



Ludwig Boltzmann Institute  
Clinical Forensic Imaging

# ANNUAL REPORT

# 2016



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## Team

### Directorate:

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PD Dr. Thorsten Schwark

### Team members:

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PD Dr. Thorsten Schwark

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## Partners

Ludwig Boltzmann Gesellschaft GmbH  
Medical University of Graz  
University of Graz  
Superior Court of Appeal of Styria and Carinthia  
Heidelberg University Hospital  
Federal Ministry of Internal Affairs

## Committees

### **Scientific Advisory Board**

Prof. Guy Rutty – University of Leicester, East Midlands Forensic Pathology Unit  
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 Genf  
Prof. Dr. Gustav Strijkers – Department of Biomedical Engineering, Eindhoven University of  
Technology

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

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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 characterized by the cooperation of four scientific disciplines: 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. Additionally interdisciplinary meetings with external experts (Radiology and MR Physics) are held on a monthly basis to incorporate new ideas and approaches into the existing scientific work.

The cooperation of the before mentioned disciplines is mirrored in 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 academic 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 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 2016 the annual budget of the LBI CFI funded by the Ludwig Boltzmann Gesellschaft (LBG) and institutional partners was 1.5 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) complementary to an external inspection could provide an objective basis for the forensic evaluation. However, the aim of forensic imaging is completely different from that of 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. It is necessary to perform additional systematic MRI and CT studies targeting at forensic problems to get a scientific basis for the implementation of 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). During these meetings, current 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. Research 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. The 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.



### **University of Graz**

The Institute of Criminal Law, Criminal Law Procedure and Criminology of the 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 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.



UniversitätsKlinikum Heidelberg

### **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.



### **Federal Ministry of Internal Affairs**

The Federal 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.

## 1.3 Supervisory Board and Scientific Advisory Board

### 1.3.1 Supervisory Board

The Supervisory Board of the LBI CFI consists of representatives from the five partner institutions (Medical University of Graz, Karl-Franzens-University of Graz, Superior Court of Appeal of Styria and Carinthia, Heidelberg University Hospital, Federal Ministry of Internal Affairs) and the management of the Ludwig Boltzmann Gesellschaft GmbH (LBG). 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 Mag.<sup>a</sup> Caroline Schober-Trummler (Medical University Graz) as chair
- Mag. Gerd Obetzhofer (Superior Court of Appeal Graz)
- Vizerektor Univ.Prof. Dr. Martin Polaschek (Karl-Franzens University Graz)
- Prof. Dr. Kathrin Yen (Heidelberg University Hospital)
- Generalmajor Gerhard Lang (Federal Ministry of Internal Affairs)
- Dr. Peter Mayrhofer (Ludwig Boltzmann Gesellschaft GmbH)

Supervisory Board meetings took place on 02.05.2016 and 16.11.2016 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:

- Prof. Guy Ruttly (University of Leicester, East Midlands Forensic Pathology Unit) 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 Genf)
- Prof. Dr. Gustav Strijkers (Department of Biomedical Engineering, Eindhoven University of Technology)

The annual meeting of the Scientific Advisory Board took place on 25.10.2016 at the Institute in Graz.

## 1.4 Human resources and development

### 1.4.1 Interdisciplinary Research within the LBI CFI

The character of the institute is shaped by its interdisciplinary research, done by the four scientific disciplines, covering forensic medicine, forensic technology, forensic natural sciences and forensic law. All researchers benefit from the expertise in their own as well as from other discipline, 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, and ideas for projects. 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. An external expert, Stefan Ropele (MR physicist) together with PhD students and the forensic radiographer come together to discuss current MR studies of the teams, new publications on MR approaches and novel ideas for further research concerning MRI. Additionally a radiology meeting is also held on a monthly basis. Again an external expert, Thomas Ehammer (forensic radiologist) discusses current research issues with the interdisciplinary team. 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. Altogether, 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 directors responsible for the juridical-administrative and the medical-scientific management. Both directors are also acting as key researchers (forensic medicine and law). This form of management ensures the research’s consistent adaptation to legal and forensic requirements. Thorsten Schwark is Key Researcher of the Team Forensic Medicine. In his research area “radiologic evidence in forensic reconstruction and age estimation” is located, as well as the Clinical Forensic Examination Unit. Reingard Riener-Hofer the Key Researcher of the Team Law, which comprises the legal research area as well as legal attendance to research concentrations & services. The Team Forensic Technology (Key Researchers: Alexander Bornik, Martin Urschler) is responsible for “image processing & computer graphics”, “crime scene & incident reconstruction”, as well as “magnetic resonance methodology”. The Team Forensic Natural Sciences (Key Researchers: Sylvia Scheicher, Hanna Sprenger) covers besides natural science studies the interdisciplinary project management of the institute. 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 1: The LBI CFI team

In 2016 the LBI CFI consisted of the following employees

	Function	Discipline
<b>Management &amp; Key Researchers</b>		
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	Senior Scientist / Scientific Editor Key Researcher	Forensic Natural Sciences, Molecular Biology
Urschler Martin	Senior Scientist, Key Researcher	Image Analysis & Computer Vision

<b>Team Forensic Medicine (Key Researcher: Thorsten Schwark)</b>		
Klasinc Isabella	Researcher, General Practitioner	Forensic Medicine
Wieland Annemarie	General Practitioner	Clinical Forensic Medicine
<b>Team Forensic Natural Sciences (Key Researchers: Sylvia Scheicher, Hanna Sprenger)</b>		
Baron Katharina	PhD Student Medical Sciences, Researcher	Biological Anthropology, Forensic Physics
Ferk Simone	FEMtech intern	Biomedical Engineering
Webb Bridgette	PhD Student Biomedical Engineering, Researcher	Forensic Sciences
Widek Thomas	Radiographer, Researcher	Forensic Radiography
<b>Team Forensic Technology (Key Researchers: Alexander Bornik, Martin Urschler)</b>		
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
Štern Darko	Post-Doc Researcher	Image Analysis & Computer Vision
Zehentner Franz	Student Assistant	Image Analysis & Computer Vision
<b>Team Law (Key Researcher: Reingard Riener-Hofer)</b>		
Kainz Simone	Researcher Doctoral Candidate Law	Law
Kerbacher Sophie (Maternity leave substitution for Simone Kainz)	Researcher Doctoral Candidate Law	Law
Pfeifer Michael (Maternity leave substitution for Simone Kainz)	Student Assistant	Law
<b>Administrative Staff</b>		
Reisner Evelyn	Executive Team assistant	
Sattler Alexandra (Maternity leave substitution for Evelyn Reisner)	Team assistant	

Table 1: Overview of staff in 2016

### 1.4.3 Education and training

#### Internal education and training

- Weekly team-meetings serve for communication between Key Researcher and researcher and help to coordinate and promote the scientific work.

- 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. Therefore, monthly interdisciplinary study presentations of all researchers support the scientific exchange between the medical, the technical, the natural sciences and the juridical team.
- 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 for the LBI CFI Team.



Figure 2: 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, as well as scientific visits abroad, in which researchers of the LBI CFI participated during 2016, are:

- 36. Spurenworkshop, organized by the German Association of Forensic Medicine, Essen, Germany (19.02.2016)
- Seminar "Gendersensible Didaktik in der universitären Lehre", organized by the KFU, Graz (04.03.2016)
- Introduction into Python for Life Science Researchers, organized by the MUG, Graz (13.04.2016)

- WIRTSCHAFTSKOMPETENZ – Einführung in die Businessplanung für WissenschaftlerInnen, organized by the MUG, Graz (14.04.2016)
- Mein Projekt gelingt! – Führungsworkshops von w-fFORTE, Wien (26.04.2016)
- Meet the Expert - Workshop „Training für Bewerbungen in und außerhalb von Universitäten“, organized by the LBG, Wien (10.05.2016)
- Aufbau Lehre „Teaching in English“, organized by the MUG, Graz (18.05.2016)
- Mein Projekt gelingt! – Führungsworkshops von w-fFORTE, Wien (23.05.2016)
- Archäologie 2.0, organized by the LBG, Wien (01.06.2016)
- Key Researcher Training - Change Management, organized by the LBG, Wien (10.06. – 11.06.2016)
- “Führungskräfteworkshop”, organized by the LBG, Hotel Panhans am Semmering (13.06. – 16.06.2016)
- Scientific Visit as a Principal Research Fellow at Griffith University, Brisbane, Australia (25.06. – 30.09.2016)
- Fortbildungsreihe GMI - „Forensik anhand von Kasuistiken“, organized by the MUG, Graz (06.07.2016)
- Fortbildungsreihe GMI - „Notfall / Katastrophenmedizin“, organized by the MUG, Graz (10.08.2016)
- Scientific Visit – MR Versuche, Lausanne, Switzerland (04.09. – 19.09.2016)
- Workshop “MRI Phase Contrast & Quantitative Susceptibility Mapping”, organized by the MUG, Graz (26.09. – 28.09.2016)
- Workshop MIGRATIONSWELLE 2015 – Das „Grenzmanagement Spielfeld“ im Fokus, organized by Verein Kriminalistische Studiengemeinschaft, Graz (19.10.2016)
- “Einführung neuer Mitarbeiter”, organized by the MUG, Graz (19.10.2016)
- Rhetorik und Präsentationstechniken, organized by the MUG, Graz (Sommer 2016)
- Workshop „Bild- und Urheberrecht in Lehre und Forschung aus der Praxis für die Praxis“, organized by the KFU, Graz (17.11.2016)
- Key Researcher Training - „Kritikgespräche und schwierige Gespräche konstruktiv führen“, organized by the LBI LVR, Bruck a.d. Mur (17.11. - 18.11.2016)
- Meet the Expert-Schreibworkshop, organized by the LBG, Wien (07.12.2016)

#### 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 20.05.2016 the 14<sup>th</sup> Styrian Leukämiehilfelauf took place. Four team members of the LBI CFI took the challenge of running 5 km for a good cause. They were actively supported by the Institute Director Dr. Reingard Riener-Hofer.



Figure 3: "Styrian Leukämiehilfelauf"

- In October, a team event took place. Together with the Ludwig Boltzmann Institute for Health Technology Assessment (LBI HTA) the LBI CFI organized a trip to the MAMUZ Museum Mistelbach, where the world's first comprehensive exhibition about Stonehenge and its landscape was shown outside of the UK. Within the exhibition, a good insight into the latest findings of the Stonehenge Hidden Landscape Project of the Ludwig Boltzmann Institute for Archaeological Propection and Virtual Archaeology (LBI ArchPro) was given. Moreover the excursion was a good opportunity to strengthen the contact between the three institutes of the Ludwig Boltzmann Gesellschaft.



Figure 4: The LBI CFI team with the LBI HTA team at MAMUZ Museum Mistelbach

- The LBI CFI Christmas dinner took place on 01.12.2016 at the Restaurant “Weißes Kreuz” in Graz. The team was spoiled with Styrian delicacies and it was a cheerful and relaxed evening.



Figure 5: The LBI CFI team before the Christmas dinner

## 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 suites). 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.

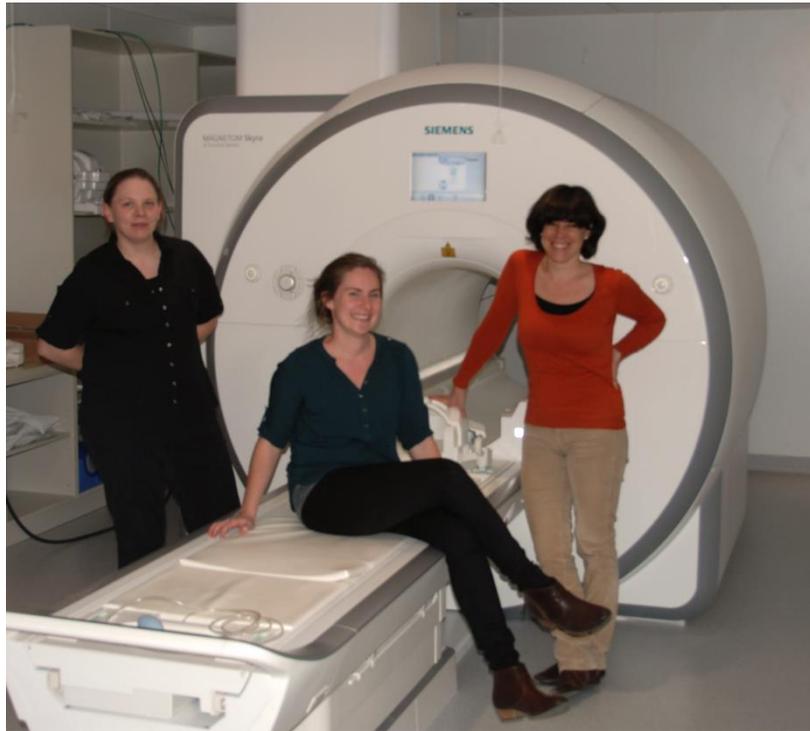


Figure 6: MR scanner at the University of Technology Graz with PhD students from the LBI CFI.

## 1.6 Highlights of the year

- **Lange Nacht der Forschung (Researcher's Night) in Graz**

For the third time, the institute took part at the Austrian-wide “Lange Nacht der Forschung 2016”. For the first time, the event was organized together with the Institute of Forensic Medicine of the Medical University of Graz. The employees of the LBI CFI showed topics of the institute to interested visitors (approximately 450 people). The highlights of the presentations were the Forensic Collection of the Institute of Forensic Medicine, an interactive visit of the DNA laboratory and the scanning of visitors with our 3D surface scanner. Moreover, a team of researchers of the Archaeology Museum, Schloss Eggenberg, showed spectacular excavations. The event was a great success and we are looking forward to the next “Lange Nacht der Forschung”!



Figure 7: 3D surface scanner at the “Lange Nacht der Forschung 2016”

- *Youth Meets Science!*

In 2015, the LBI CFI started the career information events “Youth Meets Science!”, which comprise site visits of school classes at the institute. During these visits, the institute members are presenting their personal career, information regarding high school and college opportunities for each specific profession, and have prepared some hands-on stations, e.g. 3D scans of pupils with the Microsoft Kinect sensor, blood stain or finger print analysis, or documentation of traces at the Clinical forensic Outpatient Center. From June 2015 to June 2016 we welcomed 150 pupils at the institute and the success is still ongoing, several requests reach our office every semester.



Figure 8: Youth Meets Science visit

- Project **ForensiKids** – *Kinder entdecken die Welt der Forensischen Wissenschaften*  
 Due to the great success of the *Youth Meets Science!* activities we decided to further deepen our efforts in promotion of young scientists by applying for a project within the funding program „Talents” of the Ministry of Transport, Innovation and Technology (BMVIT) together with the Austrian Research Promotion Agency (FFG). The program aims to encourage young people for a career in research and development. Therefore, it supports projects which bring together researchers with economy and schools from all over Austria to conduct science in school classes and even kindergarten. The project started in June 2016 and since then scientists of the LBI CFI are performing and will perform forensic experiments like finger print analysis, blood pattern analysis, 3D line laser scanning and much more in 2 elementary schools, 1 new secondary and 1 grammar school and even in 1 kindergarten. In the younger grades, the scientists are supported by the help of a hand puppet (Prof. Ms. Superschlau). The school classes also have the opportunity to visit the MRT of the Technical University Graz to learn more about this imaging technique.



Figure 9: Hand puppet Prof. Ms. Superschlau and finger print analysis in an elementary school

- The **FWF funded project FAME (Fully Automatic MRI based age Estimation of adolescents)** went into its first full year of research work, with Dr. Darko Štern employed at LBI CFI and DI Christian Payer working at the Institute for Computer Graphics and Vision, Graz University of Technology. Three papers from this project were accepted at the prestigious MICCAI conference on medical image computing, hosted in Athens Greece in October 2016, one of them was presented orally (< 5% acceptance rate).

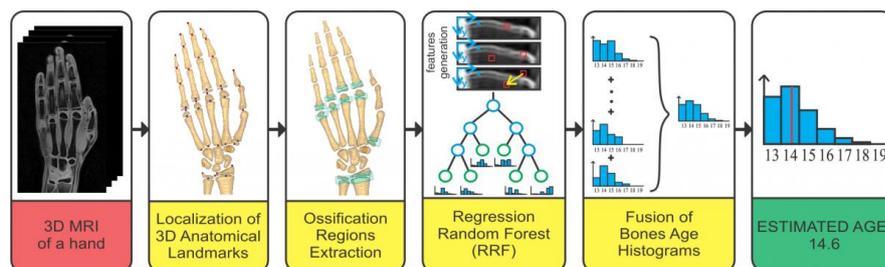


Figure 10: Work flow of the FAME project

- As part of **FFG-KIRAS funded project CSISmartScan3D** a mockup crime scene was designed and implemented by LBI CFI members with a strong forensic science background (Katharina Baron, Bridgette Webb). The scenario was used to test the developed crime scene documentation setup prototypes. Furthermore, research partners from the TU Graz (ICG, EMT) and the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology were invited to additionally document the crime scene using their own 3D scanners including the high resolution photogrammetry setup from the 3D Pitoti project (<http://www.3d-pitoti.eu>) and modern laser scanner. Besides huge amounts of data and a very comprehensive 3D documentation of the site, this event was used to maintain existing research collaboration and to initiate new ones.



Figure 11: CSISmartScan3D aims at the development of a 3D crime site documentation

- **Art meets Science!**

On 25.10.2016 the first “Art Meets Science!”-Event of the LBI CFI took place at the Café Bar Orange in Graz. The institute presented to the general public a deep house track, created by DJ Kaleeh. DJ Kaleeh used sounds generated by the MR sequences for this song. For the videoclip of the dance performance by the hip-hop group “One Nation” a thermal camera was used. The results can be seen on YouTube (“MRI-Sound of Science, Kaleeh feat. LBI CFI”; <https://www.youtube.com/watch?v=vZJvFM00o5E>)



Figure 12: Art Meets Science!

- **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 2016, the lectures were given by Dr. Andrea Kalloch; Dr. Blaz Cugmas (Ljubljana); Em.Univ.-Prof. Dr. Peter Schick (Graz); Assoz.-Prof. Mag. Dr. Christian Bergauer (Graz); Firma amsAG (Unterpremstätten); Dr. Chiara Villa, Department of Forensic Medicine (Copenhagen); Dr. Wolf-Dieter Zech (Bern); Prof. Dr. Kathrin Yen (Heidelberg).



Figure 13: Trip to the amsAG as a part of the lecture series

## 1.7 Public relations

### 1.7.1 Media contacts and reports

The LBI CFI 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:

- Ein digitaler Tatortassistent für die Polizei, Die Presse, 27.02.2016
- Lange Nacht der Forschung, 8 articles between April and June 2016
- Forschen und helfen, Profil Wissen, 15.06.2016
- Wie lässt sich nachvollziehen, wie alt ein Bluterguss ist?, Die Presse, 23.07.2016
- Ein Bild von der Todesursache, Der Standard, 05.10.2016
- Mord & Totschlag, Moments Steiermark, 05.10.2016
- Knochen und Zähne verraten das Alter, Die Presse, 15.10.2016
- Art meets Science!, grazer.at, 25.10.2016

### 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:

#### Youth Meets Science! in January, May and June 2016

In 2016 5 classes of the institutions BRG Kepler, WIKU BRG Graz and BRG Körösi visited the LBI CFI from January to June.



Figure 14: Youth Meets Science! visit BRG Kepler

Presentation of the book "Klinisch-Forensisches Netzwerk Steiermark – Sozialwissenschaftliche Evaluation und Bedarfserhebung" February 8<sup>th</sup> 2016

The LBI CFI invited to the presentation of the book "Klinisch-Forensisches Netzwerk Steiermark – Sozialwissenschaftliche Evaluation und Bedarfserhebung". The goal of the project "KfN Steiermark" (Klinisch-Forensisches Netzwerk Steiermark) was the establishment and institutionalization of a comprehensive coverage of Styria with a forensic medicine service offer for victims of violence. Within the scope of the project, the need for such a service was evaluated by social science. The result of this study has now been published in a book.

Guest Lecture „Äußere Leichenschau im Krankenhaus“ March 31<sup>st</sup> 2016

Dr. Thorsten Schwark was invited to give a lecture with the title "Äußere Leichenschau im Krankenhaus" in the Hospital of St. John of God (Krankenhaus der Barmherzigen Brüder).

AGN Kongress April 2<sup>nd</sup> 2016

Within the AGN Kongress in Graz, Dr. Thorsten Schwark gave a lecture with the title "Gewalt gegen Kinder – Prävalenz und Erkennen".

4<sup>th</sup> International Student Congress May 27<sup>th</sup> 2016

The Ludwig Boltzmann Institute for Clinical Forensic Imaging participated at the 4<sup>th</sup> ISC of the Medical University of Graz with a workshop on "Forensigraphy – Medical Imaging meets Forensics". The workshop gave an overview on forensic imaging in general and the possibilities of visual reconstruction and also included interesting case presentations of routine and scientific work at the LBI CFI. Thereby, the participants received an insight into the interdisciplinary field of research at our institute.

AMSA Project „Doctors Diary“ June 21<sup>st</sup> 2016

The Austrian Medical Students' Association invited Dr. Thorsten Schwark to their project "Doctors Diary", where doctors were able to present their different specializations to students within lectures and dialogues in small groups.

Symposium "Forensigraphie – Möglichkeiten und Grenzen IT-gestützter forensischer Bildgebung" June 24<sup>th</sup> 2016

The Law Faculty of the Karl-Franzens University of Graz invited to the conference "Forensigraphie". Within the conference, lectures were given by Dr. Reingard Riener-Hofer, Dr. Thorsten Schwark, Dr. Martin Urschler, and Dr. Alexander Bornik.

As part of the KinderUniGraz, Dr. Isabella Klasinc and Dr. Thorsten Schwark gave a lecture with the title "(Fast) wie ein Krimi - Spannendes aus der Gerichtsmedizin".

## 2 Research program and results

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### 2.1 Projects

The research program of the LBI CFI during the year 2016 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 176 MRI scans of living and deceased subjects were made. Table 2 shows an overview of the studies in which MRI scans were performed.

<b>MRT</b>	<b>2016</b>
Pedibrain	1
Subcutaneous hematomas	93
Fracture dating using MRI	29
PM Thrombus	4
Control measurements TU	4
Strangulation study	8
MRS lumbar spine (Reproducibility / Age estimation)	26
Age estimation using MRI	11
<i><b>Total</b></i>	<b>176</b>

Table 2: Overview of research MRI scans 2016

### 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.

In 2016, 1 volunteer was examined on a 3T scanner, the number of scanned persons totals 10. 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 being summarized in a diploma thesis, and the study is finished with the data available.

#### **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.

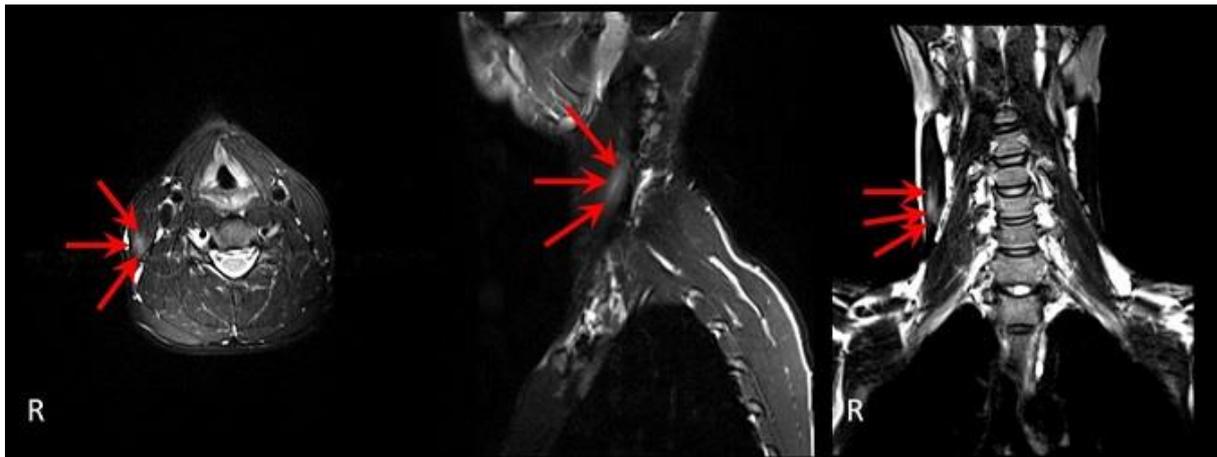


Figure 15: MR-images of the neck after survived strangulation (bleeding into the sternocleidomastoid muscle)

To date, data of 62 injured living victims and 10 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, 55 patients needing a CT scan have been recruited und 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). Recruitment of new participants has been ceased, and the available data will now be evaluated. A publication will be prepared, and the study will then be terminated.

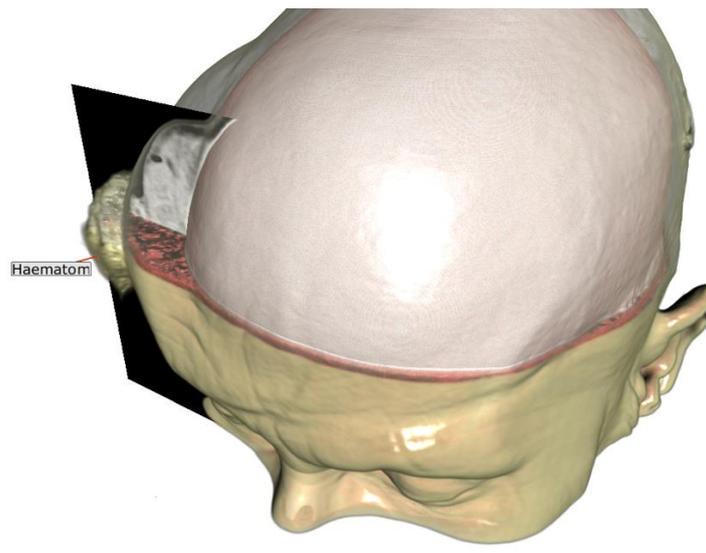


Figure 16: Example of a reconstruction of a scalp hematoma based on CT data

### **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 2016, 27 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. To enable for example a detailed assessment of inflicted fractures, various characteristics have to be considered, including the type of fracture and the localization. In these cases, 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 project aims to investigate the possible use of quantitative MR imaging (qMRI) for bone fracture dating by systematically investigating time-resolved changes in quantitative MR characteristics after a fracture event. This project was split into two main approaches. The first one is an explorative clinical trial with humans and the second one an additional data analysis of a preclinical trial with adolescent rats.

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 2016, 88 MR scans of 39 test subjects (♀:17 ♂:22; aged 19 – 65y; median: 30 y, scanned 1 to 6 times over a period of up to 18 month 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 (Baron et al., 2016b). Additionally, so far 29 of these test subjects were asked to fill in a questionnaire regarding their socio-economic standards, dietary habits or physiological fitness.

First results of the explorative clinical trial already indicated a very promising trend in time-dependent changes of quantitative MR parameters in the present number of evaluated scans. Parts of these results were published in January 2016 (Baron et al., 2016b). However, group wise comparisons indicated a dependency between qMRI and several parameters such as the socio-economic status, the age or the sex as well as tobacco or alcohol consumption of the individual test subject.

Due to the high complexity regarding several of these parameters that have to be taken into account (e.g. age, sex), an additional data analysis of a preclinical trial with rats was performed. This study aimed to simulate a longitudinal fracture analysis in order to evaluate the quantitative approach under better controlled experimental conditions. The corresponding results were published in November 2016 (Baron et al., 2016a). Since they showed detectable changes in qMRI under controlled conditions, these results underlined the findings of the clinical trial.

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

Especially the clinical trial 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.

New results were presented at conferences in May and September 2016: the ISFRI/IAFR Joint Congress (oral presentation) and the ESMRMB 33<sup>rd</sup> Annual Scientific Meeting (E-Poster and lightning talk/awarded with a Certificate of Merit (Baron et al., 2016c)).

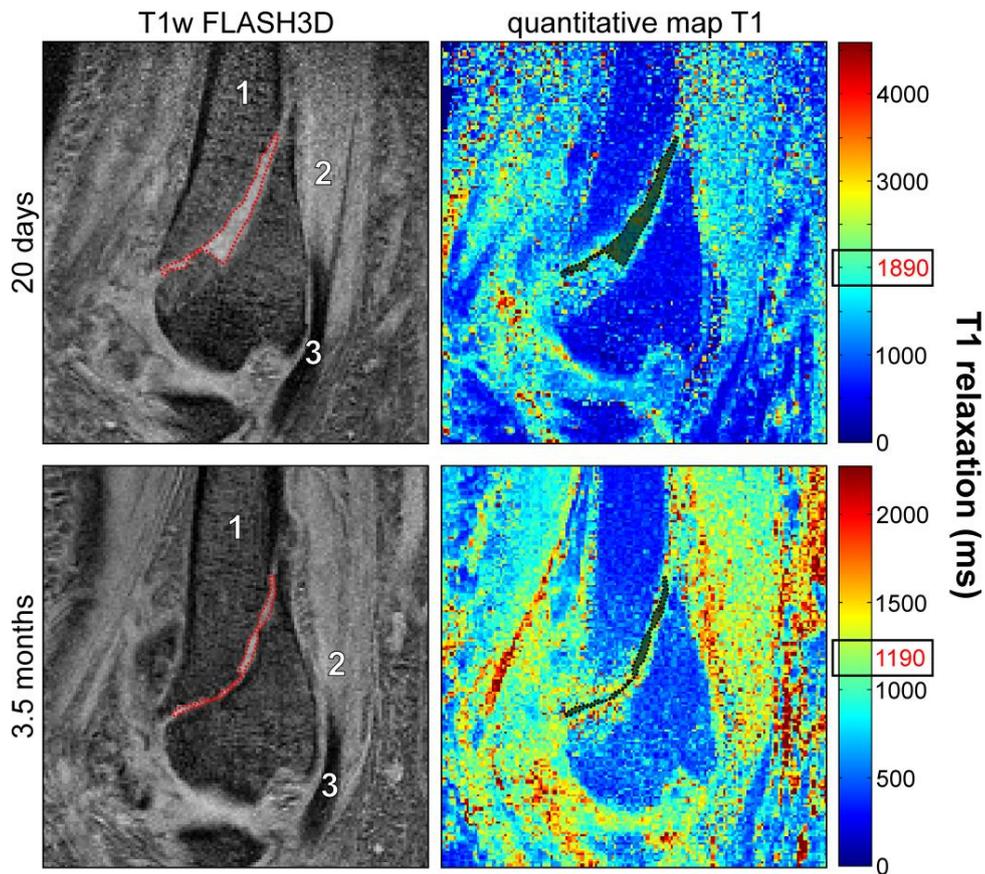


Figure 17: MR images of a Weber B fracture in a T1w FLASH3D sequence without preceding MT pulse 20 days (top) and 3.5 months (bottom) after the fracture event and corresponding quantitative T1 maps including the transferred ROIs (dashed lines). 1–3 specify the fibula, peroneus longus muscle, and peroneus longus tendon, respectively. (Baron et al., 2016b)

- BARON, K., NEUMAYER, B., AMERSTORFER, E., SCHEURER, E., DIWOKY, C., STOLLBERGER, R., SPRENGER, H. & WEINBERG, A. M. 2016a. Time-Dependent Changes in T1 during Fracture Healing in Juvenile Rats: A Quantitative MR Approach. *PLoS One*, 11, e0164284.
- BARON, K., NEUMAYER, B., WIDEK, T., SCHICK, F., SCHEICHER, S., HASSLER, E. & SCHEURER, E. 2016b. Quantitative MR Imaging in Fracture Dating - Initial Results. *For. Sci. Int.*, 261, 61-69.
- BARON, K., WIDEK, T., SPRENGER, H., NEUMAYER, B., HOFER, H., HASSLER, E. & SCHEURER, E. 2016c. Influences on fracture healing of long bones analysed by qMRI - ESMRMB 2016, 33<sup>rd</sup> Annual Scientific Meeting, Vienna, AT, September 29 – October 1: Abstracts, Saturday. *Magnetic Resonance Materials in Physics, Biology and Medicine*, 29, 389.

### 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 a 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. In 2016 we were able to publish in the journal *Forensic Science International* a work comparing individuals where hand radiographs as well as MRIs of the left hand were available regarding the applicability of the Greulich-Pyle and Tanner-Whitehouse methods on MRI data. We found that the differences are in the same range as the inter-observer errors.



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 2016, 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. Initial results of this study were reproduced in 2016 on a larger data set, and a manuscript was submitted to *Forensic Science International*, which is currently under revision. In summer 2016, student Franz Zehentner was funded by a project from the city of Graz to do research on automatic landmark localization of the clavicle and the manubrium.

### **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 have used the resources obtained from the FWF project FAME (Fully automatic MRI-based age estimation of adolescents, P28078-N33) to lay our focus on the automated biological and chronological age estimation of hand MRI data. Two works, one on landmark localization to automatically find age relevant anatomical structures and one on fusion of individual bones for age estimation of the whole hand were presented at the ISBI symposium in April in Prague. Three works, two on landmark localization and one one deep learning based age estimation from hand MRI volumes were selected for presentation at the prestigious MICCAI conference in Athens in September. The work of Christian Payer was there selected as an oral presentation, which has an acceptance rate below 5%.

Several students started working with us on this topic in 2016. Franz Zehentner and Thomas Neff are both working towards their master's theses. In summer 2016, our team was also joined by Philipp Kainz, who did software engineering work for us in the context of machine learning and deep learning.

### **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.

In 2016 work on automated and dynamic placement of text and image labels was continued Christof Sirk finished his Masters thesis and obtained his MSc. degree in April 2017. Furthermore a short-paper got accepted at EuroVis 2017. The new label placement algorithm allows labels to be flexibly placed in regions in semi-transparent portions of datasets, leading to an increased the number of simultaneously visible labels.

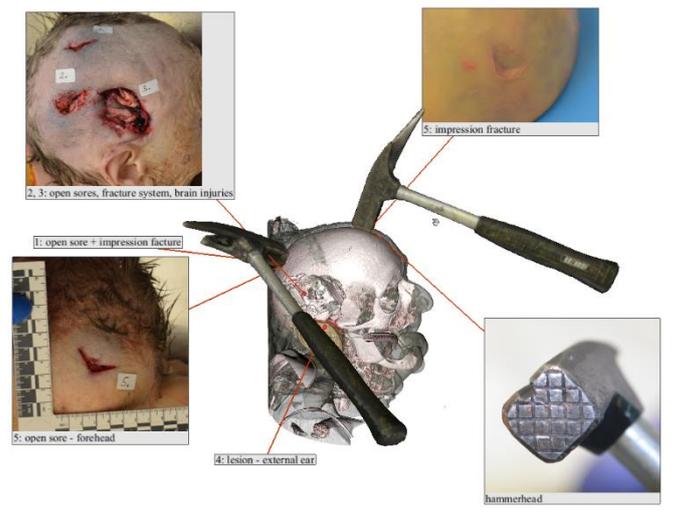


Figure 19: Reconstruction of a murder case based on post mortem CT data, a 3D surface scan data, and photographs. CT findings were annotated using text and image labels. The 3D model of the hammer could be placed based on the matching impression fractures. The resulting spatial configuration indicates possible assault directions and thereby aids the reconstruction of the course of events.

Besides label placement, functionality to efficiently extract and independently more bone fragments in CT and MRI datasets was added, leading to the possibility to reconstruct their initial configuration and thereby help the reconstruction of force mechanisms and the course of events. Results were presented at DGRM 2016.

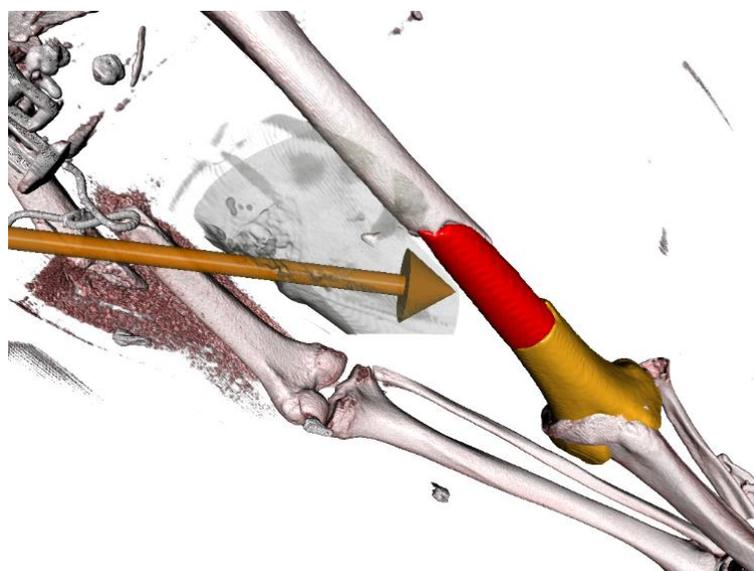


Figure 20: Reconstruction and visualization of the impact direction in a traffic accident based on CT data. The original femur geometry was reconstructed using the computer-aided case reconstruction tool by moving the dislodged fragments to their anatomically correct locations revealing the so-called Messerer-Keil (red), typical injury pattern, which, together with the corresponding laceration, allowed to reconstruct the exact force direction indicated by an arrow.

Functionality included in 2016 also includes tools to visually depict unnatural occurrences of entrapped air, such as air in stab channels, or vessels, which helps the reconstruction of stab directions and to illustrate exsanguination as a cause of death. This work was presented at the ISFRI congress 2016.

The software toolbox has been repeatedly and increasingly applied to pending cases in Graz as well as to cases supplied by other forensic institutes like e.g. Heidelberg in 2016. 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 with the Centre Universitaire Romand de Médecine Légale (Lausanne, CH) as scientific collaboration partner for the project. The objective is to improve the radiological evaluation of coronary arteries and myocardium, as well as generally support minimally-invasive autopsy procedures, in the investigation of suspected cardiac deaths. In recent years, 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.

Work already completed characterised the temperature-dependent physical and relaxation properties of the liquids potentially suitable for targeted perfusion of post-mortem vasculature. Findings were published in the *International Journal of Legal Medicine* in October 2016 [1]. Using a selection of these liquids ('perfusates'), further work was performed to evaluate their appearance using various clinical MR sequences, where parameters had been adapted under consideration of the post-mortem nature of the examinations. The suitability of these sequences for the visualisation of vessel-like structures in an *ex situ* cannula-porcine model filled with a given perfusate were presented at the ISFRI in May 2016 [2]. A more detailed evaluation of these sequences, including comparison of image quality and contrast, were presented later in 2016 at the DGRM [3].

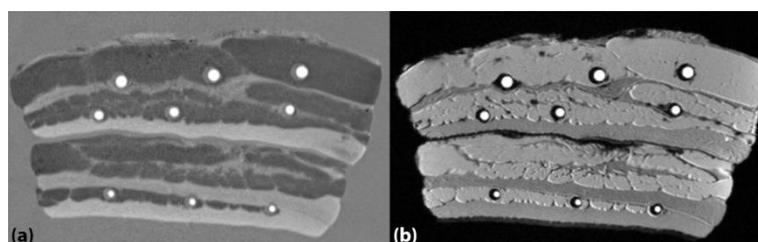


Figure 21: Cannula-porcine model enabling initial evaluation of MRI sequences for the visualisation of vessel-like structures in post-mortem porcine tissue. (a) STIR sequence (TI = 240ms) (b) 2D FLASH sequence.

Based on the results from investigations using the cannula-porcine model, an *ex situ* porcine heart model was then used to test and optimise sequences for the examination of coronary arteries and myocardium. Furthermore, given the role of decomposition and the elevated permeability of post-

mortem vessels, the extravasation of perfusates out of porcine cardiac vessels was additionally examined by imaging selectively filled cardiac vessels over 12 hours. Results from these investigations have been summarised in an accepted abstract for the ISFRI in May 2017.

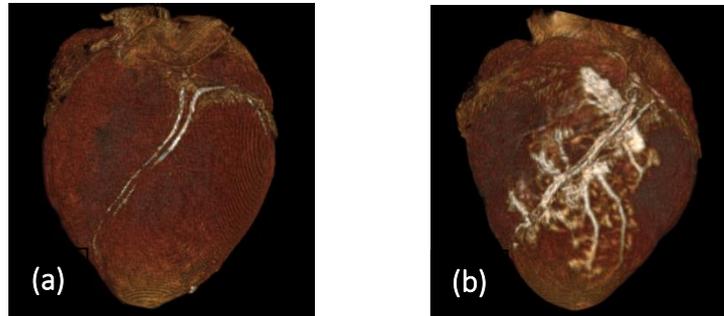


Figure 22: Visualisation of coronary arteries filled with (a) paraffin oil and (b) a Gadovist® solution.

Parallel to the examination of ex situ porcine hearts, one week in September 2016 was spent at our partner institute in Lausanne (CH). During this time, evaluated sequences were optimised and applied in the examination of anatomy cadavers filled with a perfusate commonly used in post-mortem CT angiography (contrast agent + paraffin oil). Results from these findings have been further incorporated into the development of a final MR protocol which will be intensively tested during a further 1-month research visit in May 2017.

This project additionally encompasses preliminary development a novel approach to differentiate post-mortem clots from thrombi through the application of multivariate quantitative MRI. An abstract presenting our findings has been accepted for the ISMRM in Honolulu (April 2017) [4].

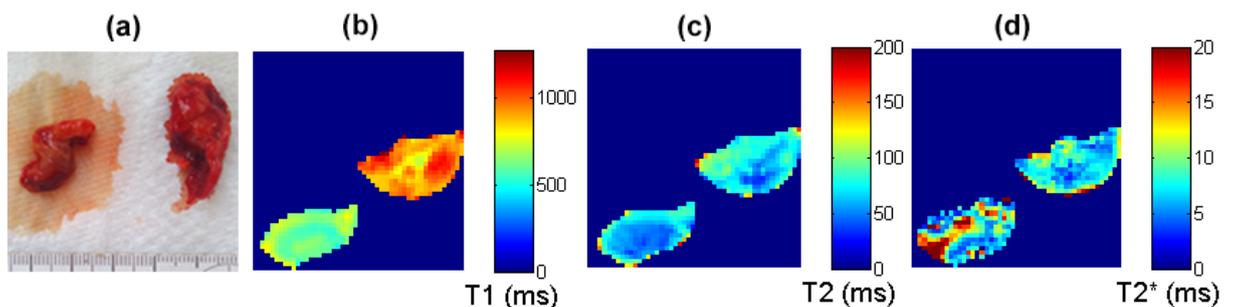


Figure 23: (a) Photograph of post-mortem clot and thrombus (b) T1 map (c) T2 map (d) T2\* map

## Publications

[1] Webb BA, Widek T, Neumayer B, Bruguier C, Scheicher S, Sprenger H, et al. Temperature dependence of viscosity, relaxation times (T1, T2) and simulated contrast for potential perfusates in post-mortem MR angiography (PMMRA). *Int J Legal Med.* 2016.

[2] Webb BA, Kirchmeyr D, Widek T, Urschler M, Stollberger R, Schwark T. Evaluation of MRI sequences and liquids potentially suitable for post-mortem vascular perfusion. 5<sup>th</sup> Annual Meeting of the International Society of Forensic Radiology and Imaging. Amsterdam 2016.

[3] Webb B, Widek T, Kirchmeyr D, Sprenger H, R S. Darstellung postmortaler Gefäße mittels MRT: Anwendung eines Schlauch-Schweinebauch-Modells zum Vergleich von MR-Sequenzen. 95 Jahrestagung Deutsche Gesellschaft für Rechtsmedizin. Heidelberg, Germany 2016.

[4] Webb B, Urschler M, Leoni M, Neumayer B, Widek T, Scheicher S, et al. Cause of death or caused by death: Differentiation of thromboemboli and post-mortem clots using quantitative MRI. 25<sup>th</sup> Annual Scientific Meeting of the ISMRM. Honolulu 2017. p. 887.

### **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 2016, several autopsies were documented using a GoPro action camera to be able to retrospectively measure distances in the video, if needed a later point in time. Furthermore, photogrammetric reconstruction of corpses prior and during autopsies was performed in some cases, with the goal to establish a routine work flow in the long run, and to thereby ensure the availability of 3D surface data for computer aided case analysis.

### **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.

In 2016, many low cost 3D sensors, computing platforms, and 3D reconstruction frameworks were evaluated, leading to the design and implementation of a first crime scene documentation device prototype, tested based on benchmark data and a mock crime scene. Based on the experience gained in evaluation algorithms and the setup were continuously improved, leading to, e.g. a novel more robust

3D camera path algorithm, which leads to increased model quality and is more suitable for the use at crime scenes.

The work on the juridical frame conditions lead to numerous publications and talks. Furthermore, the investigation of historical approaches to crime scene documentation using 3D techniques, e.g. by Hans Gross, a pioneer in forensic science, was started, leading 3D scans of exhibits and an MA thesis. An exhibition is in preparation.

#### **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. In 2016, this project was finished and the final report of the project was submitted. The project led to a large number of publications, technical reports and abstracts as can be seen from the publication list.

#### **2.1.4 Juridical issues of radiological methods in clinical forensic medicine**

The focus area of the LBI CFI's legal workgroup is to investigate the possible implementation of medical imaging techniques into the Austrian Criminal Procedure Law. Juridical research on clinical forensic imaging involves the examination of the specific juridical framework concerning criminal law, medical law and public law. The legal requirements for the routine application of radiological techniques have to be analysed and in case of legal questions, solutions are developed. Therefore, the research work of Team Law is inseparable from professional relationships with members of law enforcement agencies, including the public prosecution services and judicial bodies as well as other governing bodies such as the Ministry of the Interior and the Ministry of Justice.

Further, the work of Team law is linked with the Clinical forensic Care Unit and the daily forensic routine casework. For support in legal concerns, a representative of the juridical team participates in the meetings of the team of doctors responsible for the clinical forensic examinations.

Moreover, regular jour fixe meetings with representatives from hospitals, police and prosecution take place within the LBI CFI's facilities. Their purpose is to discuss and improve interdisciplinary processes as well as legal issues of 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.

Last but not least, 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.

**Spring 2016:** A proposal for the "Joint Justice & Daphne call - Actions grants to support national or transnational projects to enhance the rights of victims of crime/victims of violence- JUST/2015/SPOB/AG/VICT" was submitted in April 2016. In November, it was granted by the European Commission.

The main focus of the project called "JUSTeU!" is to develop a European-wide minimum standard for clinical forensic examinations and to launch a permanent European Clinical forensic Network (CFN Europe). Dr. Reingard Riener-Hofer and her team of the LBI CFI act as project leader. The partners include the Institute of Forensic and Traffic Medicine at the University Hospital Heidelberg, Germany, the Institute for Forensic Medicine at the Hannover Medical School, Germany, the Faculty of Law at Palacky University Olomouc, the Czech Republic, the Department of Forensic Medicine at the Faculty of Medicine in Hradec Králové, the Czech Republic and the Department of Medical and Surgical Specialties, Radiological Sciences, and Public Health at the Università degli Studi di Brescia, Italy.

In April Kainz/ Höller/ Klasinc/ Schwark/ Riener-Hofer published an article „CFN – A Clinical forensic Network for Austria“ in the SIAK-JOURNAL "International Edition 2016" (Volume 6). The compilation *Bildgebung in der Rechtsmedizin – Der gläserne Körper als Beweismittel* [Forensic Imaging – Glassy Corpses/ Bodies in Evidence] by Dirnhofer/ Schick was also published in April.

Alexander Brantner submitted his thesis “Relevanz von Befunden körperlicher Untersuchungen für die staatsanwaltliche Entscheidungsfindung”, that contains a Study of Relevance, in April 2016.

On the 24<sup>th</sup> of June 2016 the symposium “Forensigraphie – Möglichkeiten und Grenzen IT-gestützter klinisch-forensischer Bildgebung“ as a part of the lecture series of “Law and IT” took place at the University of Graz. The title of Dr. Reingard Riener-Hofer’s presentation was “Forensigraphie – Treffpunkt zwischen Recht und Bildgebung” [Forensigraphy – intersection between law and imaging]. A corresponding publication titled “Forensigraphie – Möglichkeiten und Grenzen IT-gestützter klinisch-forensischer bildgebender Verfahren” [„Forensigraphy“ – Possibilities and limits of clinical forensic imaging, supported by IT] will be published in the first half of 2017.

**Summer 2016:** At the „95<sup>th</sup> Annual Conference of the German Society of Legal Medicine“, which took place from August 30<sup>th</sup> till September 3<sup>rd</sup> 2016 in Heidelberg, the juridical team presented five posters and held one oral presentation:

- Neue Methoden der 3D Tatortdokumentation im Lichte der österreichischen Rechtsordnung [New methods of 3D Crime Scene Documentation in the light of the Austrian legal system]
- Rechtliche Rahmenbedingungen der forensischen Altersdiagnostik im österreichischen Asyl- und Fremdenrecht [Legal framework of forensic age estimations in the Austrian asylum and aliens’ law]
- Studie zum Einsatz von Forensigraphie im Rahmen polizeilicher Untersuchungen von Gewaltdelikten in Österreich [Study on the application of Forensigraphy within police investigations of violent offences in Austria]

- Die Normierung von Opferschutzgruppen in der österreichischen Rechtsordnung und ihre Umsetzung in der Praxis [The standardization of victim support groups in the Austrian legal system and their implementation in practice]
- Studie zur Relevanz der Klinisch-Forensischen Untersuchungsstelle Graz für das strafprozessuale Ermittlungsverfahren der Staatsanwaltschaft [Study on relevance of the Clinical forensic Care Unit for criminal investigations of the public prosecution]
- Die ärztliche Anzeigepflicht bei minderjährigen Opfern überlebter Gewalt in Österreich [The Obligation to notify and report criminal acts concerning underage victims of violence]

The article “Das klinisch-forensische Netzwerk Steiermark als Modellprojekt: Ergebnisse der sozialwissenschaftlichen Begleitstudie“ [The Clinical forensic network Styria as a model project: Results of the sociological study] by Wirnsberger/Dohr/Schwark/Riener-Hofer was published in the journal Archiv für Kriminologie (Band 238) in the issue July/August 2016.

**Autumn 2016:** At the “Eleventh Biennial International Conference Criminal Justice and Security in Central and Eastern Europe, which took place from September 26<sup>th</sup> till 27<sup>th</sup> 2016 in Ljubljana, two oral presentations were held. The corresponding papers „Clinical Forensigraphy and its legal framework in Austria“ by Reingard Riener-Hofer and “Legal aspects of a low-threshold examination service in Austria“ by Sophie Kerbacher/ Michael Pfeifer/ Reingard Riener-Hofer were published in Mesko/Lobnikar (editors) Criminal Justice and Security in Central and Eastern Europe. Safety, security, and social control in local communities (2016) (conference book).

The article „3D Tatortdokumentation und Recht. Neue Methoden der 3D Tatortdokumentation im Licht der österreichischen Rechtsordnung“ [3D-Crime Scene Documentation and law. New methods of 3D-Crime Scene Documentation in the light of the Austrian legal system] by Paulus/ Bornik/ Riener-Hofer was published in the third issue of the SIAK-JOURNAL.

**Winter 2016:** The article „Der Einsatz von Forensigraphie im Rahmen polizeilicher Untersuchungen von Gewaltdelikten in Österreich“ [The application of Forensigraphy within police investigations of violent offences in Austria] by Riener-Hofer/Höller/Kerbacher/Pfeifer/Schwark/Bornik containing the results of the online survey, which was carried out in cooperation with the Ministry of the Interior to determine the use of forensic imaging in Austria, has been published in the journal Kriminalistik in November 2016.

## 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 Prof. 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).

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 the master thesis by Christian Payer, dedicated to the automatic separation of arterial and venous vascular trees under the supervision of Martin Urschler and Prof. Horst Bischof. Results of this master thesis were published at the top ranking journal *Medical Image Analysis* in its December issue in 2016.

From end of June till end of September 2016 Dr. Martin Urschler stayed at Griffith University in Brisbane, Australia, acting as a Visiting Principal Research Fellow. There he worked with Prof. Alex Forrest, a forensic odontologist from the Forensic Sciences department of Griffith University, as well as Charles Naylor, head of Forensic and Scientific Services. It was a valuable exchange of ideas and there are ongoing efforts to strengthen this collaboration in the form of a common project proposal. During this stay in Australia, Dr. Urschler established connections to the Victorian Institute of Forensic Medicine in

Melbourne, as well as the Institute for Electrical Engineering of Queensland University. He gave invited presentations at all three sites in the respective seminar series.

We started to establish a new cooperation with the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology as part of the CSISmartScan3D project where we used the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology laser scanner to document a mock crime scene. The resulting models are used as a reference for comparison. Furthermore, the computer-aided case reconstruction software was used to visualize native ground radar data, which require techniques similar to forensic case analysis, to, e.g. depict and annotate important details in the data. We plan to step up the collaboration in the future.

### 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 2016, 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 cooperation with the Styrian Hospitals Company (KAGes) concerning in-house trainings has been continued in 2016; 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 2016	Funding body	Duration
CSISmartScan3D	KIRAS FFG,BMVIT	1.11.2015-30.06.2018
FAME	FWF	01.07.2015 – 30.06.2018
FEMtech	FFG,BMVIT	01.10. 2016 – 31.03. 2017
ForensiKids	Talente regional FFG,BMVIT	01.06.2016-31.07.2018
PMMRA	DOC-Stipendium ÖAW	01.05.2015 – 30.04.2018
Subvention “Clinical Forensic Outpatient Centre”	Stadt Graz	onetime in 2016
Subvention “Manubrium”	Stadt Graz	onetime in 2016
<b>Total number</b>	<b>7</b>	

Table 3: Third party projects 2016

In 2016, the LBI CFI attained great success in acquisition of third party funding. In addition to the ongoing, three-year DOC-fellowship from the Austrian Academy of Sciences(ÖAW) received by Bridgette Webb for the study of “Systematic development of post-mortem magnetic resonance angiography (PMMRA)”, the stand-alone project “FAME: Fully Automatic MRI-based age Estimation of adolescents” of Martin Urschler and the interdisciplinary KIRAS project “CSISmartScan3D” (lead Alexander Bornik), the institute received further funding for the project “ForensiKids”, subventions from the Stadt Graz and a Femtech student. The “ForensiKids” project (lead Hanna Sprenger) is funded by the Austrian Research Promotion Agency (FFG) and the Ministry for Transport, Innovation and Technology (BMVIT). Simone Ferk was recruited by Katharina Baron for a six-month internship in the project fracture dating using MR-based methods.

## 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 24: Clinical Forensic Care Unit

The Clinical Forensic Care Unit is the first Austrian Forensic Care Unit, and has been 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 2016, it has again 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— primarily due to financial reasons 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 gynaecologist or specialized paediatrician. Additionally, a medical doctor of the LBI CFI is a member of the clinical child protection group of the Department of Paediatric Medicine and the Department of Paediatric Surgery, with weekly meetings and interdisciplinary discussions of suspected child abuse cases. Selected persons examined at the Clinical Forensic Care Unit who match the inclusion criteria of current studies of the LBI CFI, are asked 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 migrant influx, the number of age estimations in asylum cases has stayed high in 2016.

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.

During 2016, some services of the project “Klinisch-Forensisches Netzwerk Steiermark”, 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 has also been 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 and throughout 2016.

Table 4 presents an overview of the cases that have been seen at the Clinical Forensic Care Unit in 2016. 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.

<b>Clinical Forensic Care Unit</b>	<b>2016</b>
Physical violence (against adults > 18 years)	29
Sexual violence (> 18 y)	29
Physical child abuse (< 18 y)	25
Sexual child abuse (< 18 y)	20
Forensic age estimation in living persons	345
Other cases	12
<b><i>Cases in total</i></b>	<b>460</b>

Table 4: Overview of the cases seen at the Clinical Forensic Care Unit 2016

## 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 2016. The effort put into evaluation and manuscript preparation will be pursued in 2017.

## 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.

An overview of the contributions to the different scientific communities in 2016 is given here:

### Forensic medicine

- 19<sup>th</sup> Meeting Study Group on Forensic Age Diagnostics (AGFAD), 18.03. 21.03.2016, Berlin, Germany
- Frühjahrstagung Region Süd of the German Association of Forensic Medicine, 17.06. – 18.06.2016, Frankfurt am Main, Germany
- Intersocietal Symposium of the International Academy of Legal Medicine (IALM), 21.06 – 24.06.2016, Venice, Italy
- Annual Scientific Meeting of the German Association of Forensic Medicine (DGRM), 30.08. – 03.09.2016, Heidelberg, Germany
- Criminal Justice and Security in Central and Eastern Europe Conference 26.09. – 27.09.2016, Ljubljana, Slovenia

### Magnetic resonance in medicine and biomedical engineering

- Annual Meeting ISRMRM, 07.05. – 14.05.2016, Singapore
- Annual Meeting ESMRB, 29.09. – 02.10.2016, Vienna, Austria

### Computer graphics & Image processing:

- ISBI 2016, 13.04. – 16.04.2016, Prague, Czech Republic
- MICCAI 2016, 17.10. – 22.10.2016, Athen, Greece

### Forensic Imaging:

- ISFRI/IAFC Meeting 2016, 12.05. – 15.05.2016, Amsterdam, Netherlands

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

29.01.-30.01.2016	AGFB-Treffen, Frankfurt am Main
08.02.2016	Book Presentation „Klinisch-forensisches Netzwerk Steiermark“, Graz
18.03.2016	Info-Veranstaltung des Direktoriums zu BioTechMed-Graz
01.04.2016	Workshop „Forensische Medizin“, Graz
14.04.2016	Open Innovation: Benefits for Science and Society, Wien
02.05.2016	Nationale Konferenz des Europäischen Migrationsnetzwerk (EMN) “Identitätsfeststellungen im Migrationsprozess“, Wien
04.05.2016	BioTechMed – Science Breakfast, Graz
09.05.2016	Club Scientifica “Open Innovation in Forschung und Entwicklung“, Graz
19.05.2016	Netzwerktreffen gegen sexualisierte Gewalt, Graz
20.05.2016	Leukämiehilfelauf, Graz
30.05.2016	Generalversammlung der Doctoral School "Bone, Muscle, Joint", Graz
01.06.2016	BioTechMed – Science Breakfast, Graz
01.06.2016	LBG-Veranstaltung “Archäologie 2.0“, Wien
08.06.2016	Kick-off Meeting zu Talente regional, Wien
09.06.2016	Key Researcher Training – Change Management, Wien
16.06.2016	Netzwerktreffen gegen sexualisierte Gewalt, Graz
24.06.2016	Symposium zum Thema “Forensigraphie – Möglichkeiten und Grenzen IT-gestützter klinisch-forensischer Bildgebung“, Graz
05.10.2016	BioTechMed – Science Breakfast, Graz
11.10.2016	Kick-off Opening Careers, Wien
11.10.2016	LBG Weinherbst 2016, Wien
18.10.2016	6. KIRAS Fachtagung, Wien

19.10.2016	Workshop Herbst 2016 – MIGRATIONSWELLE 2015 – Das “Grenzmanagement Spielfeld” im Fokus, Graz
07.11.-08.11.2016	5. Österreichischer Präventionskongress, Graz
10.11.-11.11.2016	Vienna Migration Conference 2016, Wien
17.11.-18.11.2016	Key Researcher Training - „Kritikgespräche und schwierige Gespräche konstruktiv führen“, Bruck a.d. Mur
24.11.2016	Netzwerktreffen gegen sexualisierte Gewalt, Graz
02.12.2016	European Flirt Expert - Beitrag zur Prävention sexualisierter Gewalt unter Jugendlichen, Graz
02.12.2016	Get together Wintertime 2016: Habilitierte, Graz
13.12.2016	Kick-off des Karriereprogramms 2017, Graz

## 3 Other activities

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### 3.1 Membership in scientific and non-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
- 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
- WdF – Wirtschaftsforum der Führungskräfte
- rtaustria - Berufsfachverband für Radiologietechnologie Österreich
- MICCAI Society

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 (Annemarie Wieland)
- FIRM - Forschungsinstitut für Recht in der Medizin (Peter Schick)
- UFG (Thorsten Schwark)
- Steirisches Netzwerk gegen sexualisierter Gewalt (Sophie Kerbacher)

## 3.2 Lecture series

In 2016, 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 2016, the following lectures took place:

- Dr. Andrea Kalloch, „Gerichtsmedizin und Notfallmedizin – Schnittstellen und Möglichkeit für Zusammenarbeit“, 27.01.2016
- Dr. Blaz Cugmas, „Is there a potential of diffuse reflectance spectroscopy in everyday forensics?“, 24.02.2016
- Em.Univ.-Prof.Dr. Peter Schick, „Bildgebung in der Rechtsmedizin. Der gläserne Körper als Beweismittel“, 23.03.2016
- Assoz.-Prof. Mag. Dr. Christian Bergauer, „Datenschutz in der forensischen Bildgebung“, 20.04.2016
- Dr. Chiara Villa, „Forensic applications of imaging and modeling techniques“, 15.06.2016
- Dr. Wolf-Dieter Zech, „Postmortale quantitative Magnetresonanztomographie“, 19.10.2016
- Prof. Dr. Kathrin Yen, „Neue Methoden und Kooperationen in der forensischen Bildgebung“, 16.11.2016

Additionally, the LBI CFI organized a visit to ams in Premstätten on May 23<sup>rd</sup> 2016. The topic of the excursion was "Highly integrated sensor technology in medical imaging technology".



Figure 25: Visit of the amsAG during the lecture series

### 3.3 Teaching and training activities

#### Teaching activities

##### Academic teaching

- Course "Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt", with lectures given by Isabella Klasinc, Kathrin Ogris, and Thorsten Schwark.
- Lecture "Basiswissen Gerichtsmedizin", with lectures given by Isabella Klasinc, Kathrin Ogris, Reingard Riener-Hofer, Thorsten Schwark, Martin Urschler, Bridgette Webb and Annemarie Wieland as well as colleagues from the Institute of Forensic Medicine, Medical University Graz (Manfred Kollroser, Peter Leinzinger, Barbara Reichenpfader).
- Lecture and course "Einführung in die forensischen Wissenschaften", with lectures given by Katharina Baron, Alexander Bornik, Reingard Riener-Hofer, Thorsten Schwark, Martin Urschler and Bridgette Webb.
- Course "Journal club 'Forensic Imaging'" given by Thorsten Schwark
- 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:**

- In-house training “How to recognize and document physical and sexual abuse” for several state hospitals, given by Isabella Klasinc, Thorsten Schwark and Annemarie Wieland, during the first half of 2016
- Lecture on “Examination of deceased in a hospital setting” for the Hospital “Barmherzige Brüder”, given by Thorsten Schwark, March 31, 2016
- Lecture on “Forensic age estimation” for the Federal Ministry of Internal Affairs, given by Thorsten Schwark, November 11, 2016
- Lecture on “Physical and sexual violence” for members of the victim protection groups of KAGes (Styrian Hospital Company) hospitals, given by Isabella Klasinc and Thorsten Schwark, December 6, 2016
- Lecture on “Typical injuries of physical violence” for the Caritas, given by Thorsten Schwark, 21.12.2016

### **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)
- 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 Reinhold Schmidt)

- 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)
- Josef Koller: “Nonlinear intensity inhomogeneity correction for quantitative MRI”  
Diploma thesis (Supervision by Prof. Rudolf Stollberger and Dr. Martin Urschler)
- Patrick Torreiter: “Evaluierung quantitative MR-Bildgebung von Hämatomen”  
Diploma thesis (Supervision by Eva Scheurer)
- Judith Schernthaler: “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)

Annals of Human Biology (Martin Urschler)

Journal of Forensic Radiology and Imaging (Reingard Riener-Hofer)

### 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)

ECCV (European Conference Computer Vision and Pattern Recognition) (Martin Urschler)

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

DGRM – Deutsche Gesellschaft für Rechtsmedizin (Alex Bornik, Reingard Riener-Hofer, Martin Urschler, Bridgette Webb)

### Scientific grants proposals

Österreichische Nationalbank

# 4 Outlook

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## Outlook

The interdisciplinary character of our research focus in clinical forensic imaging will be maintained in 2017. The main task will be to further intensify the current activities of data evaluation, manuscript preparation, and publication of results to fulfil the research program for the next term. Taking into account the suggestions made by the evaluation panel, changes in the team structure will be implemented.



Figure 26: Key Researcher from the LBI CFI. From left to right: Dr. Sylvia Scheicher, Dr. Alexander Bornik, PD Dr. Thorsten Schwark, Dr. Reingard Riemer-Hofer, Dr. Martin Urschler and Dr. Hanna Sprenger

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 continue to be an important aspect of, and an exceptional opportunity for the LBI CFI and its interdisciplinary areas of research, and will be essential in achieving its challenging goals in the future.

In 2017, the LBI CFI lecture series “The interdisciplinary world of forensic imaging” will comprise of four lectures held by nationally and internationally renowned experts, and one excursion. Following speakers are planned for the lecture series: *Prof. Dr. Friedrich Fraundorfer* (TU Graz), *Prof.<sup>in</sup> Andrea Berzlanovich*

(Medical University of Vienna), *Dr. Sarah Heinze* (University of Oldenburg, Germany), and *Prof. Dr. Stefan Ropele* (Medical University of Graz). The excursion will lead us to the State Police Headquarters, and will cover different aspects of securing and analysing trace evidence. The practical lecture series „Introduction in Forensic Sciences”, as well as the lecture series “Basiswissen Gerichtsmedizin” and “Gerichtsmedizin am Lebenden” at the Medical University Graz will be continued in the next year.

## 5 List of publications

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