (Institute of History, Institute of Criminal Law and Criminal Proceedings), Holistic Imaging (company) for the Austrian Ministry of the Interior.

HTI:Tech_for_Med: Standardisation for the computer-aided analysis of MRI data (Standard_MRI)

This project in cooperation with the TU Graz (Institute for Computer Graphics & Vision and Institute of Medical Engineering) aims to standardise MRI data using an internal or an external standard (phantom), and to further enable the customisation of 3D analysis using visualisation techniques. This would enhance computer-aided analysis of MRI data and improve efficiency in treating data within the framework of both, clinical and forensic medicine. The goal of the project is to improve the signal standardization of MRI data to enable efficient 3D visualization and segmentation on the basis of reference values in analogy to Hounsfield Units in CT. This inter-disciplinary project involving experts from image processing, MR physics and legal medicine, also helps to improve currently used MRI protocols in forensic practice and in the clinical context.

2.1.4 Juridical issues of radiological methods in clinical-forensic medicine

The juridical team analyses and evaluates the legal requirements of clinical forensic examinations in general, and of evidence acquired using medical imaging methods in particular. The focus area of the legal workgroup is to investigate the possible implementation of these methods and evidence in Austria. Juridical research on clinical-forensic imaging means to examine the specific juridical framework concerning criminal law, medical law and public law. These legal requirements for the routine application of radiological techniques have to be analysed and in the case of legal obstacles solutions are developed.

The research activities in this area are inseparable from professional relationships with members of law enforcement, including the public prosecution services and judicial bodies as well as other governing bodies, such as federal ministries. Therefore quarterly *jour fixe* meetings with representatives from hospitals, police and prosecution have been established. Their purpose is to discuss and improve interdisciplinary processes as well as legal issues of the cooperation between these institutions and to stimulate the practice-oriented analysis of cases. This cooperation between the Medical University of Graz, State Criminal Police, Prosecution Graz and the LBI CFI delivers valuable impetus for legal research. Moreover the cooperation with judges and public prosecutors helps to achieve an analysis of court proceedings and demonstrates the progress in the field of clinical-forensic methods.

The work of the team law is closely linked with the Clinical-Forensic Care Unit and the daily forensic routine casework. For the support in legal issues a representative of the juridical team participates in the meetings of the team of doctors responsible for the clinical-forensic examinations. Reporting procedures for suspected physical violence cases are defined for medical personnel as well as for the police, child protection groups and institutions for victims of violence. For this reason the collaboration of the LBI CFI, the Institute of Criminal Law, Criminal Procedure Law and Criminology of the University of Graz and the Superior Court of Appeal of Styria and Carinthia is essential.

Moreover, the juridical team gives its expert advice to the members of the interdisciplinary team of the LBI CFI concerning the legal requirements of human research.

- **Summer 2015: Relevanzstudie:**

The study was planned and supervised by the legal team and conducted by a diploma student in law, Alexander Brantner, in collaboration with the Regional Criminal Court of Graz. The “Relevanzstudie” examined the importance of clinical-forensic investigations in the context of criminal investigation proceedings. The results should provide information on a correlation between the conduct of timely investigations and the indictment by the public prosecutor.

The anonymous review of about 100 files at the Criminal Court of Graz was finished at the end of August 2015.

The results and their publication are expected soon.

- **Autumn 2015:** Compilation on the Austrian juridical framework of clinical-forensic imaging:

The writing of this compilation on the Austrian juridical framework of clinical-forensic imaging comprises the results of the LBI CFI-research. The writing is in progress and conducted by Prof. Dr. Peter Schick within a book concerning clinical forensic imaging.

The publication is planned for April 2016th.

- **Winter 2015:** Forensigraphiestudie: The aim of this scientific online survey is to determine the use of forensic imaging in Austria. This study was carried out anonymously and in cooperation with the Ministry of Internal Affairs. The questions are based on imaging techniques and procedures that are used in Police units for forensic investigations.

The publication is planned for the first half of 2016th.

2.2 Cooperation

2.2.1 Scientific cooperation

Scientific collaborations with national and international institutions have been established in the different fields and areas of research of the LBI CFI. This cooperation is 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.

Cooperation 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*, headed 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*.

A scientific collaboration also exists with the former director of the LBI CFI, Prof. Eva Scheurer, director of the *Institute of Legal Medicine in Basel, Switzerland*.

For the research in dental MRI, a cooperation has been established with Dr. Julian Boldt, *Department for Oral and Maxillofacial Surgery, University of Würzburg*, and Dr. Heiko Merkens, dentist with a private practice in Aachen. The main benefit for the collaborators in this field is the facilitated demonstration of wisdom teeth and other dental structures by MRI.

The neuroimaging research unit of the *Department of Neurology, Medical University of 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.

A cooperation with Prof. Silke Grabherr of the *Institute of Legal Medicine in Lausanne and Geneva, Switzerland*, focusses on post mortem MR angiography.

Furthermore, a good and long standing scientific cooperation exist with:

Prof. Gerhard Ranner and Dr. Gerlinde Komatz, *CT/MR Zentrum Graz*, and Prof. Michael Fuchsjäger, *Department of Radiology, Division of General Radiological Diagnostics, Medical University of Graz*, as well as Prof. Hannes Deutschmann, *Department of Radiology, Division of Neuroradiology, Medical University of Graz*, who support the LBI CFI with radiologic reading and interpretation.

Dr. Franz Quehenberger of the *Institute for Medical Informatics, Statistics and Documentation, Medical University of Graz*, supports and cooperates with the LBI CFI in relation to data analysis.

MR physics

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

For the dating of fractures, we established 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 exists with Prof. Horst Bischof and Prof. Dieter Schmalstieg, *Institute for Computer Graphics and Vision (ICG), Graz University of Technology*. In addition to Prof. Bischof, Martin Urschler works together with Prof. 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). In 2015, Dr. Darko Stern, a post-doc at the ICG financed via a Marie Curie International Exchange Fellowship grant, worked on an automatic software method for age estimation from MR hand images in close cooperation with LBI CFI, together with two master students (Thomas Ebner, Walter Unterpinker).

Our cooperation with the *Ludwig Boltzmann Institute for Lung Vascular Research, Graz* (Dr. Zoltan Balint, DI Michael Pienn) has been continued. We work together on the extraction and analysis of vascular structures from pulmonary CT images. This topic was the focus of an ongoing master thesis by Christian Payer, dedicated to the automatic separation of arterial and venous vascular trees under the supervision of Martin Urschler.

2.2.2 Non-scientific cooperation

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

As a practical interdisciplinary basis for the research at the LBI CFI, regular *jour fixe* meetings with representatives from the state hospital (LKH Graz), police and prosecution are held. The aim of these meetings is to optimize communication and cooperation between these institutions concerned with incidents of violence. Four meetings have been held in 2015 and several issues concerning work processes and cooperation as well as forensic cases have been discussed and analyzed. 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.

A new cooperation with the Styrian Hospitals Company (KAGes) concerning in-house trainings has started in fall of 2015: KAGes personnel of the peripheral hospitals is trained by physicians of the Clinical Forensic Care Unit for a better recognition and documentation of physical violence.

2.3 Third party projects

Third party projects 2015	Funding body	Duration
HTI:Tech_for_Med “Standard MRT”	Land Steiermark	01.04.2014 – 31.03.2016
DOC-Stipend “PMMRA”	ÖAW	01.05.2015 – 30.04.2018
“FAME”	FWF	01.07.2015 – 30.06.2018
FEMtech internship	FFG, BMVIT	01.09.2015 – 30.11.2015
KIRAS “CSISmartScan3D”	FFG, BMVIT	01.11.2015 – 31.10.2017
Subvention “Clinical Forensic Outpatient Centre”	Stadt Graz	onetime in 2015
Total number:	6	

Table 3: Third party projects 2015

In 2015, the LBI CFI attained great success in acquisition of third party funding. In addition to the ongoing HTI: Tech_for_Med “Standard MRT” project, Bridgette Webb received a three-year DOC-fellowship from the Austrian Academy of Sciences (ÖAW) for the study of “Systematic development of post-mortem magnetic resonance angiography (PMMRA)”. Furthermore, the stand-alone project “FAME: Fully Automatic MRI-based age Estimation of adolescents” of Martin Urschler in cooperation with the Technical University Graz was funded by the Austrian Science Fund (FWF) for three years. The interdisciplinary KIRAS project “CSISmartScan3D” started in November 2015 and receives funding from the Austrian Research Promotion Agency (FFG) and the Ministry for Transport, Innovation and Technology (BMVIT), respectively. In September 2015, Bridgette Webb recruited Daniela Kirchmeyr for a three-month internship in the PMMRA project, which was funded by the FEMtech program of the FFG and the BMVIT. The City of Graz (Stadt Graz Kulturamt) provided a one-off subvention for the Clinical-Forensic Outpatient Centre of the LBI CFI in cooperation with the Medical University of Graz.

2.4 Clinical Forensic Care Unit

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. 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.



Figure 21: Clinical Forensic Care Unit

The Clinical-Forensic Care Unit is the first Austrian Forensic Care Unit. It 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. In 2015, it has also been sponsored by the city of Graz.

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 charges have been filed. An on-call service— due to financial reasons and a staffing shortage currently available only on weekends – provides medico-legal expertise for hospitals, police stations, detention centers, and organizations offering help to victims, etc. after the usual office hours. Medico-legal assistance is also available by telephone and email to ensure a successful examination by other physicians in those cases in which an examination of the victim by LBI CFI staff is not possible (e. g. due to a great distance, etc.). Examinations in cases with suspected sexual assault or maltreatment of adults and children are mostly conducted in the corresponding hospital departments, in cooperation with a gynecologist or specialized pediatrician. Additionally, a medical doctor of the LBI CFI is a member of the clinical child protection group of the Department of Pediatric Medicine and the Department of Pediatric 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 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. As a consequence of the current migrant influx, the number of age estimations in asylum cases has greatly increased in 2015.

For the enhancement of communication between prosecution, police, clinical and forensic medicine, regular *jour fixe* meetings are conducted (see section 3.1.2); these meetings ensure an optimal procedure for victims of violence. Furthermore, this cooperation between

Medical University of Graz, the state criminal police, the district attorney of Graz, and the LBI CFI delivers interesting starting points for the key area of legal research.

After the conclusion of the state-sponsored project “Klinisch-Forensisches Netzwerk Steiermark” (clinical forensic network Styria, KfN) in December 2014, some services of the project, such as the possibility for peripheral hospitals to get medico-legal advice via telephone or email, have been sustained. This portfolio of clinical forensic services is also presented in the context of the in-house training organized by the Styrian Hospitals Company (KAGes) for their hospitals. Physicians of the Clinical Forensic Care Unit have been involved in teaching nurses and doctors in recognition and documentation of physical violence since October of 2015.

Table 5 presents an overview of the cases that have been seen at the Clinical-Forensic Care Unit in 2015. Most age estimations are performed on behalf of the Federal Office for Migration and Refugees; the other cases are examined by order of the prosecution (in criminal cases) or on a consultation basis for clinicians. Overall, 13 % of all cases (but 68 % of all clinical forensic examinations) were not reimbursed.

Clinical-Forensic Care Unit	2015
Physical violence (against adults > 18 years)	17
Sexual violence (> 18 y)	39
Physical child abuse (< 18 y)	18
Sexual child abuse (< 18 y)	21
Forensic age estimation in living persons	441
Other cases	9
<i>Cases in total</i>	545

Table 4: Overview of the cases seen at the Clinical-Forensic Care Unit 2015

2.5 Publications

2.5.1 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.

2.5.2 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 2015. The effort put into evaluation and manuscript preparation will be pursued in 2016.

2.6 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 2015 10 oral presentations and 11 poster presentations were given by researchers of the LBI CFI.

An overview of the contributions to the different scientific communities in 2015 is given here:

Forensic medicine

- Annual Scientific Meeting of the German Association of Forensic Medicine (DGRM), 15.09. – 19.09.2015, Leipzig, Germany

Magnetic resonance in medicine and biomedical engineering

- Annual Meeting ISMRM, 30.05. – 05.06.2015, Toronto, Canada
- Annual Meeting ESMRB, 01.10. – 03.10.2015, Edinburgh, United Kingdom

Computer graphics:

- MICCAI 2015, 05.10. – 09.10.2015, München, Germany
- ICCV 2015, 11.12. – 19.12.2015, Santiago de Chile, Chile
- OAGM/AAPR Workshop 2015, 28.05. – 29.05.2015, Salzburg, Austria

Forensic Imaging:

ISFRI/IAFC Joint Congress 2015, 13.05. – 17.05.2015, Leicester, United Kingdom

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

- 04.02. – 05.02.2015 Winter Augmented Reality Meeting 2015, Graz
- 24.02.2015 FIDIAS Crowdfunding Workshop der SFG, Graz
- 26.02.2015 Vernetzungstreffen der Österreichischen Opferschutzgruppen, Innsbruck
- 05.03.2015 BioTechMed Lab Visit: Klinisches Institut für Medizinische u. Chemische Labordiagnostik, Graz
- 06.03.2015 ECR-Kongress, Wien
- 18.03.2015 20 Jahre Kinder- und Jugendanwaltschaft Steiermark, Graz
- 20.03.2015 AGFAD-Treffen, Berlin
- 20.03.2015 Symposium MRT-Forschung, Graz
- 20.03.2015 Südsteirischer Frühlingsdialog – FIRM, Ehrenhausen
- 23.03. – 24.03.2015 Symposium Sterbehilfe, Frankfurt am Main
- 27.03.2015 AGFB-Treffen, Frankfurt am Main
- 09.04.2015 BioTechMed Informationsveranstaltung, Graz
- 13.04.2015 Club Scientifica „Die Kunst des Netzwerkers“, Kunstuniversität Graz
- 16.04.2015 Meet Science der Ludwig Boltzmann Gesellschaft 2015, Wien
- 17.04.2015 Workshop „Dokumenten-Check“ und „Kriminalpolizeiliche Untersuchungsstelle“, Graz
- 22.04.2015 Netzwerktreffen: Sexualisierte Gewalt beginnt im Alltag – Alltagssexismus, Graz
- 11.06. – 12.06.2015 Menschenrecht – Bürgerrecht – Kinderrecht, Graz
- 24.06.2015 Netzwerktreffen gegen sexualisierte Gewalt, Graz
- 01.07.2015 Buchpräsentation „Die Vermessung der Seele“, Graz
- 07.07.2015 Informationsveranstaltung zur Verwendung medizinischer Proben & Daten, Graz
- 14.07.2015 Expertinnen-Gipfel zum Thema „Gewaltschutz“, Graz
- 23.09.2015 Fachtagung „Klinische Forschung an Einwilligungsunfähigen“, Graz
- 28.09.2015 Club Scientifica „The Privilege Walk“, TU Graz
- 05.10.2015 Symposium „Opferschutzorientierte Täterarbeit in Österreich“ des BMI, Wien
- 20.10.2015 Horizon 2020 Informationstag in der Steiermark, Graz
- 20.10.2015 LBG Weinherbst – Treffen der Wissenschafts- und Forschungscommunity, Wien
- 29.10.2015 Workshop: BioTechMed-Graz im europäischen Forschungsraum, Forschungsmanagement, Graz
- 29.10.2015 Informationsveranstaltung zu den Neuerungen bei BioTechMed, Graz
- 06.11.2015 KIRAS-Fachtagung, Wien

09.11.2015	Informationsveranstaltung „Zukunft Gerichtsmedizin und LBI-CFI“, Graz
16.11.2015	FFG Spezial-Workshop: Informationstechnologien im Gesundheitssektor – Förderungen in Horizon 2020, Wien
16.11.2015	FFG-Workshop „Humanpotenzialförderungen 2015/16“ - Förderinfotag, Wien
16.11.2015	FEMtech Netzwerktreffen: Kulturwandel in der außeruniversitären Forschung?, Wien
17.11.2015	Präsentation des Werkes „Korruption und Amtsmissbrauch“, Wien
26.11.2015	BioTechMed Lab Visit am Institut für Maschinelles Sehen und Darstellen, Graz
27.11.2015	Club Scientifica – Netzwerktreffen EWMD Austria, Graz
02.12.2015	IraSME Partnering Event - „Matchmaking Event“ um Partnerschaften für Forschung und Technologieentwicklung anzubahnen, Wien
04.12. – 05.12.2015	XV. Forensische Gespräche – Alkohol „Älteste Droge – immer aktuell“, Lübeck
10.12.2015	20 Jahre Gewaltschutzzentrum Steiermark, Graz
11.12.2015	7. Thementag Compliance-Management, Standards – Tools – Haftung, Graz
14.12.2015	Club Scientifica “Netzwerken im interdisziplinären Rahmen”, LBI CFI Graz

3 Other activities

3.1 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 in der DGRM
- AGFB – Arbeitsgruppe Forensische Bildgebung in der DGRM
- UFG – Arbeitsgruppe Universitäre Forensische Genetik in 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
- ISFG – International Society for Forensic Genetics
- IABPA – International Association of Bloodstain Pattern Analysts
- Deutscher Verkehrsgerichtstag

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

- AGFB (Alexander Bornik, Thorsten Schwark)
- AGFAD (Isabella Klasinc, Thorsten Schwark)
- Arbeitsgruppe Klinische Rechtsmedizin der DGRM (Nikolaus Krebs, Annemarie Wieland))
- FIRM - Forschungsinstitut für Recht in der Medizin (Peter Schick)
- UFG (Thorsten Schwark)

3.2 Lecture series

In 2015, the LBI organized the annual lecture series “The interdisciplinary world of forensic imaging”, which is open to the public. Nationally and internationally renowned speakers are invited to give a talk about their area of expertise, including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution, and criminal law as well as victim support. In 2015, the following lectures took place:

- Priv.-Doz.in Dr.in Nicole von Wurmb-Schwark, „Forensische Spurenanalyse – Von der Spur zum genetischen Fingerabdruck“, 28.01.2015
- Prof. Henning Müller, PhD, „Medizinische Bildanalyse für die Informationssuche und die Entscheidungsunterstützung“, 18.03.2015
- Dr. Michael Sandholzer, „Aktuelle Entwicklungen und neue Forschungsansätze in der Brandleichenidentifikation“, 22.04.2015

- Sara Kondert, „Die Bedeutung der rechtsmedizinischen Altersfeststellung für minderjährige Afghanen in Österreich“, 10.06.2015
- Prof. DDr. Fritz Schick, „Magnetresonanztomographie: Von der diagnostischen Bildgebung zur quantitativen Gewebecharakterisierung“, 23.09.2015
- Univ.-Prof.in Dr.in Silvia Ulrich, „Das Europaratsübereinkommen zur Verhütung und Bekämpfung von Gewalt gegen Frauen und häuslicher Gewalt“, 28.10.2015
- PD ao. Univ.-Prof. Mag. Dr. Wolfgang Neubauer, „Bildgebende Verfahren in der Archäologie“, 25.11.2015

Additionally, the LBI CFI organized a visit to LayerLab.net GmbH, „3D Scan und Printtechnik der Firma LayerLab.net“, on 25.02.2015, an event, which was also open to the public.

3.3 Teaching and training activities

Teaching activities

Academic teaching

- Appointment of Thorsten Schwark at Medical University Graz, as lecturer for the course “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt”, since WS 2014, with lectures given by Clemens Kauderer, Isabella Klasinc, Nikolaus Krebs, Kathrin Ogris and Thorsten Schwark.
- Appointment of Thorsten Schwark at Medical University Graz, as lecturer for the interdisciplinary course “Basiswissen Gerichtsmedizin”, since WS 2014, with lectures given by Clemens Kauderer, Isabella Klasinc, Nikolaus Krebs, Reingard Riener-Hofer, Thorsten Schwark, Martin Urschler, Bridgette Webb and Annemarie Wieland as well as some colleagues from the Institute of Forensic Medicine, Medical University Graz (Manfred Kollroser, Peter Leinzinger, Kathrin Ogris, Barbara Reichenpfader).
- Appointment of Thorsten Schwark at Medical University Graz, as lecturer for the interdisciplinary course “Einführung in die forensischen Wissenschaften”, since WS 2015, with lectures given by Katharina Baron, Alexander Bornik, Reingard Riener-Hofer, Thorsten Schwark, Martin Urschler and Bridgette Webb.
- Appointment of Martin Urschler at Graz University of Technology, as lecturer in “Medical Image Analysis” as a part of the computer science and biomedical engineering curricula, since SS 2008.

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. Thus, the strategic policy of the management is to support such activities and, particularly, to encourage the residents in forensic medicine to acquire experience in teaching.

Examples of non-academic teaching:

- Lecture on “Sexual abuse – what evidence to secure” for University Hospital Graz, Department of Gynecology and Obstetrics, given by Isabella Klasinc and Thorsten Schwark, August 12, 2015
- Lecture on “Physical and sexual violence“ for members of the victim protection groups of KAGes (Styrian Hospital Company) hospitals, given by Isabella Klasinc, Thorsten Schwark and Annemarie Wieland, October 5, 2015
- In-house training “How to recognize and document physical and sexual abuse” for Feldbach State Hospital, given by Isabella Klasinc, Thorsten Schwark and Annemarie Wieland, November 30, 2015
- Lecture on “Effects of alcohol consumption on minors” for Child Welfare Graz, given by Thorsten Schwark, October 13, 2015
- Workshop “Age diagnostics in living persons”, lectures given by Thorsten Schwark, Martin Urschler, and Thomas Widek, November 11, 2015
- Lecture on “Typical injuries of child abuse” for the Medical Service of the City of Graz, given by Thorsten Schwark, 27.11.2015

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)
- Dr. Kathrin Ogris: “Characterization of subcutaneous soft tissue injuries”.
Dissertation (Supervision by Eva Scheurer)
- Mag. Katharina Baron, M.Sc.: “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)

- Bridgette Webb, M.Sc.: “Systematic development of post-mortem MR angiography (PMMRA) procedures and analysis of potential contributions to minimally-invasive autopsy (MIA)”.
Dissertation (Supervision by Rudolf Stollberger, TU Graz)
- Naira Martinez Vera, M.Sc.: “Alzheimer drugs incorporated in nanoparticles for specific transport over the blood brain barrier”.
Dissertation (Supervision by Stefan Ropele)
- 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)
- Stefan Ozlberger: “PID und embryopathischer Schwangerschaftsabbruch – ein Rechtfertigungsproblem”.
Diploma thesis (Supervision by Peter Schick)
- Kerstin Hammernik: “Convex Framework for 3D Medical Image Segmentation using Global Constraints”
Diploma thesis (Supervision by Martin Urschler and Thomas Pock, ICG, Graz University of Technology)
- Thomas Ebner: “Automatic detection of wrist bones from MRI”
Diploma thesis (Supervision by Martin Urschler)
- Christian Payer: “Separation of Arterial and Venous Pulmonary Trees from CT Images”
Diploma thesis (Supervision by Martin Urschler together with Michael Pienn and Zoltan Balint, LBI LVR, Graz)
- Walter Unterpinker: “Anatomical landmark localization for an automatic multi-factorial age assessment system”
Diploma thesis (Supervision by Martin Urschler)
- Patrick Torreiter: “Evaluierung quantitative MR-Bildgebung von Hämatomen”
Diploma thesis (Supervision by Eva Scheurer)
- Judith Schernthaner: “Forensische Rekonstruktion von Schädelhirntraumata bei Kindern und Jugendlichen”
Diploma thesis (Supervision by Eva Scheurer)
- Christof Sirk: “Dynamic Label Placement in Volumetric Scenes”
Diploma thesis (Supervision by Alexander Bornik)

- Alexander Brantner: "Relevanz von Befunden körperlicher Untersuchungen für die staatsanwaltliche Entscheidungsfindung"
Diploma thesis (Supervision by Peter Schick)
- Nadja Paulus: "Der virtuelle Lokalausweis und seine strafrechtlichen und strafprozessualen Schranken"
Diploma thesis (Supervision by Peter Schick)
- Sabine Grassegger: "Aufgaben des Krankenhausmanagements bezüglich der gesetzlichen Verpflichtung zur Einrichtung von Opferschutzgruppen gemäß §8e Abs 4 KaKuG"
Diploma thesis (Supervision by Peter Schick)
- Lisa Moser: "Beeinträchtigung von Frakturheilungsverläufen durch spezifische Indikatoren"
Diploma thesis (Supervision by Katharina Baron)
- Daniela Kirchmeyr: "PMMRA Sequenzen"
FEMtech internship (Supervision by Bridgette Webb)
- Thomas Widek: "Dental age estimation: The chronology of mineralization and eruption of the wisdom teeth with 3T MRI"
Master thesis (Supervision by Eva Scheurer)

3.4 Reviewing activities

Journals

European Journal of Oral Sciences (Thorsten Schwark)

Forensic Science, Medicine and Pathology (Thorsten Schwark)

IEEE Transactions on Visualization and Computer Graphics (Alexander Bornik)

Forensic Science International (Alexander Bornik)

IEEE Transactions on Medical Imaging (Martin Urschler)

IEEE Transactions on Pattern Analysis and Machine Intelligence (Martin Urschler)

Pattern Recognition (Martin Urschler)

Computer Vision and Image Understanding (Martin Urschler)

Medical Physics

Conferences

ISMAR (International Symposium on Mixed and Augmented Reality) (Alexander Bornik)

VRST (Symposium on Virtual Reality Software and Technology) (Martin Urschler)

MICCAI (International Conference on Medical Image Computing and Computer Assisted Intervention) (Martin Urschler)

ICCV (International Conference Computer Vision and Pattern Recognition) (Martin Urschler)

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

Book proposals

VISCERAL Book 2015, 2 chapters

Scientific grants proposals

Österreichische Nationalbank

4 Outlook

Outlook

Following the interdisciplinary character of our research focus in clinical forensic imaging the scientific program of 2016 is characterized by the interdisciplinary cooperation of our four teams: Team Forensic Medicine, Team Forensic Technology, Team Forensic natural sciences and Team Law. The main task will be to intensify the current activities of data evaluation, manuscript preparation and publication of results to fulfil the research program for the next term, which takes into account the suggestions made by the evaluation panel, has been prepared.



Figure 21: Key Researcher from the LBI CFI. From left to right: Dr. Thorsten Schwark, Dr. Hanna Sprenger, Dr. Reingard Riener-Hofer, Dr. Alexander Bornik, and Dr. Martin Urschler

The collaboration with our institutional partners Medical University Graz (MUG), 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) and the Ministry of Internal Affairs will support us. 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.

In the next year, 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 area of expertise, 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. Following speakers are planned for the lecture series in 2016: *Dr.in Andrea Kalloch* (Rotes Kreuz Steiermark), *Dr. Blaz Cugmas* (Faculty of Electrical Engineering, University of Ljubljana), *Em.Univ.-Prof. Dr.iur. Peter Schick* (Institut für Strafrecht, Strafprozessrecht und Kriminologie, Karl-Franzens-Universität Graz), *Assoz.-Prof. Mag.iur. Dr.iur. Christian Bergauer* (Institut für Rechtsphilosophie, Rechtssoziologie und Rechtsinformatik, Karl-Franzens-Universität Graz), *Dr.in Chiara Villa* (Department of Forensic Medicine, University of Copenhagen), *Dr. med. Wolf-Dieter Zech* (Institut für Rechtsmedizin, Medizinische Fakultät, Universität Bern), *Prof.in Dr.in Kathrin Yen* (Institut für Rechtsmedizin und Verkehrsmedizin, Universitätsklinikum Heidelberg). Moreover, an excursion to the headquarters of ams AG, located in Unterpremstätten (Tobelbader Straße 30, 8141 Unterpremstätten), are planned. The newly started practical lecture series „Introduction in

Forensic Sciences”, which was a great success in 2015, as well as the lecture series “Basiswissen Gerichtsmedizin” at the Medical University Graz will be continued in the next year.

The following projects are ongoing in 2016:

To continue successfully ongoing projects and submit new project proposals will constitute a large part of our work in 2016:

- **Fame - Fully Automatic MRI-based age Estimation of adolescents**

(Project Leader: Dr. Martin Urschler)

This project is funded by the Austrian Science Fund (FWF). The FWF is Austria's central funding organization for basic research.

Work on FAME starts with July, 1st 2015 and will last for three years. Dr. Darko Stern and MSc. Christian Payer will work on this project, together with master students at Institute for Computer Graphics and Vision. Students interested in participating in this project with master projects, master theses or summer jobs are invited to get in contact.

- **CSISmartScan3D**

(Project Leader: Dr. Alexander Bornik)

This is a project within the framework of KIRAS. The Austrian Security Research Programme KIRAS supports national research projects whose results contribute to the security of all members of society.

CSISmartScan3D is funded for a period of 24 months starting with November 2015 and has the aim to create the technical and basis to establish 3D surface scanning for crime site documentation in daily routine by overcoming technical, ergonomic and economic restrictions of current 3D scanners.

- **ForensiKids**

(Project Leader: Dr. Hanna Sprenger)

This project was submitted in late 2015 at the FFG (The Austrian Research Promotion Agency) and is funded for a period of 26 months.

The aim of the project "ForensiKids" is to introduce children and adolescents from kindergartens and schools in Graz and its surroundings to the interdisciplinary nature of forensic sciences with emphasis in the area of forensic imaging. Interest in science and technology should be already awakening in the childhood in order to allow an expansion of career prospects.

5 List of publications

Peer reviewed papers

Baumann P, Widek T, Merkens H, Boldt J, Petrovic A, Urschler M, Kirnbauer B, Jakse N and E. Scheurer. Dental age estimation of living persons: comparison of MRI with OPG. *Forensic Sci Int*, 253:76-80 DOI: 10.1016/j.forsciint.2015.06.001 (2015)

Diwoky C, Liebmann D, Neumayer B, Reinisch A, Knoll F, Strunk D and R. Stollberger. Positive contrast of SPIO-labeled cells by off-resonant reconstruction of 3D radial half-echo bSSFP. *NMR Biomed.*, 28(1):79-88 (2015)

Hassler E, Ogris K, Petrovic A, Neumayer B, Widek T, Yen K and E. Scheurer. Contrast of artificial subcutaneous hematomas in MRI over time. *Int J Legal Med*, 129(2):317-324 DOI: 10.1007/s00414-014-1124-8 (2015)

Modrow JH, Revyakina O, Reder H, Hasse J, von Wurmb-Schwark N and T. Schwark. Molekulargenetische Identifikation von Canidae in der forensischen Praxis. *Rechtsmedizin*, DOI: 10.1007/s00194-015-0036-3 (2015)

Petrovic A, Scheurer E and R. Stollberger. Closed-form solution for T2 mapping with nonideal refocusing of slice selective CPMG sequences. *Magn Reson Med*, 73(2):818-827 (2015)

Schenk F, Aichinger P, Roesner I and M. Urschler. Automatic high-speed video glottis segmentation using salient regions and 3D geodesic active contours. *Annals of the BMVA*, 2015(3):1-15 (2015)

Schwark T, Modrow J. H., Steinmeier E, Poetsch M, Hasse J, Fischer H and N. von Wurmb-Schwark. The auditory ossicles as a DNA source for genetic identification of highly putrefied cadavers. *Int J Legal Med*, DOI: 10.1007/s00414-015-1177-3 (2015)

Urschler M, Grassegger S and D. Stern. What automated age estimation of hand and wrist MRI data tells us about skeletal maturation in male adolescents. *Annals of Human Biology*, 42(4):356-365 DOI: 10.3109/03014460.2015.1043945 (2015)

von Wurmb-Schwark N, Podruks E, Schwark T, Göpel W, Fimmers R and M. Poetsch. About the power of biostatistics in sibling analysis – comparison of empirical and simulated data. *Int J Legal Med*, 129(6):1201-1209 DOI: 10.1007/s00414-015-1252-9 (2015)

Webb B A, Petrovic A, Urschler M and E. Scheurer. Assessment of fiducial markers to enable the co-registration of photographs and MRI data. *Forensic Sci Int*, 248:148-153 (2015)

Webb B A and S. Scheicher. Engaging police and community: The role of forensic practitioners in responding to abusive situations. *European Police Science and Research Bulletin* 13 (2015)

Book, book chapters and other publications

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