PD Dr. Kate Gerber (née Gavaghan)

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Education

13.07.2021	**Venia Docendi for Biomedical Engineering**, Faculty of Medicine, University of Bern, Switzerland
28.01.2014	**Doctor of Philosophy in Biomedical Engineering**, University of Bern, Switzerland
30.06.2009	**Bachelor Science (Biomedical Science) / Bachelor Engineering (Electronics and Computer systems)**, Swinburne University of Technology, Melbourne, Australia
30.11.2003	**Bachelor of Science**, Computer Science, University of Melbourne, Australia

Professional Experience

2019 – present	**Co-Head of the Personalised Medicine research group**, sitem Center for Translational Medicine and Biomedical Entrepreneurship, University of Bern, Switzerland
2019 – 2021	**Program Coordinator, MAS in Medical Device Regulations and Regulatory Affairs**, sitem Center, University of Bern, & sitem-insel, Bern, Switzerland
2014 – 2018	**Postdoctoral Researcher – Head of Microsurgical Robotics Research**, Image Guided Therapy Group, ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland
2010 – 2014	**PhD Candidate**, Image Guided Therapy group, ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland
2009 – 2010	**Research Engineer**, Computer Aided Surgery group, Institute for Surgical Technology and Biomechanics, University of Bern, Switzerland
2009	**Research Assistant**, Department of Engineering, Monash University, Melbourne, Australia
2008 – 2009	**Biomedical Engineer**, Ingeneus Pty Ltd, Melbourne, Australia
2007	**Cardiac Technologist**, Department of Cardiology, Royal Children’s Hospital, Melbourne, Australia

Approved Research Funding

2019	PI	Surgical Planning for Rotator Cuff Repair, Innosuisse	1,068,321 CHF
2017	Co-PI	Robotic Cochlear Implantation, Eurostars Project Grant	745,400 Euro
2016	Co-PI	NerveSafe – Neuromonitoring to protect the facial nerve during minimally invasive cochlear implantation, Nano-Tera Collaborative Project Grant	31,921 CHF
2016	Co-PI	MIRACI – Minimally Invasive and Robotically Assisted Cochlear Implantation, Commission for Technology and Innovation Grant	871’879 CHF
2015	Co-PI	Image-guided micro surgery for hearing aid implantation, Nano-Tera Project Grant	2’600’000 CHF
2014	PI	Multicenter validation of an image guided robotic system for minimally invasive cochlear implantation, CURAC Society, Mobility Grant	2’700 CHF

Supervision of Junior Researchers

2020 – present	Adrian Ruckli, PhD, Robust AI for diagnosis and surgical planning
2020 – present	Hanspeter Hess, PhD, Patient specific surgical outcome prediction for rotator cuff repair
2020 – present	Johanna Menze, PhD, Biomechanical modelling of the shoulder for patient specific rotator cuff repair surgical planning and outcome prediction
2022 – present	Finn Bürki, MSc, Automated 3D diagnosis of rotator cuff tears from MRI for treatment planning
2022 – present	Rebecca Brachat, MSc, Predicting Segmentation Performance – A Shape Based Analysis of Algorithm Robustness
2021	Stefan Weber, MSc, Deep Learning based Fully Automatic Quantification of Rotator Cuff Tears from MRI

2021	Eylem Akalp, MSc, Modality dependent accuracy analysis of patient-specific 3D anatomy modelling
2020	Michael Herren, MSc, Deep learning-based segmentation and fat fraction analysis of the shoulder muscles using quantitative MRI
2020	Cédric Moser, MSc, Unsupervised Domain Adaption for Cross-Modality Hip Joint Segmentation
2020	Adrian Ruckli, MSc, Automated quantification of cartilage quality for hip treatment decision support
2018	Camilo Mendez, MSc, Template based patient-to-image registration utilising Intraoperative Imaging for procedures on the lateral skull base
2017	Aarati Chacko MSc, Development of thin-film sensors for surgical drills
2017	Apollonius Schwarz, MSc, Evaluation and improvement of force-based tool pose estimation confidence, accuracy and robustness
2016	Jariyaporn Thongbudda, Msc, An evaluation of image motion blur and its effect on the accuracy of image guided surgery
2015	Ahtisham Sikandar, MSc, Image-based intraoperative evaluation for minimally invasive cochlear implantation

Teaching Activities

2022 – present	Biomedical Engineering Laboratory, M.Sc., 3 ECTS, University of Bern, Project Supervisor
2015 – present	Computer Assisted Surgery, M.Sc., 3 ECTS, University of Bern, Main Lecturer
2014 – present	Image Guided Therapy Lab, M.Sc., 3 ECTS, University of Bern, Main Lecturer
2015 – 2018	Clinical Applications of Image-Guided Therapy, M.Sc., 3 ECTS, University of Bern, Lecturer

Memberships & Network

Scientific Societies	Member of: MICCAI Society, the International Society of Biomechanics
Scientific Reviewer	Annals of Biomedical Engineering, HNO, IEEE Transactions on Biomedical Engineering, IEEE Transactions on Automation Science and Engineering, International Journal of Computer Assisted Radiology and Surgery (IJCARS), The International Journal of Medical Robotics and Computer Assisted Surgery (MRCAS), Otology & Neurotology, MICCAI AE-CAI: Workshop on Augmented Environments for Computer-Assisted Interventions, Computer Assisted Radiology and Surgery (CARS), Annual conferences of the German society for computer and robot assisted surgery (CURAC), EuroVis Conference on Visualisation

Organisation of Conferences

2021	AI Symposium – Artificial Intelligence in Diagnostic Medical Systems, Bern, Switzerland
2016	CURAC The German Society for Computer and Robot Assisted Surgery, Bern, Switzerland

Awards & Prizes

2018	Surgical Robot Challenge Best Video Award, Hamlyn Symposium of Medical Robotics, London, UK
2017	CURAC 1st Paper Award, German Society Computer Aided and Robotic Surgery
2017	Olympus ISCAS 1st Paper Award, International Society, Computer Aided Surgery
2015	Best Poster Award, The Swiss Society of OtoRhino-Laryngology , Head and Neck Surgery Meeting
2013	Best Paper, Hamlyn Symposium of Medical Robotics
2012	Medvis Karl-Heinz Höhne Award for Medical Visualization
2011	Top five best paper selection, the IMIA Yearbook of Medical Informatics

Career Breaks

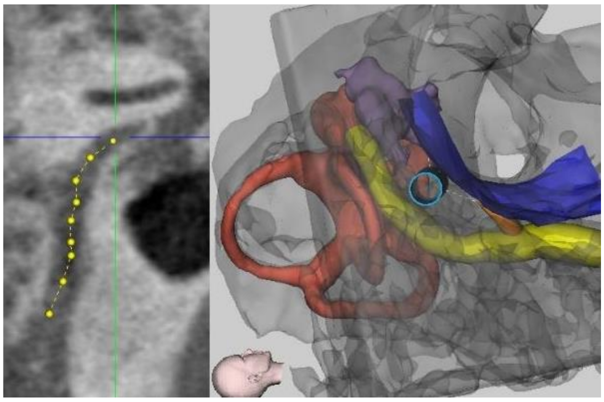
01.2021 – 04.2021	Maternity leave
11.2016 – 03.2017	Maternity leave

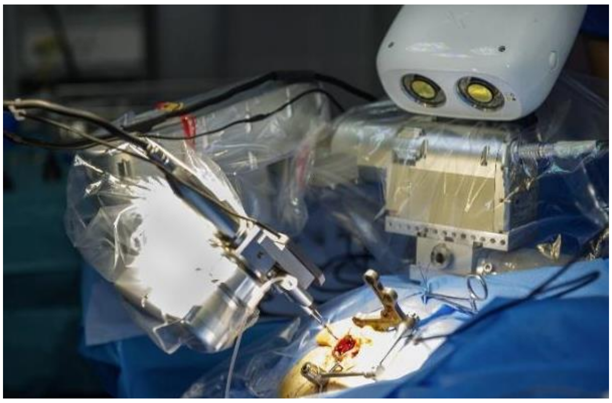
Major Scientific Achievements

My research focusses on the investigation and development of technologies for patient specific diagnosis, treatment decision support, surgical planning, treatment outcome prediction, treatment guidance and outcome evaluation.

Robotic Minimally Invasive Cochlear Implantation

From 2010 until 2018 my research focused on the development and validation of systems and processes for robotic cochlear implantation. Research on the topics of high accuracy patient-to-image registration techniques, navigation software and drilling accuracy assessment, contributed to the achievement of image guided robotic positioning accuracy sufficient for middle ear access for the first time. As the head of the microsurgical robotics research team within the group of Image Guided Therapy at the ARTORG Center, and, as a co-PI of the "HearRestore" NanoTera collaborative project, I investigated the emerging topic of functional guidance as a means to increase the safety and reliability of robotic cochlea implantation. In particular, my work focussed on the utilisation of intraoperative electromyography, tissue impedance and force-torque measurements for the safety verification of an image guided robotically positioned drill during percutaneous access to the cochlear. Concurrently, working in collaboration with the research team of Prof. Dr. Philippe Zysset, I investigated thermal risk to the facial nerve during percutaneous drilling to the cochlear and contributed to the development and verification of a model based on intraoperatively sensed force and torque signals for the real time assessment of thermal risk





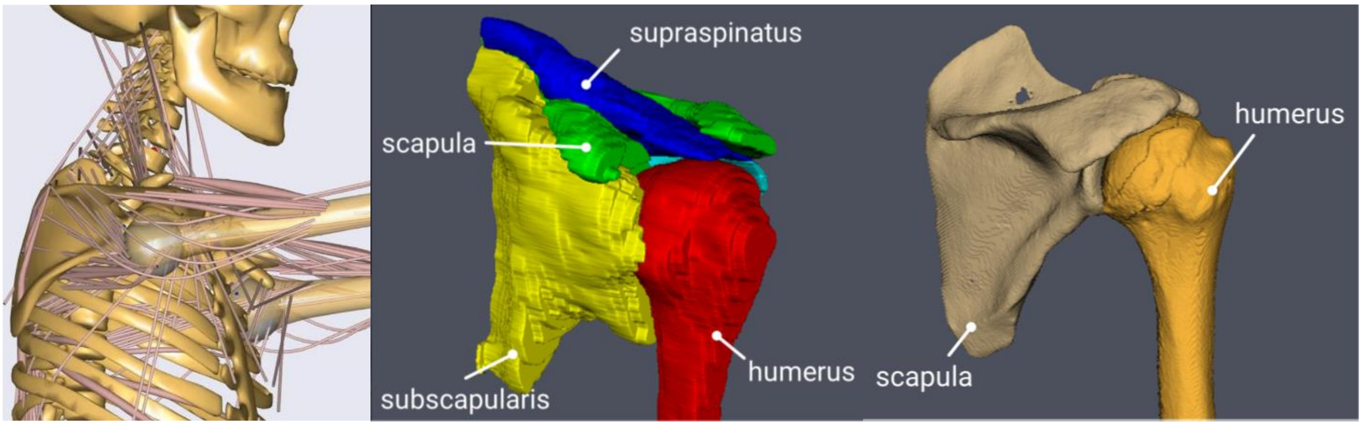
My research activities extended to surgical planning for robotic cochlear implantation and included: fiducial detection accuracy verification, clinically relevant subpixel segmentation of the facial nerve and modelling of the chorda tympani. Towards the first clinical trial of robotic cochlear implantation I was involved in the development of systems for the use of intraoperative imaging for drill positioning verification and the fusion of multi-sensor safety systems in addition to surgical decision making during automated robotic procedures and the study of clinical implications of robotic cochlea implantation and the optimisation of electrode insertion. This work culminated in a first in man clinical trial of automated robotic middle ear access for minimally invasive cochlear implantation within the department of ENT Surgery at Inselspital and commercial transfer of the technology to a commercial partner (CAScination AG).

Links: https://www.cascination.com/en/otoplan
https://www.cascination.com/en/hearo
https://www.science.org/doi/10.1126/scirobotics.aal4916

Computer assisted planning for rotator cuff repair

In the beginning of 2019 I co-founded the Personalised Medicine research group within the new Center for Translational Medicine and Biomedical Entrepreneurship (sitem Center) of the University of Bern. The group's research focusses on the investigation and development of technologies for image-based patient specific diagnosis, treatment decision support, surgical planning, and treatment outcome prediction utilising methods of artificial intelligence. In January 2019, I commenced a research collaboration with Prof. Dr. Matthias Zumstein with the aim of developing deep learning based diagnosis and surgical planning techniques to support the treatment planning of rotator cuff tears. As PI and project manager of the multidisciplinary, multi-institute project entitled “Computer assisted planning for rotator cuff repair“ (funded by Innosuisse, 2020-2022, partners: ETHZ, DePuy Synthes AG, Inselspital Department of Orthopaedic surgery, Department of Neurology and Department of Radiology) my research has focused on the development of clinical applicable software aiming to assist surgical decision making for improved surgical outcomes.

To enable three dimensional (3D) diagnosis of rotator cuff tears and patient shoulder morphology in clinical routine, methods for the deep learning segmentation of the shoulder anatomy have been investigated from CT arthrography and MRI. Accuracies of 98-99% for CT arthrography and 82%-90% for MRI have been achieved, showing the feasibility of a deep learning based segmentation of the shoulder. Research into methods for the automatic quantification of prognostic factors for rotator cuff repair based on 3D imaging has also been undertaken and is currently ongoing. Methods for the automatic quantification of Y-view fat fraction and whole muscle fat fraction from quantitative Dixon MRI and T1-weighted MRI have been investigated with preliminary accuracies of 1.5 % and 4.6% respectively. Algorithms are being implemented into a web-based software for the clinical diagnosis of rotator cuff tears.

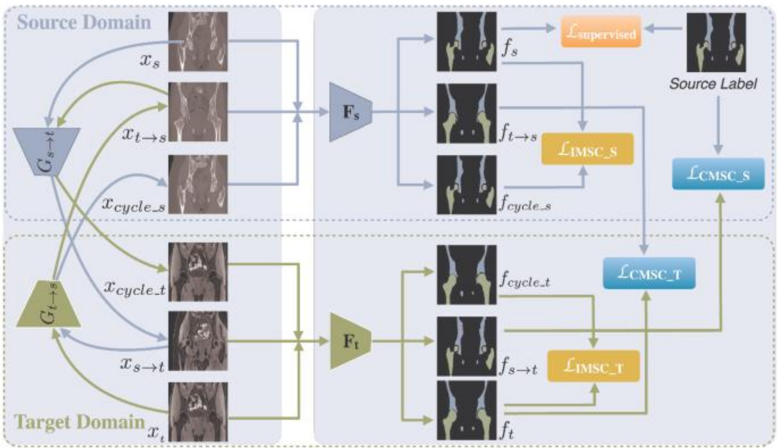


To investigate the effect of 3D prognostic parameters for rotator cuff repair on outcome, a computation model has been developed (AnyBody™, Denmark). Different massive rotator cuff tear (MRCT) patterns have been assessed in the shoulder model to identify important compensatory musculature and the effect on limited range of motion (ROM). The importance of teres minor integrity was identified during external rotation which can only sufficiently compensate for the lost infraspinatus function if it increases its strength. It was found that lost subscapularis function can be compensated by multiple muscles during internal rotation in front of the body, however, not behind the back. Morphological parameters that increase the loading on the rotator cuff and consequently also the RC repair were investigated to identify high risk patients for symptomatic RC injuries. It could be shown that subscapularis and infraspinatus are most sensitive to changes in acromion lateralization and glenoid inclination. This could imply they are the key muscles for shoulder joint stability. An upward glenoid inclination appeared to be more important for supraspinatus loading than the acromion lateralization. The continuous overstraining of these RC muscle due to the scapula geometries with an upward tilted glenoid and a laterally extended acromion could be the underlying reason for the higher incidence of RC tearing. Functionality from this project has been developed into a web based application for use in research studies and for future use in clinical diagnosis.

Link: https://www.sitem.unibe.ch/rcr

Robust AI for clinical application

Deep learning based segmentation algorithms have additionally been developed for the diagnosis and treatment decision support for femoroacetabular impingement, which includes the evaluation of cartilage quality for treatment outcome prediction. One issue with deep convolutional neural network is that their performance on cross-modality or cross-centre test images often drops significantly (domain shift) and creating annotations in new domains is particularly expensive. We have investigated unsupervised domain adaptation methods to address this challenge and our results on hip joint show that our methodology outperforms other state-of-the-art unsupervised domain adaptation methods by a large margin (10% Dice gain).



Performance of convolutional neural networks for image segmentation and analysis, on data unrepresented by the training and testing set can also be subject to unexpected errors. Methods for the automatic evaluation of case specific segmentation accuracy, in relation to the effect on the final clinical metric, is currently being investigated. Methods for the identification and feedback of sufficient accuracy and methods for the guided optimisation of corrections are being investigated to improve the robustness of AI based segmentation and analysis when applied in clinical or research study settings.

Link: https://doi.org/10.1007/978-3-030-87199-4_19