



Ludwig Boltzmann Institute  
Clinical Forensic Imaging

# ANNUAL REPORT

## 2014

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

### 1.1 Aims

The main goals of the Ludwig Boltzmann Institute for Clinical-Forensic Imaging (LBI-CFI) are:

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

#### Ad 1)

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

#### Ad 2)

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

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

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

## 1.2 Quantity structure

### Finances

Table 1 presents an overview of the 2014 finances. The income consisting of cash and in kind contributions from the LBG GmbH and institutional partners was approximately 1,65 M Euro, the expenses amounted to approximately 1,58 M Euro (cash and in-kind contributions).

<b>Finances</b>	<b>2014</b>
<b>Income</b>	1.651.334,00
<i>Personnel</i>	1.167.688,00
<i>Material expenses</i>	155.823,00
<i>Research expenses</i>	246.240,00
<i>Assets</i>	10.850,00
<b>Expenses in total (EUR)</b>	1.580.601,00

Table 1: Financial overview 2014

### Human resources

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

<b>Staff (31.12.2014)</b>	<b>Head Count</b>		<b>Fulltime Equivalents</b>	
	Total	Women	Total	Women
Management & Key Researchers	5	2	4.8	1.8
Medical Doctors	5	3	4.6	2.6
Law & Criminalistics	4	3	3.3	2.9
Computer Graphics & MR Physics	3	1	3	1
Administrative & Technical Staff	3	2	2.5	1.5
<b>Total</b>	<b>20.0</b>	<b>11.0</b>	<b>18.2</b>	<b>9.8</b>

Table 2: Overview of human resources 2014

### 1.3 Institutional partners



#### Medical University of Graz

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

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

## SIEMENS

#### Siemens AG Österreich

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

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



#### Karl-Franzens-University of Graz

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

discussions about criminal law and criminal law procedures. The partnership with the LBI-CFI allows this partner to influence the development and implementation process with respect to possible legal implications from the beginning.

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



### **Superior Court of Appeal of Styria and Carinthia**

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

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



UniversitätsKlinikum Heidelberg

### **Heidelberg University Hospital**

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

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

### **Bundesministerium für Inneres**

Since June 2013, the Ministry of Internal Affairs is a new partner of the LBI-CFI. Specifically, the support from the Ministry will allow a study concerning 'Injury Documentation' to be undertaken. Additionally, the Ministry will provide expert advice regarding digital communication and compliance with data protection legislation for the transfer of forensic and/or sensitive data. At a press conference on 22.11.2013, the new partnership between the Ministry of Internal Affairs and the LBI-CFI was announced by the Minister herself, Mag. Johanna Mikl-Leitner and the Director of the Institute, Dr. Eva Scheurer.

## **1.4 Supervisory Board und Scientific Advisory Board**

### 1.4.1 Supervisory Board

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

The members of the Supervisory Board are:

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

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

Supervisory Board meetings took place on 27.05.2014 and 28.10.2014 at the Institute in Graz.

### 1.4.2 Scientific Advisory Board

The Scientific Advisory Board consists of 5 experts representing the various disciplines within the Ludwig Boltzmann Institute for Clinical-Forensic Imaging:

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

This year the annual meeting of Scientific Advisory Board took place together with the Evaluation of LBI-CFI (7.10. – 8.10.2014).

## 1.5 Human resources and development

### 1.5.1 Human resources

For the last five years the management of the LBI-CFI has consisted of a director and a deputy director (both acting also as key researchers). Since November 2014, the institute leadership is organized as a diarchy comprising two equal executive directors responsible for the juridical-administrative and the medical-scientific management. This form of management ensures the research's consistent adaptation to legal and forensic requirements. Both directors are also acting as key researchers (forensic medicine and law).



Since September 2014 staff is organized in four content-based teams:

1. Within the Team Forensic Medicine (Key Researcher: Thorsten Schwark), the research area “radiologic evidence in forensic reconstruction and age estimation” is located, as well as the Clinical Forensic Examination Unit.



2. The Team Forensic Technology (Key Researcher: Alexander Bornik, Martin Urschler) is responsible for “image processing & computer graphics”, “crime scene & incident reconstruction”, as well as “magnetic resonance methodology”.
3. The Team Forensic natural sciences (Key Researcher: Sylvia Scheicher) covers besides natural science studies the interdisciplinary project management of the institute.



4. The Team Law (Key Researcher Reingard Riener-Hofer) comprises the legal research area as well as legal attendance to research concentrations & services.

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

In 2014 the LBI-CFI consisted of the following 22 employees (see overview in Table 3).

	Function	Entrance date	Exit date	Remarks
<b>Management &amp; Key Researchers</b>				
Scheurer Eva	Director, Key Researcher Forensic Medicine & Physics	09.05.2008	31.10.2014	
Riener-Hofer Reingard	Deputy Director, Key Researcher Law	01.03.2010		
Bornik Alexander	Key Researcher, Visualization Specialist	01.12.2008		
Ehammer Thomas	Key Researcher Radiology	01.11.2010	30.09.2014	
Scheicher Sylvia	Senior Scientist / Scientific Editor	10.12.2013		
Schwark Thorsten	Key Researcher Deputy Director, Key Researcher Forensic Medicine	01.09.2014		
Urschler Martin	Key Researcher, Image Analysis Specialist	01.12.2008		
<b>Medical Doctors</b>				
Grassegger Sabine	Researcher Radiology	02.04.2012		
Kauderer Clemens	Researcher, General Practitioner	01.12.2012		
Klasinc Isabella	Researcher, General Practitioner	15.10.2012		
Krebs Nikolaus	Researcher, Resident Forensic Medicine	01.10.2008		Parental leave from 27.03. - 26.09.2014
Miklauc Natascha	General Practitioner	02.06.2014	30.06.2014	Clinical-Forensic Care Unit
Ogris Kathrin	Doctoral Student, Resident Forensic Medicine	02.05.2012	31.05.2014	
Tamegger-Jelinek Nathalie-Belin	General Practitioner	01.02.2010 30.09.2013	30.04.2013 28.01.2014	Clinical-Forensic Care Unit
Trimmel Viktoria	General Practitioner	17.03.2014	27.03.2014	Clinical-Forensic Care Unit
Wieland Annemarie	General Practitioner	11.09.2014		Clinical-Forensic Care Unit

<b>Law &amp; Criminalistics</b>			
Baron Katharina	Doctoral Student Biology	17.03.2014	
Hesterberg Silja	Doctoral Student Biology	03.01.2013	28.02.2014
Kainz Simone	Researcher Doctoral Candidate Law	01.04.2011	
Schick Peter	Scientific Expert Law	01.10.2008	Em. Professor at KFU Graz
Webb Bridgette	Researcher Criminalistics	01.06.2013	
<b>Computer Graphics &amp; MR Physics</b>			
Höllner Johannes	Researcher, 3D Modelling	15.11.2010	
Martinez Vera Naira Pilar	Researcher	18.08.2014	
Neumayer Bernhard	Doctoral Student MR Physics	16.01.2012	
Petrovic Andreas	Doctoral Student MR Physics	06.07.2009	27.03.2014
<b>Administrative and Technical Staff</b>			
Brandl Elisabeth	Executive Team assistant	01.08.2013	Maternity leave substitution
Habersatter Stefanie	Team assistant	13.04.2010	Maternity leave since 16.09.2011
Reisner Evelyn	Executive Team assistant	01.10.2008	Maternity leave since 11.10.2013
Schachner Silvia	Team assistant	14.03.2011	Maternity leave substitution
Widek Thomas	Technologist, Radiology	03.05.2011	

Table 3: Overview of staff in 2014

- Nathalie-Belin Tamegger-Jelinek left the LBI-CFI at the end of January 2014 to work at the Klinikum Graz.
- Silja Hesterberg left the LBI-CFI at the end of February.
- Katharina Baron joined the team as a doctoral student in the research area fracture dating in March.
- Nikolaus Krebs was on parental leave from 27.03.2014 to 26.09.2014.
- Andreas Petrovic left the LBI-CFI at the end of March 2014 to work as a university assistant at the Institute of Medical Engineering, Graz University of Technology. He still cooperates with the LBI-CFI in the research area of hematomas and in a joint third party funding project.
- Kathrin Ogris left the LBI-CFI at the end of May 2014 to work at the Institute of Forensic Medicine (MUG).
- Naira Pilar Martinez Vera joined the LBI-CFI in August 2014.

- Thorsten Schwark joined the LBI-CFI in September 2014.
- Annemarie Wieland joined the LBI-CFI in September 2014.
- Thomas Ehammer left the LBI-CFI at the end of September 2014.
- In April Eva Scheurer was appointed as a full professor for forensic medicine at the University Basel and as director of the Institute of Forensic Medicine in Basel / Switzerland. She left the LBI-CFI at the end of October 2014.

### 1.5.2 Career development

#### Internal education and training

Journal club meetings of all researchers with presentations of current scientific papers and discussion (28.01.2014, 25.02.2014, 29.04.2014, 20.05.2014, 24.06.2014) were organized in 2014, to support continuing education and training of the researchers of the LBI-CFI.

In April 2014, a team development workshop was held under the guidance of an external specialist, Bernd Peters and his partner Beate Ehmke. This seminar was dedicated to the future development of the LBI-CFI, its research focuses, and its forthcoming evaluation in autumn 2014.

#### External education and training

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

Examples of externally organized activities with educational aspects, in which researchers of the LBI-CFI participated during 2014, are:

- “Basismodul Lehre”, organized by the MUG, Graz (21.01.2014)
- “Teaching in English”, organized by TU Graz (30.01.2014)
- “Aufbau Lehre: Professionelle Hochschuldidaktik”, organized by the MUG, Graz (07.02.2014)
- “Gerichtsmedizin Workshop”, organized by the Österr. Wissenschaftsrat, Vienna (21.02.2014)
- “Gutachterworkshop”, organized by the KAGes, Bad Radkersburg (27.03. – 28.03.2014)
- “Basismodul: Forschung an der MUG – Abläufe und Ansprechpartner”, organized by the MUG, Graz (08.04.2014)
- Key-Researcher Training, organized by the LBG (24.04. – 25.04.2014)
- “Literaturrecherche Grundlagen mit PubMed”, organized by the MUG, Graz (13.05.2014)

- Workshop Horizon 2020: “Der Impact-Teil im Projektantrag”, organized by the FFG, Graz (21.05.2014)
- “Der Weg zum Christian Doppler Labor”, organized by the MUG, Graz (09.10.2014)
- “Grundlagen des Projektmanagements für wissenschaftliche Mitarbeiter”, organized by the MUG, Graz (16.10.-17.10.2014)
- “Zeitmanagement” Workshop, organized by the MUG, Graz (22.10.2014)
- Key Researcher Training, organized by LBI-CFI, Graz (17.11. – 18.11.2014)
- “Aufbau Forschung: Good Scientific Practice”, organized by the MUG, Graz (20.11.2014)
- “Führungskräfteworkshop”, organized by the LBG, Schloss Weikersdorf (24.11. – 26.11.2014)
- “Statistik für Fortgeschrittene”, organized by the MUG, Graz (26.11.2014)
- “Literaturrecherche”, organized by the MUG, Graz (02.12.2014)
- “Einführung neuer Mitarbeiter”, organized by the MUG, Graz (03.12.2014)

### 1.5.3 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.

- Every three months, we celebrated the birthdays of team members at special birthday lunches.
- On Faschingsdienstag, the members of the institute participated in the traditional carnival lunch with sparkling wine and doughnuts, where carnival costumes were highly appreciated.
- The LBI-CFI bowling evening in October, including a friendly tournament, was a good opportunity to strengthen team spirit and corporate feeling.
- On the 23.10.2014, Eva Scheurer’s farewell party took place in the Café Kaiserfeld in Graz. There, she had the opportunity to say good-bye to all cooperating partners and friends of the LBI-CFI.



- The LBI-CFI Christmas dinner took place on 11.12.2014 at the Restaurant “Condor” in Graz, where the team enjoyed an excellent meal and celebrated the end of a successful and interesting year.



## 1.6 Infrastructure

The institute is located on the second floor of Universitätsplatz 4, directly adjacent to the Institute of Forensic Medicine of the Medical University Graz, with which it shares some rooms (e.g., kitchen, examination room, autopsy rooms). A second branch of the institute is located at Elisabethstraße 27. This second office with workplaces for 6 team members is within walking distance (approx. 7 minutes) from the main office.

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

## 1.7 Highlights of the year

- KfN-Projekt

In December 2014, the project “Klinisch-forensisches Netzwerk Steiermark”, which was funded by the “Zukunftsfond Steiermark” of the Land Steiermark, was completed.

The main goal of the project was to establish and institutionalize easy accessible forensic services for victims of violence area-wide in Styria, including independent examination of victims with documentation and preservation of evidence valid in court. To reach this goal,

local clinical-forensic contact points were established and connected to build the network. Prior to the end of the funding period, three hospitals across Styria were successfully acquired as partners for the network. Particularly noteworthy is the Styrian-wide 24/7 hotline, which greatly contributed to the project's success. The network received positive feedback from its partners and interested community members, and all participants would be interested in continuing the project. Currently, we endeavour to enable the continuation of the project.



- In September 2014, the LBI-CFI participated in the 2<sup>nd</sup> MICCAI Workshop & Challenge “Computational Methods and Clinical Applications in Spine Imaging (CSI)”, where several groups from all over the world compared their automatic vertebrae segmentation algorithms. Master student Kerstin Hammernik, supervised by Dr. Martin Urschler at LBI-CFI, and Dr. Thomas Pock at Graz University of Technology, developed a software for spine vertebra segmentation, making use of prior knowledge and an original energy minimization method for segmentation. Her algorithm finished in 2<sup>nd</sup> place at the challenge, and she got an “Honourable Mention Award” for her paper “Vertebrae Segmentation in 3D CT Images based on a Variational Framework”.
- In 2014, the LBI-CFI published a large number of conference abstracts and full papers as well as journal paper contributions. 12 journal papers, 7 of them in top 20% impact factor journals, demonstrate our excellent scientific performance in 2014, accompanied by 8 peer-reviewed conference full papers and 10 conference abstracts, most of them presented to the scientific community by talks. The wide scope of scientific subjects of these publications, ranging from legal medicine to MR physics, computer graphics/medical image analysis, and jurisdiction, emphasizes the interdisciplinarity of our institute.

## 1.8 Public relations

### 1.8.1 Media contacts and reports

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

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

- Magazine article entitled “Verletzungen sichtbar machen” in “Öffentliche Sicherheit”, January 2014
- Magazine article entitled “CSI Graz – Der Gewalt auf der Spur” in “Business Monat”, March 2014
- Magazine article entitled “Inject Power” in “Der Standard – Forschung Spezial”, 05.02.2014
- Radio report about “in dubio pro minore – Altersschätzungen” at “Radio Ö1”, 17.04.2014
- Magazine article entitled “Knochen-Code Ausstellung – Grazer Museum rollt mittelalterlichen Mordfall auf” in “Der Standard”, 16.05.2014
- Magazine article entitled “Wort der Woche – Geheimnisse von alten Knochen” in “Die Presse am Sonntag”, 18.05.2014
- Magazine article entitled “Bolzen-Georg” in “Der Standard – Forschung Spezial”, 04.06.2014

#### 1.8.2 Public presentations

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

12.03.2014: Visit of the police at the LBI-CFI

We organized a guided tour at the LBI-CFI for interested members of the Styrian Criminal Investigation Department, where we presented the research focus of the institute and the Clinical-Forensic Outpatient Centre, including how to secure evidence. The event was well attended.

04.04.2014: Lange Nacht der Forschung (Researcher’s Night) in Graz

The institute presented itself for the 2<sup>nd</sup> time at the Austrian-wide “Lange Nacht der Forschung”, themed: “Gewalt sichtbar machen - tauch ein, in die spannende Welt der forensischen Bildgebung!”. The employees of the LBI-CFI showed interested groups (approximately 300 people) round the Institute. The highlight of the presentations was the scanning of people with our surface scanner. The visitors who were scanned by us received a personal 3D-model. The event was a great success and we are looking forward to the next Researcher’s Night!



15.05.2014: Bone Code. Bodies Tell the Story of War.

In cooperation with the LBI-CFI, the Archaeological Museum Schloss Eggenberg organized the exhibition “Bone Code - Bodies Tell the Story of War”.

The exhibition focused on a skeleton with clearly visible traces of violence. The injuries were studied with modern methods and the results were presented within this exhibition.



11.06.2014: “KfN-summer party” in Graz

In June 2014, the KfN project team organized a summer party in the courtyard of the Karl-Franzens-University, where our project partners and interested parties were invited. The visitors had the possibility to exchange their experiences with the project in an informal atmosphere.

## 2. Research program and results

### 2.1 Projects

The research program of the LBI-CFI during the year 2014 was conducted within five main key areas, each comprising different studies, which are briefly described in the following sections.

Across all studies, some of which were conducted in parallel, a total of 256 MRI scans of living and deceased subjects were made. Table 4 shows an overview of the studies in which MRI scans were performed.

<b>MRT</b>	<b>2014</b>
Blood in-vivo study	114
MRS subcutaneous fatty tissue	19
Fracture dating using MRI	24
Traumatic brain injury	2
Strangulation study	4
MRS lumbar spine (Reproducibility / Age estimation)	64
Age estimation using MRI	29
<b>Total</b>	<b>256</b>

Table 4: Overview of research MRI scans 2014

#### 2.1.1 Hematomas and other soft tissue injuries

##### **Artificial hematomas in subcutaneous fatty tissue of living volunteers**

In this study the MR characteristics of blood volumes injected into the subcutaneous fatty tissue of healthy living volunteers were evaluated longitudinally over 2 weeks using MRI. An external visual evaluation of the hematomas and the lobular structure of the fatty tissue were performed, and the thickness of the subcutaneous fat was measured. The aim of the study was to explore factors influencing the contrast of subcutaneous hematomas in order to date them for the forensic reconstruction of events using MRI.

In an initial part of this study, 20 subjects were measured. After excluding subjects with technical problems and artefacts, twelve data sets were evaluated. For the radiological interpretation and the modelling of the contrast behaviour of the hematomas, the contrast between hematoma and muscle and between hematoma and fat regions was determined and the Michelson coefficient, which allows the comparison of different subjects, was calculated.

Additionally, a model was built to reproduce the contrast behaviour between the hematoma and the surrounding tissues.

As additional part, a bachelor thesis was conducted with the aim to design a standardized measurement setup for the depiction of hematomas using IR photography, and to identify the optimum combination of filtering and contrast correction techniques best suited for this application. As the human skin exhibits the smallest extinction coefficient and therefore the maximum penetration depth in the infrared (IR) range, the acquisition of the infrared light reflected by hematomas might improve the visualization of their subcutaneous size and therefore helps to define the region of interest for an MRI measurement. The hematomas of 17 volunteers were documented using infrared photography longitudinally over 2 weeks, using a 750 nm light source, and different polarization setups. After acquisition of the images, the influence of different image correction techniques on hematoma segmentation and surface area was investigated. The study concluded that a model-based image correction provides the best results in terms of optimized background removal, and that hematomas occurring near the skin surface that are not visible in plain light, can potentially be visualized through the application of IR photography.

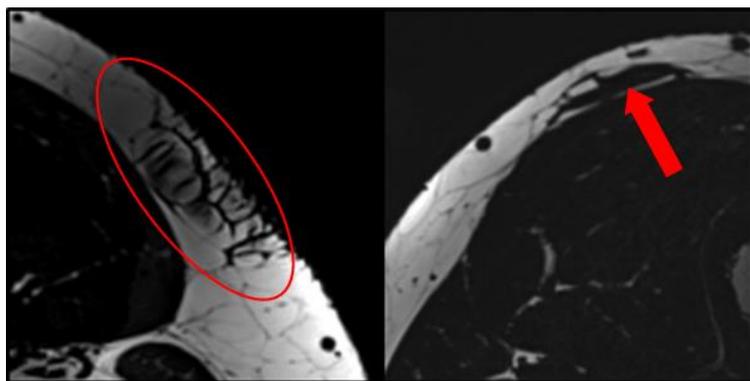


Figure 1: MR images of two types of artificial hematomas

On the basis of the initial results, a second group of 20 volunteers was investigated longitudinally over 2 weeks in order to consolidate the already gained results and to obtain a larger group for statistical evaluation. Additionally, factors, which were assumed to influence hematoma regeneration such as the hematoma shape and the morphological structure of the fatty tissue, were taken into account.

### **Correlation of photographs and MRI data using fiducial markers**

This completed study was performed in addition to the research topic stated in the research program for 2012 – 2015. It was undertaken in two consecutive phases, an *ex vivo* phase followed by an *in vivo* phase. The objective of the *ex vivo* study was to investigate the visibility of a strand-shaped fiducial marker in MRI, macroscopic photography and histopathology with the aim of correlating images across these modalities. Eight samples of porcine tissue were examined, and the correlation of a specific MR image with a given histology slide was possible.

This study demonstrated that the markers examined are visible in macroscopic photography, histology and MRI, providing a way in which results from these modalities can be combined (see Figure 2 and 3).

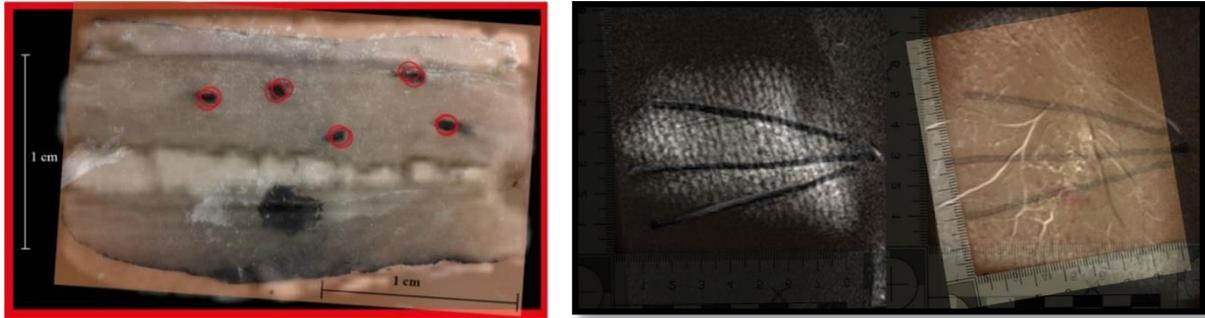


Figure 2: Correlation of MR image and histology slide demonstrating minimal difference in the location of markers  
 Figure 3: Fiducial marker enabled co-registration of photographs (external findings) and MR images (internal findings)

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

### 2.1.2 Forensic aspects of traumatic brain injury

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

The aim of this study is to assess MRI as a diagnostic tool for the detection of lesions, the estimation of impact power, and the age of the findings. The project is carried out on deceased subjects with a blunt head trauma, and a control group of deceased subjects without brain trauma. Technically, the study is based on conventional structural MRI, diffusion weighted MRI (DWI), and susceptibility MRI (SWI). The different parts concern:

- Cerebral micro-bleeds with the differentiation of the cause and mechanism of origin for a forensic reconstruction of the traumatic incident;
- Detection and visualization of nerve fibre lesions and the degradation process;

- Measurements of trace element concentrations (e.g. iron content), and their role in traumatic lesions.

Already published results show significant differences of mean diffusivity values and the magnetization transfer ratio in all sub-cortical white matter regions in the TBI group. Quantitative measurements revealed that iron is the dominant contributor to magnetic susceptibility in grey matter tissue. In white matter regions, myelin content and iron are negatively correlated. However, both myelin and iron impact the effective transverse relaxation rate  $R2^*$  significantly. The concentrations of six selected trace elements, and tissue wet-to-dry mass ratios from 13 brain regions showed heterogeneous distribution. Linear correlation of concentration values were found for iron and copper as well as for manganese and magnesium. Age dependent increase (calcium, magnesium, copper, zinc) and significant inter-hemispherical differences (copper, magnesium, calcium and iron) were seen in just a few regions. Tissue wet-to-dry mass ratios as an expression of the water content allow a comparison of concentration values with and between results of other studies.

Radiological evaluation of the MRI data was performed by experts in neuroradiology. Macroscopic photographs were evaluated by external experts in forensic neuro-traumatology. The data analysis demonstrates a better detection rate for local findings of contusion and micro-bleedings by macroscopic examination, but a larger range and a higher number of clinically relevant findings by radiologic evaluation.

### 2.1.3 Radiologic evidence in forensic reconstruction and age estimation

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

The diagnosis of strangulation in surviving victims on the basis of objective findings is important in the criminal proceedings related to the assault. The gold standard in forensic medicine is an external examination, which often shows no injury despite a credible history of strangulation. 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 injuries, 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 subjects of group A are asked to come back for a follow-up examination one week after the initial visit. The individuals of the deceased groups (B and D) additionally undergo autopsy with a neck dissection performed by a forensic pathologist.

MRI data are evaluated by two blinded board certified radiologists, according to a predefined diagnostic scheme (bleedings or oedema in skin or subcutaneous tissue/muscle/lymph nodes/salivary glands, and changes in arterial walls).

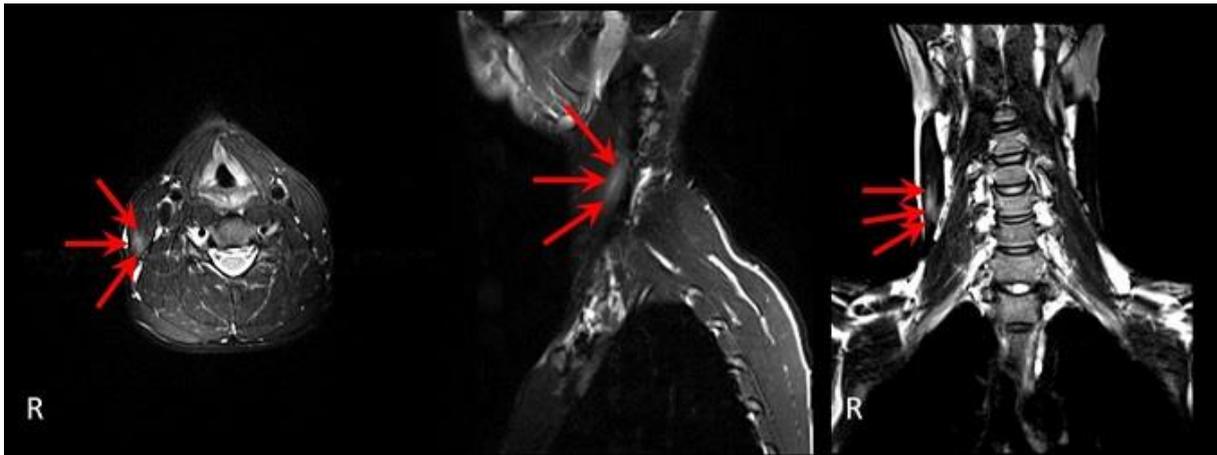


Figure 4: MR-images of the neck after survived strangulation (bleeding into the sternocleidomastoid muscle)

To date, data of 37 injured living victims and 5 subjects deceased due to strangulation as well as of 10 living and 5 deceased controls were collected, and most of the data (i.e., 32 living and 4 deceased as well as both control groups) has been read and evaluated.

Initial results showed that the most frequent radiological findings are subcutaneous and intramuscular bleedings or oedema. These findings offered additional evidence in cases with only slight external findings. The radiological 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.

To enhance the informative value of the study, the persistence of pathological findings in living victims are investigated by performing a second MRI scan approximately 9 days after the strangulation incident. To date only two victims underwent the second MRI scan, probably due to a lack of motivation for the patients to come again for a second MRI investigation.

### **Fracture dating using MR-based methods**

The determination of the time frame of fracture healing is of special interest in the field of clinical forensic examinations of child abuse, but can also be applied to the reconstruction of accidents and medical investigations of bone healing. To date, fracture dating is performed using radiographic methods, allowing only for qualitative results and being strongly depending on the experience of the examiner. Moreover, a considerable radiation dose is associated with this approach. Magnetic resonance imaging, in contrast, allows the investigation of bone as well as surrounding soft tissue structures without any exposure to radiation.

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

In the beginning of 2014, an MRI acquisition protocol for this study was finalized in cooperation with Prof. Fritz Schick of the Department of Experimental Radiology at the University of

Tübingen. This protocol includes 8 sequences for the determination of both, quantitative as well as qualitative parameters.

Between May and December 2014, 20 MR scans of 12 subjects (♀:7 ♂:5; aged 19 – 63 y; median: 32 y, scanned 1 to 5 times over a period of up to 191 days after fracture event), were acquired using the optimized 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 version and evaluated by comparing between reference areas of muscle and bone and the fractured area by defined ROIs (R2014a, ©MathWork Inc.; Figure 5).

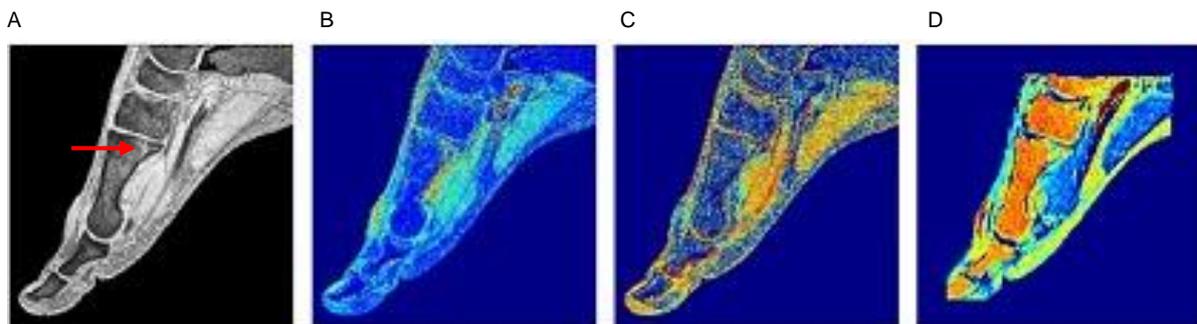


Figure 5: (A) T1w image of a metatarsal bone after fracture (red arrow) event and quantitative maps for (B) T1, (C) T2 and (D) MTR

First results indicate a very promising trend in time-dependent changes of quantitative MR parameters already in a small number of evaluated scans.

The evaluation and incorporation of additional data from a greater number of subjects, which is planned for the next years, will allow for a more accurate determination of the correlation of quantitative MR characteristics with single fracture healing phases. These results will form the basis for a more accurate fracture dating in forensics as well as better assessment of bone healing processes in a clinical perspective.

The preliminary results will be presented at two international conferences in 2015: the ISFRI/IAFR Joint Congress and the ISMRM 23<sup>rd</sup> Annual Meeting.

### **Dental age estimation of living persons: comparison of MRI with OPG**

The need for forensic age estimations in living adolescents is high, mainly due to migration, particularly from countries where birth dates are not reliably documented. To date, the gold standard of dental age estimation is the evaluation of the mineralization and eruption stages of the third molars using an orthopantomogram (OPG). However, the use of ionizing radiation without medical indication is ethically controversial and not permitted in many countries. Thus, the aim of this study was to investigate, if dental MRI can be used for the assessment of dental age with equally good results as when using an OPG.

In this completed study 27 healthy volunteers underwent an MRI scan of the jaw after a clinically indicated OPG. Mineralization and eruption stages of the molars were independently analysed on OPGs and MRI. The results of OPG and MRI were compared and correlated with

chronological age. For both, mineralization and eruption, there was a good correlation between MRI and OPG. Although a validation of these results using modality-specific reference values is needed, dental MRI seems to be suitable for a use in dental age estimation. In 2014, we finished in writing a journal paper on this topic, and currently are revising it for final publication.

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

In this ongoing study 500 healthy males in 3 age groups from 13 to 24 years are included, and undergo MRI examination of the wrist, the clavicles, and the wisdom teeth. The aim of the study encompasses the investigation of all information currently used for forensic age estimation to understand the developmental differences between these 3 indicators of growth. Furthermore, statistically relevant reference values for central European males will be calculated which shall pave the way for age estimation by performing an MRI of these 3 body regions in a single examination. Since the use of radiographic examinations such as the X-ray of the wrist, the CT of the clavicles and the OPG, currently considered as the gold standard, is paralleled by radiation exposure, juridical issues and public debates occur. Therefore, an adequate or even better alternative method using MRI would be highly appreciated.



Figure 6: 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.

MRS data was acquired on a clinical 3T MR scanner measuring in vertebral bodies L2 and L3 with a set of varying values of the repetition time TR and echo time TE. For the assessment of the reproducibility 30 volunteers between 20 and 44 years were each examined 3 times (3 volunteers repeated the measurement one week later to investigate scanner dependent

variations) and for the age study the measurements were performed once for 31 volunteers between 51 and 79 years. The resulting spectral data were quantified using jMRUI software, and the fat content was determined after correcting for T2 and T1 relaxation. Additionally, person-specific information on exercise and nutrition were retrieved for each volunteer to correct for influences caused by environmental factors. The reproducibility was determined by calculating the standard deviation of all mean adjusted results.

We found a high reproducibility of the determination of fat fraction with an overall standard deviation of 0.67% and the increase of the fat fraction with age is also evident in the relatively small range between 51 and 79 years. The correlation of the fat fraction is too weak ( $R^2=0.28$  assuming a linear increase) to solely use it for a reliable estimation of the chronological age; however, the additionally acquired data shows either an influence on the fat fraction or a correlation with age. Integrating this information in the age estimation will increase the accuracy of the method, but still demands a higher number of subjects to show statistical relevance.

### **Age estimation of the wrist using MRI: evaluation and comparison of two methods**

The hand and wrist is one of the most frequently utilized areas for age estimation in children and adolescents. X-ray images of the regions are frequently assessed according to the Greulich and Pyle (GP) method for age estimation. An alternative method based on MR images was published by J. Dvorak et al. in 2007 (*Br J Sports Med*). In this study, the two methods were compared based on the assessment of MRI of the hand and wrist, i.e., data from the ongoing validation study (page 23). Native MRI-scans of the hand and wrist of 60 male youths and young adults (aged 13 – 19) were evaluated according to the GP method and the DV method. As a result, the GP method could be confirmed to be valid for MRI age assessment as accurate as plain radiographs. Furthermore, the method is superior to the DV methods, since it is more accurate.

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

In the following sections, the results of the three main research directions are presented and some of the publications are mentioned where appropriate.

### **Visualization & interactive segmentation for analysis & presentation**

In accordance with the research program of the past years, a number of basic algorithmic techniques and software applications for the planned forensic software toolbox were established. Our main concern is the processing of forensic findings from photographic and volumetric (MRI/CT) data, and the visualization of forensic findings in the context of easy-to-understand reference models. The prototype of the software toolbox developed in this context has undergone a major revision. It has been continuously extended and improved based on feedback and knowledge gained when applying the tool to various cases and datasets.

Research work in 2014 was focused on techniques to make the 3D visualizations more self-explanatory, especially for non-experts. Text and image labels are helpful means to support understanding of the data. However, their automated, unobtrusive, and dynamic placement is a challenging task. Consequently, novel algorithms have been developed to efficiently solve the underlying optimization problem.

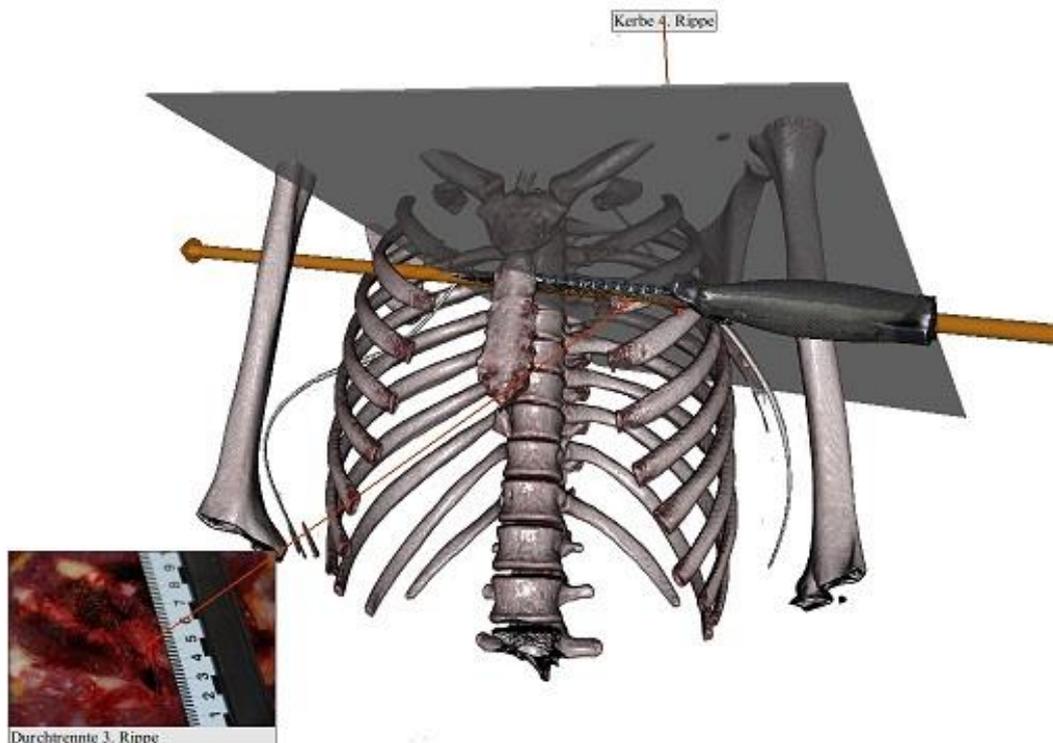


Figure 7: Reconstruction of a murder case

Reconstruction of a murder case: A post-mortal CT scan and the 3D surface scan of the knife involved were used to reconstruct the stab direction, based on findings in the CT data and the autopsy. An artificial arrow and a plane indicate the stab direction and blade orientation for a better understanding of the spatial relations. The key injuries used to determine the knife orientation are depicted by labels in text and/or image form.

In 2014, reconstruction results obtained using our software tools were applied to a pending case for the first time. Annotated illustrations and videos documenting injuries were taken to the files and presented in court during the summary trials. Furthermore, possibilities for economic use have been investigated.

### Image Processing

We have started a third-party funded project on MRI signal standardization with the purpose of automatic transfer function generation and segmentation in spring 2014, where we collaborate with the Institute of Medical Engineering and the Institute for Computer Graphics and Vision at Graz University of Technology. First results and detailed information on this topic can be found in section 3.1.3.

In the context of segmentation, our ongoing cooperation with the Ludwig Boltzmann Institute for Lung Vascular Research in Graz led to a publication in PLOS One (see section 5.1), following the master thesis of Michael Helmberger from the year before. This work was continued in 2014 by master student Christian Payer, who worked on the separation of venous and arterial trees from thoracic CT images in the context of pulmonary hypertension. Another student, Kerstin Hammernik, worked on the topic of interactive segmentation of dental jawbone implant images. Master student Fabian Schenk was involved in the automatic segmentation of the glottis from high speed larynx videos.

Continuing our work on machine learning based computer vision approaches for medical image analysis, we have published two papers at the prestigious MICCAI conference in Boston in September 2014. One of our works showed how to automatically localize bone structures in MRI hand data sets, and the other work gave an algorithm for fully automatic age estimation of hand MRIs. Both approaches make heavy use of state of the art machine learning approaches based on Random Regression Forests. We were excited that one of these two papers was accepted as an oral presentation at the MICCAI conference, since oral presentations have an acceptance rate of roughly 5%! Further publications on the topic of automatic age estimation were accepted at ISMRM 2014 and ISBI 2014.

### **Patient-specific & generic 3D reference models for case presentation**

We have strengthened our efforts to reconstruct patient-specific models for the purpose of accurately localizing patient imaging data from different sources (photographs and MRI/CT) in relation to each other. With a cost effective Microsoft Kinect based scan setup with a motorized scan table, we are able to capture textured 3D surface models of humans and objects. They can be visualized in combination with MR/CT data for presentation in court. We are working now on a fixed installation that can be used to scan patients who undergo routine clinical-forensic examinations at the Clinical-Forensic Care Unit. We currently use the Kinect to create scans of humans and a more sophisticated projector/camera structured light setup for detailed scans of small objects. In a first attempt we created a 3D model of a murder weapon with this projector/camera setup. In addition, passive photogrammetry is used to reconstruct small objects.

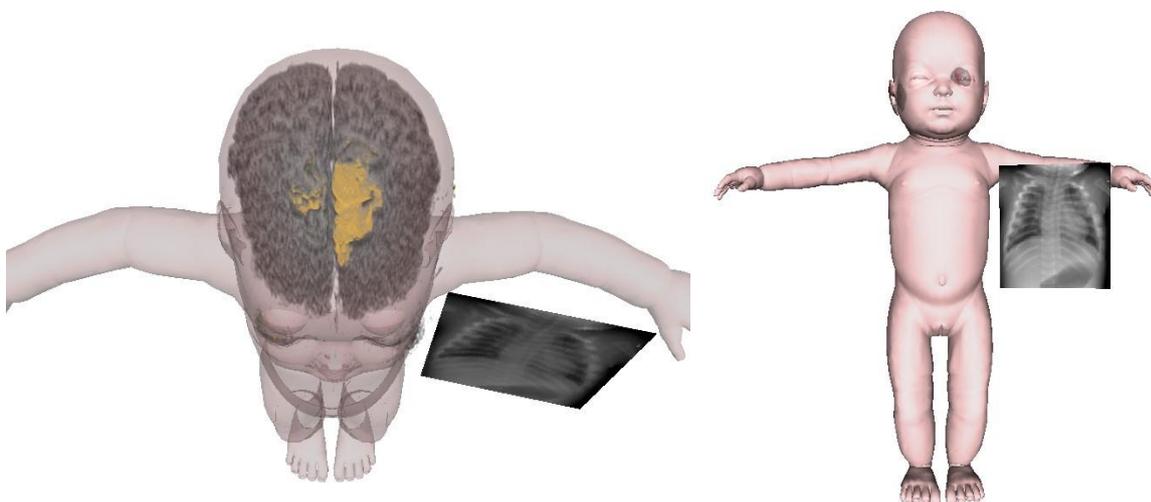


Figure 8: Example of the 3D visualization framework for presenting forensic findings on a reference manikin model

In 2014, a journal paper on the topic of 3D reference manikins for forensic case presentations was accepted in *Forensic Science International*. In this work we have also deepened our understanding of Kinect based structured light reconstruction by investigating an external calibration of the Kinect sensor and comparing scans to a high-resolution gold standard scan of a display dummy. Within our cooperation with RISC Software GmbH, we provided 3D scans of mannequins for evaluation of their “Rapid Burn Assessor”. As extension to this work we used the tools for measurements of findings. Another part of this cooperation addressed the creation of artificial 3D Models based on measures of children.

Finally, our forensic case management toolkit for documenting injuries in clinical-forensic cases was continuously improved in terms of functionality and usability.

#### 2.1.5 Juridical issues of radiological methods in clinical-forensic medicine

Juridical research on clinical-forensic imaging means to examine the specific juridical framework concerning criminal law, medical law and public law.

The juridical research is closely linked with the Clinical-Forensic Care Unit. For the support in legal issues, a representative of the juridical team participates in the daily meetings of the team of doctors responsible for the clinical-forensic examinations. Moreover, the juridical team gives its juridical advice concerning the legal requirements of human research.

The legal workgroup is also focused on the relationship and cooperation with judges, public prosecution and other governing bodies. Therefore, quarterly *jour fixe* meetings with representatives from hospitals, police and prosecution have been established. Their purpose is to discuss and improve interdisciplinary processes as well as legal issues of the cooperation between these institutions and to stimulate the practice-oriented analysis of cases. This cooperation between the University Hospital of Graz, State Criminal Police, Prosecution Graz and the LBI-CFI delivers valuable impetus for legal research. Additionally, 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.

A study was conducted in cooperation with the Regional Criminal Court of Graz.

- **June 2014:** “LBI-CFI Comparative Study 2009 – 2012”: The study reviews the role of the Clinical-Forensic Care Unit of the LBI-CFI in legal proceedings concerning bodily harm between 2009 and 2012. It was planned and supervised by the legal team and conducted by a diploma student in law, Nicole Malleg. The results were published in her diploma thesis in June 2014.
- **Autumn 2014:** A summary of the main results of the study on the value of expert reports in criminal court and the follow-up study on the sentencing of bodily injury were published in “*Österreichische Richterzeitung*”.

- **Autumn 2014:** “KfN-Steiermark” was presented by the legal team at a meeting on the Isle of Usedom and at a meeting in Linz. Especially in the light of the Istanbul Convention, the network is of great importance. For this purpose, also a contribution was written by the legal team.
- **Winter 2014:** The new umbrella term for the application of imaging techniques “Forensigraphy” was published in Europe in an English journal “European Police Science and Research Bulletin”.

#### 2.1.6 Clinical Forensic Care Unit

The first Austrian Forensic Care Unit was established in October 2008 by the Ludwig Boltzmann Institute for Clinical-Forensic Imaging in Graz as a facility of the LBI-CFI together with its institutional partner, the Medical University of Graz. The Clinical-Forensic Care Unit offers medico-legal examinations of living persons after incidents of suspected physical or sexual violence, as well as forensic age estimations in living persons. 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.



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 available 24/7 guarantees the availability of a medico-legal examination in the greater Graz area (hospitals, police stations, detention centres, and organizations offering help to victims, etc.) within 35 to 45 minutes. 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 LBL-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 usually conducted in the corresponding hospital departments, in cooperation with a gynaecologist or specialized paediatrician. Additionally, a medical doctor of the LBI is a member of the clinical child protection 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.

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.

Table 5 presents an overview of the cases, which have been seen at the Clinical-Forensic Care Unit in 2014. 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, 22% of all cases were not reimbursed.

<b>Clinical-Forensic Care Unit</b>	<b>2014</b>
Physical violence (against adults > 18 years)	35
Sexual violence (> 18 y)	31
Physical child abuse (< 18 y)	42
Sexual child abuse (< 18 y)	31
Forensic age estimation in living persons	289
Other cases	17
<b>Cases in total</b>	<b>445</b>

Table 5: Overview of the cases seen at the Clinical-Forensic Care Unit 2014



## 2.2 Publications

### 2.2.1 Publication policies and intellectual property rights

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

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

### 2.2.2 Publications

The scientific output in the form of publications, proceedings, and abstracts as well as book chapters (see the complete list of publications in section 5) was positive in 2014. The effort put into evaluation and manuscript preparation will be pursued in 2015.

## 2.3 Participation in scientific conferences

As a portrayal of the interdisciplinarity of the LBI-CFI, numerous contributions to international scientific meetings and conferences within the scientific communities of forensic medicine,

magnetic resonance in medicine, and computer graphics have been made. Overall in 2014, 8 oral presentations and 7 poster presentations were given by researchers of the LBI-CFI.

An overview of the contributions to the different scientific communities in 2014 is given here:

#### Forensic medicine

- Annual Scientific Meeting of the German Association of Forensic Medicine (DGRM), 09.09. – 13.09.2014, Greifswald, Germany  
2 oral presentations

#### Magnetic resonance in medicine and biomedical engineering

- Annual Meeting ISRM-ESMRMB, 10.05. – 16.05.2014, Milano, Italy  
4 poster presentations

#### Computer graphics:

- MICCAI 2014, 14.09. – 18.09.2014, Boston, USA  
2 workshop oral presentations, 1 main conference poster presentation, 1 main conference oral presentation
- MIUA London 2014  
1 oral presentation
- Society for the Studies of Human Biology Symposium on Age Estimation, 09.12. – 11.12.2014, Oxford, UK  
2 oral presentations

#### Clinical medicine:

- International Conference of the American Thoracic Society, 16.05. – 21.05.2014, San Diego, USA  
2 poster presentations

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

14.03.2014	AGFAD, Berlin
16.04.2014	Radiologische Kolloquium Univ.-Klinikum Tübingen
24.04. – 26.04.2014	7. Kongress der Arbeitsgemeinschaft für Notfälle, Graz
13.06. – 14.06.2014	Meeting “44. Treffen der Oberrheinischen Rechtsmediziner”, Basel
27.06.2014	15. Münchner Neuroradiologisches Symposium, München
01.07.2014	Club Scientifica Meeting, Graz
09.07. – 10.07.2014	Meeting “Fachkonferenz Netzwerk ProBeweis”, Hannover
24.09.2014	Med&Care Conference 2014, Messe Congress Graz

13.10.2014	Conference “Aktuelle Entwicklungen im Gewaltschutz”, Johannes-Kepler Universität Linz
29.10. – 30.10.2014	Antic Battlefields – History, Archaeology, Anthropology (International Symposium), Graz
12.11.2014	Meeting “Medizinrechtlicher Nachmittag”, Bad Waltersdorf
15.11.2014	Meeting “Arbeitsgemeinschaft Forensische Bildgebung”, Frankfurt
25.11.2014	Club Scientifica Meeting, Graz
25.11.2014	Presentation “Einblicke und Ausblicke: Maßnahmen gegen sexualisierte Gewalt an Frauen und Mädchen mit Behinderung”, Graz
09.12. – 10.12.2014	2. LBG Health Sciences Meeting, Vienna
Quarterly	SIDS-Meeting (Sudden infant death syndrome), Univ. Kinderklinik Graz

### 3. Other activities

#### 3.1 Cooperations

##### 3.1.1 Scientific cooperations

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

##### Cooperations with a focus in forensic medicine

In addition to an institutional partnership, a scientific cooperation has been established with the *Institute of Forensic and Traffic Medicine, University of Heidelberg*, 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.

For the research in dental MRI, a cooperation has been established with Prof. Norbert Jakse, *Department for Oral and Maxillofacial Surgery, Medical University Graz*, Dr. Julian Boldt, *Department for Oral and Maxillofacial Surgery, University of Würzburg*, and Andreas Hopfgartner, *Department for Experimental Physics, University of Würzburg*, as well as with *Dr. Heiko Merkens*, dentist with a private practice in Aachen. The main benefit for all collaborators in this field is the facilitated demonstration of wisdom teeth and other dental structures by MRI. Within the research area “traumatic brain injury”, analyses of trace elements in human brain are performed in cooperation with Prof. Walter Goessler, *Department of Chemistry, University of Graz*. The neuroimaging research unit of the *Department of Neurology, Medical University Graz* under the direction of PD Dr. Stefan Ropele and supported by the head of Department,

Prof. Franz Fazekas, is specialized in quantitative MRI for assessing brain tissue changes. Myelin integrity, blood and iron are the most notable factors impacting MR relaxation behaviour and MRI contrast, and have to be differentiated when drawing conclusions about the origins of blunt force.

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

Further good and long standing scientific cooperations exist with:

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

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

Collaboration with the neuropathology unit at Hamburg university medical centre (UKE) is planned.

#### 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*. Through a set-up financing two post-docs via the ICG, a knowledge transfer in both directions is optimally established. Martin Urschler works together with Thomas Pock, an expert in variational methods for low-level image processing. Alexander Bornik works together with a team of post-docs and PhD students on volume visualization techniques. This tight collaboration is also visible in the co-authorships of methodological computer vision and computer graphics papers (see publication list in section 5). In 2014, Dr. Darko Stern, a post-doc at the ICG financed via a Marie Curie International Exchange Fellowship grant, worked on an automatic software

method for age estimation from MR hand images in close cooperation with LBI-CFI, together with two master students (Thomas Ebner, Walter Unterpirker).

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

Our cooperation with the *Ludwig Boltzmann Institute for Lung Vascular Research, Graz* (Dr. Zoltan Balint, DI Michael Pienn) has been continued. We work together on the extraction and analysis of vascular structures from pulmonary CT images. This topic was the focus of an ongoing master thesis by Christian Payer, dedicated to the automatic separation of arterial and venous vascular trees under the supervision of Martin Urschler. Furthermore, we are working together with the *Clinical Department for Prosthodontics of the Medical University Graz* (Dr. Susanne Vogl) on the topic of registration and segmentation of jawbone images, a project done by Kerstin Hammernik and supervised by Martin Urschler. Finally, cooperation with the *Medical University of Vienna* (Philipp Aichinger) on the topic of segmentation of the glottis from high-speed videos of the larynx was continued. Master student Fabian Schenk finished his master's degree in November 2014.

### 3.1.2 Non-scientific cooperations

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

As a practical interdisciplinary basis for the research at the LBI-CFI, regular *jour fixe* meetings with representatives from the hospital (LKH Graz), police and prosecution are held. The aim of these meetings is to optimize communication and cooperation between these institutions concerned with incidents of violence. Five meetings have been held in 2014 and several issues concerning work processes and cooperation as well as real cases have been discussed and analysed. The results from these discussions have been incorporated into the activities of the Clinical Forensic Care Unit and will also be a central part in the juridical key area of research.

### 3.1.3 Third party projects

#### **Klinisch-forensisches Netzwerk Steiermark (KfN Steiermark)**

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

In July 2013 the project "Klinisch-forensisches Netzwerk (KfN) Steiermark" sponsored by the "Zukunftsfond Steiermark" of the Land Steiermark started. The objective of the project planned for a period of 18 months was the comprehensive build-up of a network of medical institutions in Styria being capable and willing to offer clinical forensic services.

Within the year 2014, which included the final 12 months of the project, the network was expanded in order to reach coverage of Styria with easy accessible forensic services for victims of violence. Till the end of the funded period of the “Klinisch-forensisches Netzwerk Steiermark”, three hospitals distributed over Styria were successfully gained as partners for the network (Figure 9).

We established a Styrian wide hotline, which is available 24 hours a day and allows contacting the physician with on-call duty. A more general access to information about the project is provided by the online platform of the “Klinisch-forensisches Netzwerk Steiermark” ([www.kfn-steiermark.at](http://www.kfn-steiermark.at)). The website provides general information about the project, partners and outpatient centres, but also a secured member area exclusively accessible to network members.

The project was accompanied by scientific studies, which examined the project from juridical, medical and sociological perspective. The medical study was conducted in cooperation with Medical University of Graz and focused to assess the need of specialised clinical-forensic facilities for medical personnel in order to conduct physical examinations. The juridical study, which was conducted with the Superior Court of Appeal of Styria and Carinthia in Graz, addresses the utilisation of clinical-forensic experts at court. In the sociological study, interviews with occupational groups involved in cases of suspected violence were conducted. All three studies clearly underlined the need of the availability of clinical forensic services.

With this Styrian clinical forensic network model we play a pioneering role in Austria, and subsequently could serve as a prototype for other Austrian states. In particular, partner hospitals and clinics with specific infrastructural opportunities, i.e. providing an emergency service and gynaecological expertise, are expected to participate.



Figure 9: Partners of the “Klinisch-forensisches Netzwerk Steiermark” (clinical forensic network Styria). LKH Feldbach, LKH Leoben, LKH Deutschlandsberg

## **HTI:Tech\_for\_Med: Standardisation for the computer-aided analysis of MRI data (Standard\_MRI)**

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

This project in cooperation with the TU Graz (Institute for Computer Graphics & Vision and Institute of Medical Engineering) aims to standardise MRI data using an internal or an external standard (phantom), and to further enable the customisation of 3D analysis using visualisation techniques. This would enhance computer-aided analysis of MRI data and improve efficiency in treating data within the framework of both, clinical and forensic medicine.

In 2014, the investigation of fluid and gelatinous calibration phantom materials continued. Phantom materials closely resembling the tissues of interest were characterized in terms of their MRI properties. The stability and spatial homogeneity of these properties were continuously examined over approximately 8 months, leading to the identification of substances suitable for subsequent use as external standards in the project. These phantoms will be used to study the field inhomogeneity in the scan volume in the near future, work that has already started in the form of a master thesis project supervised at LBI-CFI and at TU Graz. The first step in that direction – development of software tools to compute T1, T2, and MT based on GPU accelerated curve fitting series of measurements - has already been taken. In the near future, the resulting multivariate volume datasets will be used for 3D visualization and to study the possibility to separate different tissue types using multidimensional transfer functions. We expect that fat and muscles, as well as blood can be separated more efficiently this way. The goal of the project is to improve the signal standardization of MRI data to enable improved visualization and segmentation on the basis of reference values, similar to Hounsfield Units in CT, which can be used to automate the visualization of forensic findings from MRI. This inter-disciplinary project, which involves experts from image processing, MR physics and legal medicine, will help to improve currently used MRI protocols in forensic practice as well as in the clinical context.

### **3.2 Membership in scientific associations**

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

- DGRM – Deutsche Gesellschaft für Rechtsmedizin
- ÖGGM – Österreichische Gesellschaft für Gerichtliche Medizin
- AGFAD – Arbeitsgruppe für Forensische Altersdiagnostik in der DGRM
- AGFB – Arbeitsgruppe Forensische Bildgebung in der DGRM
- UFG – Arbeitsgruppe Universitäre Forensische Genetik in der DGRM
- Berufsverband Deutscher Rechtsmediziner
- ISMRM – International Society of Magnetic Resonance in Medicine
- ESMRMB – European Society of Magnetic Resonance in Medicine and Biology
- ESR – European Society of Radiology
- RSNA – Radiological Society of North America

- ÖRG – Österreichische Röntgengesellschaft
- ISFRI – International Society of Forensic Radiology and Imaging
- Kriminalistische Studiengemeinschaft Steiermark
- FIRM – Forschungsinstitut für Recht in der Medizin
- Forschungsfeld Neurowissenschaften der Medizinischen Universität Graz
- SIDS (sudden infant death syndrome)-AG Austria
- Eurographics
- FIRS – Forensic Imaging Society of the Americas
- IEEE – Institute of Electrical and Electronics Engineers
- ISFG – International Society for Forensic Genetics
- IABPA – International Association of Bloodstain Pattern Analysts
- Deutscher Verkehrsgerichtstag
- SGRM – Schweizer Gesellschaft für Rechtsmedizin

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

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

### 3.3 Lecture series and workshops

In 2014, 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 2014, the following lectures took place:

- DI Ursula Buck, “Anwendung und Möglichkeiten des 3D-Oberflächenscanning in der Forensik”, 12.03.2014
- Prof. Andreas Berg, “Hoch-ortsauflösende Magnetresonanzbildgebung zur zerstörungsfreien mikroskopischen Analyse von Gewebe: Methodik und Anwendungen”, 23.04.2014
- Dr. Tanja Germerott, “Netzwerk ProBeweis – Erfahrungen aus dem Aufbau eines Ambulanznetzwerkes zur verfahrensunabhängigen Beweissicherung”, 04.06.2014

- Prof. Dr. Stefanie Ritz-Timme, “Lebensaltersschätzung: Möglichkeiten und Grenzen”, 24.09.2014
- Prof. Dr. med. Dirk Petersen, “Wie alt ist das Blut? Alter von intrakraniellen Blutungen im CT und MRI”, 26.11.2014

Additionally, the LBI-CFI organized a visit to the “Hans Gross Kriminalmuseum” on 22.01.2014, an event, which was also open to the public.

### 3.4 Teaching and training activities

#### 3.4.1 Teaching activities

##### Academic teaching

- Appointment of Martin Urschler at Graz University of Technology, as lecturer in “Medical Image Analysis” as a part of the computer science and biomedical engineering curricula, since SS 2008.
- Appointment of Eva Scheurer at Medical University Graz, as lecturer for the course “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt”, since WS 2010, with lectures given by Felicitas Dahlmann, Nikolaus Krebs, Kathrin Ogris, Isabella Klasinc, and Clemens Kauderer.
- Appointment of Eva Scheurer at Medical University Graz, as lecturer for the interdisciplinary course “Basiswissen Gerichtsmedizin”, since WS 2013, with lectures given by Nikolaus Krebs, Isabella Klasinc, Clemens Kauderer, Kathrin Ogris and Reingard Riener-Hofer, as well as some colleagues from the Institute of Forensic Medicine, Medical University Graz (Peter Leinzinger, Manfred Kollroser, Barbara Reichenpfader).
- Appointment of Reingard Riener-Hofer at the FH Joanneum Graz, as lecturer for the course “Rechtsgrundlagen für klinische Studien”, SS 2014.
- Starting October 2014, Thorsten Schwark was appointed as lecturer for both “Basiswissen Gerichtsmedizin” and “Gerichtsmedizin am Lebenden”.

##### 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. Table 6 shows the numbers of lectures given in the different fields; and below, some examples of individual presentations are given.

<b>Number of lectures</b>	<b>2014</b>
Hospitals, Clinical Units, Medical Doctors	7
Victim Support Institutions, Child Protective Services	0
Police, Prosecution authorities, Court, Jurists	2
Training (nursery, medical care, social work, etc.)	1
<b>Total</b>	<b>10</b>

Table 6: Number of non-academic lectures given by team members 2014

Examples of non-academic teaching:

- Lecture on “Klinisch-forensisches Netzwerk” for LKH Feldbach given by Eva Scheurer and Isabella Klasinc, 20.01.2014
- Lecture on “Klinisch-forensisches Netzwerk” for LKH Leoben given by Eva Scheurer and Isabella Klasinc, 27.02.2014 and 30.10.2014
- Lecture on “Kindesmisshandlung, sexueller Kindesmissbrauch – Diagnose und Dokumentation” given by Clemens Kauderer for medical personnel of the Landeskrankenhaus Amstetten, 27.03.2014
- Lecture on “Gewalt gegen Lebende – Klinische Rechtsmedizin” given by Eva Scheurer for the Ärztekammer Graz, 28.03.2014
- Lecture on “Kindesmisshandlung – Wie verhalte ich mich” given by Isabella Klasinc at the Kongress der Arbeitsgemeinschaft für Notfälle, 24.04.2014
- Lecture on “Erkennen von Misshandlungen im Bereich Säuglinge und Kleinkinder” given by Isabella Klasinc for the employees, social workers and medical doctors organized by “Elternberatungszentrum BH Hartberg”, 03.09.2014
- Lecture for the “Militärpolizei” given by Thorsten Schwark and Isabella Klasinc, 18.11.2014
- Lecture on “Klinisch-forensisches Netzwerk” for LKH Deutschlandsberg given by Thorsten Schwark and Isabella Klasinc, 27.11.2014

### **Ongoing student projects**

- Mag. Simone Kainz: “Die rechtsmedizinische Beurteilung von Körperverletzungsdelikten – Eine medizinrechtliche Studie”.  
*Dissertation* (Supervision by Peter Schick)
- Mag. Elisa Florina Ozegovic: “Die Rechtfertigung medizinischer Eingriffe aus Forschungs- und Lehrzwecken”.  
*Dissertation* (Supervision by Peter Schick)
- Dr. Kathrin Ogris: “Characterization of subcutaneous soft tissue injuries”.  
*Dissertation* (Supervision by Eva Scheurer)
- Mag. Katharina Baron, M.Sc.: “Fracture dating using MR based methods”.

*Dissertation* (Supervision by Eva Scheurer)

- DI Bernhard Neumayer: “Quantitative Analysis of Selected Contrasts in Magnetic Resonance Imaging”.

*Dissertation* (Supervision by Rudolf Stollberger, TU Graz)

- DI Andreas Petrovic: “Methodological improvements of quantitative MR imaging”.

*Dissertation* (Supervision by Rudolf Stollberger, TU Graz)

- Bridgette Webb, M.Sc.: “Systematic development of post-mortem MR angiography (PMMRA) procedures and analysis of potential contributions to minimally-invasive autopsy (MIA)”.

*Dissertation* (Supervision by Rudolf Stollberger, TU Graz)

- 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)

- Margot Kauderer: “Schulmedizin vs. Alternativbehandlung: medizin- und strafrechtliche Probleme”.

*Diploma thesis* (Supervision by Peter Schick)

- Michael Schneeberger: *Master thesis* at Joanneum Research on the topic of synthetic wound simulation. Martin Urschler supervises this thesis to deepen relationships with the group for human centred image analysis at the DIGITAL institute of Joanneum Research, which is headed by Dr. Heinz Mayer.

- Kerstin Hammernik: *Diploma thesis* together with Dr. Susanne Vogl from the Clinical Department for Prosthetics at Medical University Graz. Her topic is the segmentation of dental bone implant material for the analysis and tracking of absorption of jawbone implants. The work is jointly supervised by Martin Urschler, LBI-CFI and Thomas Pock, ICG, Graz University of Technology.

- Thomas Ebner: *Diploma thesis* on the topic “Detection of wrist and hand bones from MR images”. This topic is a necessary pre-processing step for enabling automatic bone age estimation from MRI. He works closely together with Dr. Darko Stern from ICG, Graz University of Technology and is supervised by Martin Urschler, LBI-CFI.

- Christian Payer: *Diploma thesis* together with Michael Pienn and Zoltan Balint from the Ludwig Boltzmann Institute for Lung Vascular Research. Based on the work of Michael Helmberger on vessel segmentation, his topic is the separation of lung vascularity in venous and arterial trees, to investigate the effect of both trees on the recently established non-invasive method for quantification of pulmonary hypertension.

- Josef Koller: “Intensity inhomogeneity reduction in MR images”

*Diploma thesis* (Supervision by Martin Urschler)

- Walter Unterpinker: “Detection of Clavicle Bones and Wisdom Teeth from MRI Images”

- Diploma thesis* (Supervision by 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)
- Carlo Hamm: “Beeinträchtigungen von Frakturheilungsverläufen durch spezifische Indikatoren”  
*Diploma thesis* (Supervision by Eva Scheurer)

### 3.5 Reviewing activities

#### Journals

*International Journal of Legal Medicine* (Eva Scheurer)  
*Journal of Forensic and Legal Medicine* (Eva Scheurer)  
*Forensic Science International* (Eva Scheurer, Alexander Bornik)  
*European Radiology* (Eva Scheurer, Bridgette Webb)  
*American Journal of Neuroradiology* (Eva Scheurer)  
*Journal of Magnetic Resonance Imaging* (Eva Scheurer, Thomas Ehammer)  
*International Journal of Human-Computer Studies* (Alexander Bornik)  
*Medical Image Analysis* (Martin Urschler)  
*IEEE Transactions on Medical Imaging* (Martin Urschler)  
*IEEE Transactions on Pattern Analysis and Machine Intelligence* (Martin Urschler)  
*Pattern Recognition* (Martin Urschler)  
*Computer Vision and Image Understanding* (Martin Urschler)  
*Analytical Chemistry* (Nikolaus Krebs)  
*Forensic Science, Medicine and Pathology* (Sabine Grassegger, Thorsten Schwark)

#### Conferences

*CVPR (International Conference Computer Vision and Pattern Recognition)* (Martin Urschler)  
*ECCV (European Conference on Computer Vision)* (Martin Urschler)

#### Book proposals and scientific grants proposals

*Proposal for the use of the Stanford Synchrotron Radiation Lightsource* (Nikolaus Krebs)

## 4. Outlook

### **Institutional partners**

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

### **Scientific program**

In 2015, the scientific program will be continued in form of the five defined key areas. The main task will be to intensify the current activities of data evaluation, manuscript preparation and publication of results. A research program for the next term, which takes into account the suggestions made by the evaluation panel, has been prepared.

### **Teaching and training**

In the next period, the LBI-CFI lecture series “The interdisciplinary world of forensic imaging” for which nationally and internationally renowned speakers are invited to give talks about their area of expertise, including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support, will be continued. Following speakers are planned for the lecture series in 2015: PD Dr. Nicole von Wurmb-Schwark (Institute for Forensic Medicine, UKSH Schleswig-Holstein, Germany), Prof. Henning Müller (Institute for Business Information Technology, HES-SO Valais, Switzerland), Dr. Michael Sandholzer (Medical Research Council Harwell, Oxford Harwell Innovation & Science Campus, UK), Sara Kondert (Interpreter and Translator, Graz, Austria), Prof. DDr. Fritz Schick (Sektion für Experimentelle Radiologie, Abteilung für Diagnostische und Interventionelle Radiologie, University of Tübingen, Germany), Univ.-Prof. Dr. Silvia Ulrich (Institute for Legal Gender Studies, Johannes Kepler University Linz, Austria), PD ao. Univ.-Prof. Mag. Dr. Wolfgang Neubauer (LBI for Archaeological Prospection and Virtual Archaeology, Vienna, Austria)

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

## 5. List of publications

### 5.1 Peer-reviewed papers

Diwoy C, Liebmann D, Neumayer B, Reinisch A, Knoll F, Strunk D, Stollberger R. Positive contrast of SPIO-labeled cells by off-resonant reconstruction of 3D radial half-echo bSSFP. *NMR Biomed*, 28 (1):79-88 <http://dx.doi.org/10.1002/nbm.3229> (2014)

Hassler E, Ogris K, Petrovic A, Neumayer B, Widek T, Yen K, Scheurer E. Contrast of artificial subcutaneous hematomas in MRI over time. *Int J Legal Med*, <http://dx.doi.org/10.1007/s00414-014-1124-8> (2014)

Helmberger M, Pienn M, Urschler M, Kullnig P, Stollberger R, Kovacs G, Olschewski A, Olschewski H, Balint Z. Quantification of tortuosity and fractal dimension of the lung vessels in pulmonary hypertension patients. *PLOS One*, 9 (1) <http://dx.doi.org/10.1371/journal.pone.0087515> (2014)

Kamolz L.P, Lumenta D.B, Parvizi D, Dirnberger J, Owen R, Höller J, Giretzlehner M. Smartphones and burn size estimation: "Rapid Burn Assessor". *Annals of Burns and Fire Disasters*. *Annals of Burns and Fire Disasters XXVII* (n.2):101-104 (2014)

Krebs N, Langkammer C, Goessler W, Ropele S, Fazekas F, Yen K, Scheurer E. Assessment of trace elements in human brain using inductively coupled plasma mass spectrometry. *J. Trace Elem. Med Biol.*, 28 (1):1-7 <http://dx.doi.org/10.1016/j.jtemb.2013.09.006> (2014)

Neumayer B, Hassler E, Petrovic A, Widek T, Scheurer E. Age Determination of Soft Tissue Hematomas. *NMR Biomed*, 27 (11):1397-1402 <http://dx.doi.org/10.1002/nbm.3202> (2014)

Petrovic A, Scheurer E, Stollberger R. Closed-Form Solution for T2 mapping with Nonideal Refocusing of Slice Selective CPMG Sequences. *Magn Reson Med*, 73 (2):818-827 <http://dx.doi.org/10.1002/mrm.25170> (2014)

Riener-Hofer R, Webb B, Scheurer E. Forensigraphy: The integration of imaging techniques into the criminal justice system. *European Police Science and Research Bulletin*, 11:47-56 (2014)

Rudyanto R D, Kerkstra S, van Rikxoort E M, Fetita C, Brillet P-Y, Lefevre C, Xue W, Zhu X, Liang J, Oksüz I, Ünay D, Kadipasaoglu K, Estepar R S J, Ross J C, Washko G R, Prieto J-C, Hernandez Hoyos M, Orkisz M, Meine H, Hüllebrand M, Stöcker C, Lopez Mir F, Naranjo V, Villanueva E, Staring M, Xiao C, Stoel B, Fabijanska A, Smistad E, Elster A C, Linseth F, Foruzan A H, Kiros R, Popuri K, Cobzas D, Jimenez-Carretero D, Santos A, Ledesma-Carbayo M J, Helmberger M, Urschler M, Pienn M, Bosboom D G H, Campo A, Prokop M, de Jong P A, Ortiz-de-Solorzano C, Munoz-Barrutia A, van Ginneken B. Comparing algorithms for automated vessel segmentation in computed tomography scans of the lung: The VESSEL12 study. *Med Image Anal*, 18 (7):1217-1232 <http://dx.doi.org/10.1016/j.media.2014.07.003> (2014)

Scheurer E, Schoelzke S. Consent to forensic radiologic examinations by living crime victims. *Int J Legal Med*, 128 (2):323-328 <http://dx.doi.org/10.1007/s00414-013-0831-x> (2014) <http://www.ncbi.nlm.nih.gov/pubmed/23381578>.

Urschler M, Höller J, Bornik A, Paul T, Giretzlehner M, Bischof H, Yen K, Scheurer E. Intuitive Presentation of Clinical Forensic Data Using Anonymous and Person-Specific 3D Reference Manikins. *Forensic Sci Int*, 241:155-166 <http://dx.doi.org/10.1016/j.forsciint.2014.05.017> (2014)

Webb B, Petrovic A, Urschler M, Scheurer E. Assessment of fiducial markers to enable the co-registration of photographs and MRI data. *Forensic Sci Int*, 248:148-153 (2014)

## 5.2 Books, book chapters and other publications

Ebner T, Stern D, Donner R, Bischof H, Urschler M. Towards Automatic Bone Age Estimation from MRI: Localization of 3D Anatomical Landmarks. In: Springer LNCS 8674 (Eds), Proc Medical Image Computing and Computer Assisted Intervention (MICCAI) Boston:421-428 (2014).

Hammernik K, Ebner T, Stern D, Urschler M, Pock T. Vertebrae Segmentation in 3D CT Images based on a Variational Framework. In: (Eds), Proc MICCAI Workshop Computational Methods and Clinical Applications for Spine Imaging (CSI) Boston (2014). Honourable Mention Award.

Kainz S, Riener-Hofer R, Schick P, Scheurer E. Die Relevanz von (rechts-)medizinischen Untersuchungen in der gerichtlichen Beurteilung von Körperverletzungen. In: *Österreichische Richterzeitung*; (Eds), Wien 10/14:221-224 (2014).

Riener-Hofer R, Scheurer E, Kainz S. Fünf Jahre Klinisch-Forensische Untersuchungsstelle in Graz. In: *Kriminalistik - Unabhängige Zeitschrift für die kriminalistische Wissenschaft und Praxis*; Verlagsgruppe HJR GmbH Kriminalistik Verlag (Eds), Heidelberg 5/2014:317-322 (2014).

Schenk F, Urschler M, Aigner C, Roesner I, Aichinger P, Bischof H. Automatic glottis segmentation from laryngeal high-speed videos using 3D active contours. In: (Eds), Proc 18th Conf Medical Image Understanding and Analysis (MIUA) London:111-116 (2014).

Stern D, Ebner T, Bischof H, Grassegger S, Ehammer T, Urschler M. Fully Automatic Bone Age Estimation from Left Hand MR Images. In: Springer LNCS 8674 (Eds), Proc Medical Image Computing and Computer Assisted Intervention (MICCAI) Boston:220-227 (2014).

Stern D, Ebner T, Bischof H, Urschler M. Determination of legal majority age from 3D magnetic resonance images of the radius bone. In: (Eds), Proc International Symposium Biomedical Imaging Beijing (2014).

Urschler M, Leitinger G, Pock T. Interactive 2D/3D Image Denoising and Segmentation Tool for Medical Applications. In: (Eds), Proc MICCAI Workshop Interactive Medical Image Computation (IMIC) Boston (2014).

## 5.3 Abstracts and conference presentations

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#### 5.4 Diploma, bachelor, and master theses

- Fabian Schenk: *Diploma thesis* together with Philipp Aichinger from the Medical University Vienna. His topic is the localization and segmentation of the glottis from high-speed larynx videos. He is supervised by Martin Urschler, LBI-CFI.
- Marlene Vukmanic: "Survey and Comparison of Transfer Functions for GPU Based Direct Volume Rendering"

*Bachelor thesis* (Supervision by Alexander Bornik)

- Stefanie Christina Reumüller: “Einwilligung in die klinisch-forensische Untersuchung”.  
*Diploma thesis* (Supervision by Peter Schick).
- Ingo Wieser: “Die Befangenheit des rechtsmedizinischen Sachverständigen in den verschiedenen Verfahrensarten”.  
*Diploma thesis* (Supervision by Peter Schick)
- Nicole Malleg: “Gerichtsmedizin am Lebenden – Die körperliche Untersuchung und deren Bedeutung im Strafprozess am Beispiel der Tätigkeit des Ludwig Boltzmann Instituts”  
*Diploma thesis* (Supervision by Peter Schick)
- Mag. Oliver Neuper: “Patientensicherheit und Risikomanagement – Rechtliche Grundlagen und Verantwortung in Krankenanstalten”.  
*Dissertation* (Supervision by Peter Schick)
- Andreas Lesch: Diploma thesis “Quantification of T1, T2 and relative spin density using bSSFP with correction of non-ideal flip angle profiles” at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).
- Sabrina Masser: “Radiologische Untersuchungen bei Verdacht auf Kindesmisshandlung”  
*Bachelor thesis* (Supervision by Thomas Widek)