KU LEUVEN

OMFS
IMPATH

Yearbook 2019

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Preface

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Preface

OMFS-IMPATH research group has been established 7 years ago. Gradually we've seen increasing maturity in the group resulting in improved study design, statistical depth and improved research methods. This has led to an increased output of accepted manuscripts. This further attracts young talents from many countries to achieve a Master or PhD thesis. Increased quality of research facilitates companies to invest in KUL research and development, whether in contracts or in chairs. The physical proximity between the clinical imaging department and active 3D-facility is an university setting allow implementation of translational research into daily clinical practice. Industrial progress is fast and it remains difficult to stay on top of most recent developments. Yet, a consistent finding is that many of the industrial innovations in OMFS lack sufficient validation before being implemented into Maxillofacial surgical practice. This holds true for both hardware and software. University research groups can make the difference due to their unique setting between industry and clinical practice. The multicultural and multidisciplinary exercise serves output and fosters tolerance. To forge a group out of a heterogeneous mix of cultures and scientific backgrounds necessitates a talented coach. Prof. dr. Reinhilde Jacobs has been the perfect person, heading this team in the right direction. Fundraising remains vital to keep ongoing. The Yearbook 2019 reflects the efforts made in a research field where imaging science, nerve damage and orthognatic surgery have been the main focus in the past few years.

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The OMFS-IMPATH research group relates to development and validation of surgical tools and image-based solutions to advance in oromaxillofacial surgery, with an ultimate aim to obtain an optimized treatment outcome while minimizing the peri- and postsurgical risks, such as neurovascular trauma. In order to achieve this, a global integration of digital datasets will enable the creation of a virtual replica of the patient. This may allow full simulation of the surgery as well as of its expected outcome. While the latter may help to further modify and fine-tune the planned surgery, the former integrated virtual data may allow presurgical simulations, development of image-based surgical tools and navigation. Research is focused on image-based development of surgical aids with validation of their clinical applicability. Research lines also include: optimized image acquisition with the least radiation dose, especially when children are concerned; image-based development of individualized surgical tools, while striving for advanced applications of e.g. 3D printing; maximized visualization of the trigeminal nerve pathway to minimize the surgical risks for trigeminal nerve damage. Such visualization may also assist in creating new access routes and surgical strategies to modulate trigeminal neuropathic pain. In that respect, important progress has been made in the trigeminal research field in 2019. For updates on research of the omfsimpath team, see www.omfsimpath.be. The team produces high quality research output, with more than one scientific article a week.

DEPARTMENT OF IMAGING & PATHOLOGY - HEAD: PROF. TANIA ROSKAMS

Biomedical MRI	Uwe Himmelreich
Forensic Biomedical Sciences	Wim Van de Voorde
Medical Physics & Quality Assessment	Hilde Bosmans
Nuclear Medicine & Molecular Imaging	Koen Van Laere
Radiology	Raymond Oyen
Theragnostic Laboratory	Yicheng Ni
Translational Cell & Tissue Research	Tania Roskams
Translational MRI	Vincent Vandecaveye
OMFS-IMPATH	**Constantinus Politis** www.omfsimpath.be

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Tania ROSKAMS

Tania Roskams obtained her medical degree in 1989 at the University of Leuven. She specialized in Pathology (University of Leuven) and obtained her PhD in liver pathology in Leuven and Oklahoma University, USA. In 1996 she became head of the Liver Research Unit, in 2002 of the Research group Translational Research and Pathology and in 2015 Head of the Departement of Imaging & Pathology. She was nominated Professor in pathology in 2002. From 2007-2009 she was visiting professor at the University of Utrecht. In the clinical department she is responsible for hepatobiliary, pancreas and gastrointestinal pathology. Her main interest is liver research with special emphasis on liver progenitor cells and their role in regeneration and carcinogenesis.

Peter VERMAELEN

Peter Vermaelen obtained his degree in Medical Laboratory Technology in 1994 and gained experience in different clinical and research topics. In 2000, he joined the pre-clinical unit of the Nuclear Medicine & Molecular Imaging research group and was co-founder of the Molecular Small Animal Imaging Center (MoSAIC). Since 2012, he is as department manager responsible for the financial and personnel administration of the Department of Imaging & Pathology.

A. STAFF

Constantinus POLITIS

Constantinus Politis is Oral and Maxillofacial Surgeon. He is currently Professor and Chairperson of the Department of Oral and Maxillofacial Surgery at KU Leuven, Belgium. He is an invited Lecturer at the EHSAL in Brussels. He graduated at the Catholic University of Leuven in medicine (MD, summa cum laude), in dentistry (DDS, magna cum laude). He specialized in oral and maxillofacial surgery at the Catholic University of Leuven. Postgraduate training was additionally followed in Arnhem (Stoelinga), Aachen (Koberg), Copenhagen (Pindborg), Göteborg (Bränemark) and San Francisco (Marx). He also holds a master degree in management (MM) from the Applied Economic Scienes at the University of Hasselt and a master degree in Hospital Management (MHM) from the KU Leuven. He became a recognition as medical specialist in management of health care data and is now member of the National Council of Hospital Facilities. He is Secretary General of the Professional Union of Belgian Oral and Maxillofacial Surgeons. He is acknowledged trainer of OMFS trainees. He defended his doctor's thesis on the subject of complications of orthognathic surgery (PhD). His professional field of intrest is in orthognathic and orthodontic surgery and trigeminal nerve dysfunction. Clinical research projects include prevention and repair of iatrogenic trigeminal nerve injury.

Reinhilde JACOBS

Reinhilde Jacobs is dentist, Doctor in Dental Sciences (PhD University of Leuven), periodontologist (KU Leuven) and Master in Dental Radiology (University of London). She is full professor at the University of Leuven and visiting professor at Karolinksa Institutet, Stockholm, Sweden and the Dalian Medical University in China. R. Jacobs is heading the OMFS-IMPATH research group of the KU Leuven (omfsimpath.be), being responsible for research, education and clinical activities in the field of dentomaxillofacial radiology. She is Secretary General of the International Association of DentoMaxilloFacial Radiology, past president of the European Academy of DentoMaxilloFacial Radiology as well as DDS board member. She is section editor of Clinical Oral Investigations, International Journal of Oral Implantology, European Journal of Radiology and Oral Radiology meanwhile being editorial board member of Clinical Oral Implant Research, Journal of Oral Rehabilitation, Imaging Science in Dentistry, Oral Surgery Oral Medicine Oral Pathology Oral Radiology, Revista Odonto Ciencia and Archives of Oral research. She has received the D Collen Research Travel Award (1994), a postdoctoral fellowship of the European Commission (1994), the IADR Young Investigators Award (1998) and the Belgian Joachim Award in the Odontostomatology (1999). In 2013, she received a Dr Honoris Causa at the "Iuliu Hatieganu" University of Medicine and Pharmacy in Cluj-Napoca. She is involved in many multidisciplinary and interuniversity research collaborations, with a specific focus on oral implant physiology and imaging research. She has been actively participating in European projects (ref. Minosquare, Osteodent, SedentexCT, Dimitra). She is (co-)author of 5 books and more than 410 publications in peer-reviewed journals besides multiple invited lectures and publications in other journals or books. Web of Science (2018): h:62

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Paul LEGRAND

Prof. dr. Paul Legrand studied medicine at the KU Leuven and graduated as medical doctor in 1982. Afterwards he studied dentistry and graduated in 1984. He was trained as an oral- and maxillofacial surgeon at the KU Leuven and at the Rheinisch-Westfälische Technische Hochschule in Aachen. In 1988 he became a certified oral and maxillofacial surgeon. In October 1988, he founded the oral and maxillofacial surgery department in the Maria Hospital in Overpelt, where he was medical head of OMFS from 1988 to 2017. He is a certified OMFS instructor and a member of the OMFS accreditation committee. Furthermore, he is on the board of the association of Flemish oral and maxillofacial surgeons (VVMKA) and the VBS MKA.
Since 2011 professor Legrand was part-time affiliated with the UZ Leuven and in 2016 he was appointed guest lecturer at the KU Leuven. Since November 2018, professor Legrand is fulltime staff member at OMFS UZ Leuven.
In Belgium, professor Legrand is a pioneer in intravenous sedation in the OMFS department and he has made this is most important area of interest. His principal activities are dento-alveolar surgery, implantology and further development of intravenous sedation techniques.

Titiaan DORMAAR

Titiaan Dormaar is a Cranio-Maxillofacial and Cleft surgeon currently working in the department of oral and maxillofacial surgery at UZ Leuven. He obtained his MD from Maastricht University, where he was involved in a research project focusing on liquid ventilation in neonatal respiratory distress syndrome. He obtained his DDS from the Radboud University Nijmegen (the Netherlands). Before continuing his specialist training he spent 2 years in the UK, where he worked as a senior house officer in ENT and OMFS in Guildford and London. He completed his OMFS training at Utrecht University (the Netherlands). During his training in Utrecht he was the lead surgeon in an animal model research project on alveolar bone grafting with beta-TCP bone substitute in alveolar clefts. Following this he did a 3 year Fellowship in Cleft Surgery at Guy's and St Thomas' Hospital, London (UK), whilst he also provided regular on-call duties at King's College Hospital, a tertiary trauma centre.

Ruxandra Gabriela COROPCIUC

Ruxandra Gabriela Coropciuc graduated as double qualified (MD, DDS) Oral and Maxillofacial Surgeon from the University of Medicine and Pharmacy Carol Davila, Bucharest in 2013. She was trained in the Clinical Hospital or Oral and Maxillofacial Surgery, Bucharest and at Leuven University Hospitals. She joined the Department of Maxillofacial Surgery at the UZ Leuven Belgium in 2013. Her PhD research is focused on bisphosphonate-related osteonecrosis of the jaw bone. Her clinical field of interest is in oral implantology, salivary gland pathology and head and neck oncology and reconstruction. Being multilingually talented with backgrounds in Canada, Romania and Belgium allow her to easily address patients in Dutch, English, French or Romanian.

Michel BILA

Dr. Michel Bila graduated from Antwerp University in 2009 as Medical Doctor and graduated from Leuven University in 2012 as Master in Dentistry. He obtained his specialty degree in Oral and Maxillofacial Surgery in 2016. He further specialized in Head and Neck Oncology at the Maxillofacial and Head and Neck Service at University College London Hospitals. He is Clinical Staff Member in Oral and Maxillofacial Surgery at UZ Leuven. His clinical focus is Head and Neck Oncology and Reconstruction. His PhD research covers the use of immunotherapy in head and neck squamous cell carcinoma (HNSCC).

Robin WILLAERT

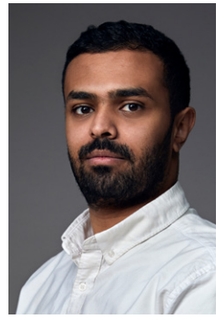
Dr. Robin Willaert finished his medical and dental studies at the Faculty of Medicine in Leuven University with the highest distinction. He successfully obtained his Board Certification in Oral and Maxillofacial Surgery in 2018. He is Clinical Staff Member in Oral and Maxillofacial Surgery at UZ Leuven. His clinical focus is Head and Neck Oncology and maxillofacial reconstruction using 3D technology. His PhD research covers orbital imaging and reconstruction surgery. He further specializes in Head and Neck Oncology in different centres in Australia, South-Africa and Asia.

Isabel MICLOTTE

Dr. Isabel Miclotte obtained her Medical Degree at the KU Leuven in 2012 and finished her Master in Dentistry in 2015. She was trained in maxillofacial surgery at the University Hospitals in Leuven and the Elisabeth-TweeSteden Ziekenhuis (ETZ) in Tilburg, The Netherlands and graduated as maxillofacial surgeon in 2019. Her clinical focus is orthognatic surgery and traumatology, in which she is further specializing at the University Hospitals Leuven. Her research focusses on optimal management of antithrombotic drugs in patients undergoing dento-alveolar surgery, and she is investigator of the EXTRACT-NOAC trial.

B. RESEARCHERS

Khalid Ayidh ALQAHTANI



Khalid Ayidh Alqahtani was born on 21 August, 1992. He achieved his Bachelor of Dental Surgery (BDS) degree from Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia in the year 2016. He worked as a demonstrator in the department of oral and maxillofacial radiology at Prince Sattam Bin Abdulaziz University from the year 2016 to 2018. He has obtained a postgraduate diploma in advanced medical imaging and is currently PhD student under the supervision of Prof. dr. Reinhilde Jacobs at the OMFS-IMPATH research group, KU Leuven. His main focus of research involves three-dimensional assessment of root resorption in orthognathic surgery.

Oliver DA COSTA SENIOR

Oliver da Costa Senior is a PhD candidate at the OMFS-IMPATH research group at the University of Leuven under promotorship of Prof. dr. Constantinus Politis, Prof. dr. Reinhilde Jacobs and Dr. Ir. Eman Shaheen. He graduated at the Catholic University of Leuven in Medicine in June 2018. Currently, he is an Oral and Maxillofacial trainee at the department of Oral and Maxillofacial Surgery at the University Hospitals of Leuven. His research is focused on the three-dimensional planning, follow-up and complications of orthognathic surgery with special interest in Segmental Maxillary Osteotomy and Surgical Assisted Rapid Palatal Expansion (SARPE).

Karla de Faria VASCONCELOS

Karla de Faria Vasconcelos is dentist (2006), Doctor in Dental Radiology (2015; PhD at State University of Campinas - Brazil, with one year of external internship at KU Leuven - Belgium), Master in Dentistry (2010; Federal University of Goiás - Brazil) and Specialist in Oral Radiology (2012; University of Campinas). She has worked, as Radiologist, in private radiology clinics, and as a Collaborator Professor of Graduate Program of Dentistry from the Federal University of Goias at the Discipline of "Imaging Diagnostic". She performed postdoctoral research at Dental Radiology Department, Piracicaba, Brazil (Prof. dr. Francisco Haiter-Neto) and OMFS-IMPATH research group, Leuven, Belgium (Prof. dr. Reinhilde Jacobs), with a FAPESP fellowship (2015-2017). In 2018 she obtained the diploma of Postgraduate Studies in Advanced Medical Imaging at KU Leuven, Leuven, Belgium. At present she is postdoctoral researcher in the OMFS-IMPATH Research Group, under the supervision of Prof. dr. Reinhilde Jacobs and Prof. dr. Politis Constantinus. She has been involved in interuniversity research collaborations, with a specific focus on digital radiography, cone beam computed tomography, micro and nano-CT.

Mostafa EZELDEEN

Mostafa EzEldeen was born on July 19th, 1984 in Mansoura, Egypt. He obtained his Bachelor of Dental Medicine and Surgery (2007) from Mansoura University, Egypt and Master in Dentistry (2013), Summa cum laude, at the KU Leuven, Belgium. Further, he obtained a specialization in Paediatric Dentistry and Special Dental care (2012), at the KU Leuven under the guidance of Prof. dr. Frans Vinckier and Prof. dr. Dominique Declerck. In 2013, he obtained the diploma of Postgraduate studies in Advanced Medical Imaging at the KU Leuven under the guidance of Prof. dr. Reinhilde Jacobs. He works as a dentist in private practice and UZ Leuven (department of Paediatric Dentistry and Special Dental Care). Currently he is a PhD candidate (OMFS-IMPATH research group, KU Leuven, Belgium) with Prof. dr. Reinhilde Jacobs as his promoter. His research topics are; assessment of the patterns of healing in teeth and bone after regenerative processes using Cone Beam Computed Tomography, developing of reliable teeth segmentation methods, bio-3D printing and chemokine-mediated regeneration in the oral and maxillofacial region.

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Koenraad GRISAR

Koenraad Grisar is a PhD candidate at the OMFS-IMPATH research group (Department Imaging and Pathology, Faculty Medicine, Catholic University Leuven), where he studies the autogenous transplantation of maxillary canines. He received his Medical Degree from the Leuven University in 2013. He graduated in June 2016 as Master of Science in Dentistry at Leuven University with a Master's Thesis in early dental implant survival and risk factors. He has had several articles published in internationally renowned journals on topics related to oral and maxillofacial surgery (Human papillomavirus and head and neck cancers; Osteoradionecrosis and medication-related osteonecrosis of the jaw, Dental implantology). Currently he is an oral and maxillofacial trainee at the University Hospital Leuven.

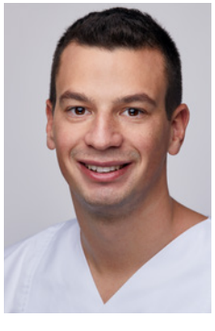
Yifei GU

Gu Yifei was born on April 17th, 1992. She achieved her degree in Bachelor of Medicine from West China college of Stomatology, Sichuan University, Chengdu, Sichuan, China (2010 - 2015). After that, she continued to obtain her degree in Master of Dental Medicine, majored in oral implantation, from West China college of Stomatology, Sichuan University, Chengdu, Sichuan, China, under the guidance of Professor Mo Anchun (2015-2018). During her Masters, she worked on the impact of non-steroid anti-inflammatory drugs on implant osseointegration, as well as the digital workflow in implant dentistry. She started working as a PhD candidate (OMFS-IMPATH research group, KU Leuven) from 2018, with Prof. dr. Constantinus Politis and Prof. dr. Reinhilde Jacobs as her promotors. Her research topic for PhD is related to tissue engineering for bone defect reconstruction by using biomimetic calcium phosphate/BMP-2 coated 3D printed implants.

Pierre LAHOUD

Pierre Lahoud was born on June 7th 1996 in Amchit, Lebanon. In July 2019, he obtained his Bachelor Degree in Dental Medicine and Surgery from the Lebanese University, Beirut, Lebanon. In 2018, he did an internship (Erasmus +) in clinical training at the Catholic University of Louvain in Saint-Luc's Hospital, Brussels, Belgium. Between 2016 and 2018, he volunteered as an Emergency Medical Technician (EMT) with the Red Cross, Byblos, Lebanon. He is currently (2019-2020) doing Postgraduate Studies in Advanced Medical Imaging at KU Leuven, combined with research work at the OMFS-IMPATH research group, focusing on artificial intelligence based segmentation for tooth auto-transplantation.

Artúr KESZTYÜS



Artúr Kesztyüs graduated as a dentist in 2017 at the Semmelweis University Budapest, Hungary. Since that he has been working as a Phd student at the First Department of Pediatrics Semmelweis University and a part-time dentist. In January 2019 he started a joint degree programme under the supervision of Prof. dr. Reinhilde Jacobs (OMFS-IMPATH research group, KU Leuven) and Dr. Krisztián Nagy (First Department of Pediatrics, Semmelweis University Budapest) with the main research interest in three-dimensional cleft palate evalutation, surgical planning and follow-up supported by AI technology.

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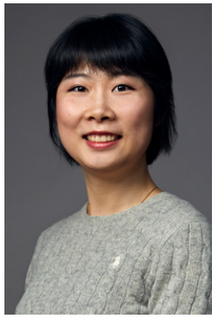
Jiqing LI



Jiqing Li was born on April 15th, 1991. She achieved her degree in Bachelor of Dental Medicine from School of Stomatology, Shandong University, Jinan, China (2009-2014). She obtained her Master of Dental Medicine degree in Oral and Maxillofacial Surgery from West China College of Stomatology, Sichuan University, Chengdu, China, under the guidance of Professor Jihua Li and Professor Jing Hu (2014-2017). During her Masters, she worked on the effect of hyaluronidase on skin necrosis caused by hyaluronic acid. After her graduation, she worked as a general dentist at West China Hospital of Stomatology, Chengdu, China (2017-2018). Currently, she is a PhD candidate in OMFS-IMPATH research group, KU Leuven, with Prof. dr. Reinhilde Jacobs as her promoter. She is studying the effect of systemic diseases on patients undergoing orthognathic surgery.

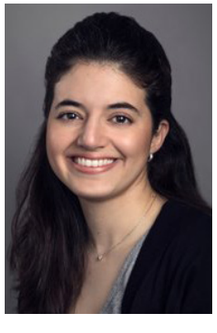
Hongyang MA

Hongyang Ma obtained his Bachelor of Dental Medicine and Surgery from Harbin Medical University and Master degree of Oral and Maxillofacial Surgery in Department of Oral and Cranio-maxillofacial Surgery, Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine. Currently, he is a PhD candidate (OMFS-IMPATH research group, KU Leuven, Belgium) with Prof. dr. Reinhilde Jacobs as his promoter and Prof. dr. Constantinus Politis as his co-promoter. He studies the assessment of the long-term follow-up of patients performed with oral oncologic reconstruction surgery.

Joeri MEYNS

Dr. Joeri Meyns has a degree as a Medical doctor, Dentist and Maxillofacial surgeon. After obtaining his degree as a maxillofacial surgeon in 2011 he was a staff member at the Academic Hospital Maastricht (MUMC) for almost 4 years, where he further specialised in oral oncology and reconstructive surgery. He is Medical Head of the department of Oral and Maxillofacial Surgery at Ziekenhuis Oost-Limburg (ZOL) in Genk. His main speciality is orthognathic surgery and oncology. His PhD research is growth modification of the face in children.

Catalina Moreno RABIE



Catalina Moreno Rabie was born in Concepción, Chile, in 1992. She studied her bachelor and master degree in Dentistry at the University of los Andes in Chile between 2011 and 2016. During her last year of Dentistry, she did an internship in Clinical and Research training at KU Leuven, where she studied the mandibular bone on CBCT. She continued doing postgraduate studies in Advanced Medical Imaging (2018-2019) and has meanwhile started a PhD project on osteonecrosis the jaw bone. She is currently (2018-2019) doing Postgraduate Studies in Advanced Medical Imaging at KU Leuven, combined with research work at the OMFS-IMPATH research group.

Nermin MORGAN

Nermin Morgan was born on September 20th, 1990. She obtained her degree in Bachelor of Dental Surgery (B.D.S) from Faculty of Dentistry, Mansoura University, Egypt (2007-2012). After her graduation she worked there as a teaching assistant in the department of Oral radiology and Diagnostic sciences (2013-2018). Meanwhile She has awarded her master's degree of Oral Diagnosis and Radiology (2017). During the same year she became a radiology specialist at Ministry of health, Cairo, Egypt. Her research work has focused on Cone Beam CT (CBCT), and its different clinical applications in maxillofacial region. Currently, she is a PhD Candidate in OMFS-IMPATH research group, KU Leuven, with Prof. dr. Reinhilde Jacobs as her promoter.

Delphine MULIER

Delphine Mulier is a PhD candidate at the OMFS-IMPATH research group at the University of Leuven under promotorship of Prof. dr. Constantinus Politis, Prof. dr. Reinhilde Jacobs and Dr. Ir. Eman Shaheen. She graduated at the Catholic University of Leuven in Medicine in June 2018. Currently, she is an Oral and Maxillofacial trainee at the department of Oral and Maxillofacial Surgery at the University Hospitals of Leuven. Her research is focused on three-dimensional planning and follow-up of orthognathic surgery with special interest in new three-dimensional techniques and patient satisfaction.

Laura NICOLIELO

Laura Nicolielo is a Dental Surgeon (University of São Paulo, Brazil) (2009), Postgraduate in Oral Surgery (University of São Paulo, Brazil) (2010), Master in Applied Dental Sciences with focus in Stomatology and Radiology (University of São Paulo, Brazil) (2013), Implantologist (Opem Institute, Bauru, Brazil) (2013) and Postgraduate in Advanced Medical Imaging (KU Leuven, Belgium) (2014). In October 2013, she was granted by the Brazilian Government to start the PhD in the OMFS-IMPATH research group under supervision of Prof. dr. Reinhilde Jacobs. Her main research topic is validation of 3D imaging modalities in the assessment of neurovascular structures of the jaw bones, bone quality and quantity and condylar resorption after orthognathic surgery.

Anna OCKERMAN

Anna Ockerman is a PhD candidate at the OMFS-IMPATH research group in cooperation with the Department of Cardiovascular Sciences. She performs research in the domain of antithrombotics in the oral and maxillofacial surgery and dentistry. More specifically, she investigates how to reduce bleeding complications after dental extractions in patients on non-vitamin K oral anticoagulants (NOACs) and what the influence of antithrombotic drugs is on the characteristics of Leukocyte Platelet Rich Fibrin (L-PRF) membranes. Her promotors are Prof. dr. Reinhilde Jacobs, Prof. dr. Constantinus Politis (Department Imaging and Pathology, KU Leuven) and Prof. dr. Peter Verhamme (Department of Cardiovascular Sciences, KU Leuven). Anna graduated in June 2017 as MSc in Biomedical Sciences (KU Leuven). Her Master's Thesis 'The eruption potential of wisdom teeth predicted by tooth inclination in a premature development stage', was awarded with the Best Master's Thesis Biomedical Sciences 2017, third place.

Flavia PREDA

Flavia Preda has graduated as Dentist (2012) and as Orthodontics Specialist (2015) at the University of Medicine and Pharmacy Carol Davila, Bukarest-Romania. Since then, she has practiced orthodontics in private dental clinics in both Romania and Belgium. Since 2019 she is a visiting Orthodontics Consultant in the cleft facility at Marie S. Curie Children's Hospital in Bukarest-Romania. Currently, she is a part-time PhD student in the OMFS-IMPATH research group at KU Leuven under the supervision of Prof. dr. Reinhilde Jacobs with the main research interest 3D supported and AI enhanced diagnosis and treatment planning for cleft patients.

Mehdi SALAR AMOLI

Mehdi is a PhD candidate at OMFS-IMPATH research group in collaboration with Faculty of Engineering Technology working under supervision of Prof. Veerle Bloemen and Prof. Reinhilde Jacobs. He studied biomaterials and tissue engineering for bachelor's at Amirkabir University of Technology in Iran working on multiphasic chitosan scaffolds for cartilage regeneration. He obtained his master's degree at Imperial College London in biomaterials and tissue engineering and worked under supervision of Prof. Molly Stevens and Dr. Ioanna Mylonaki on developing non-viral methods for nucleic acid delivery to the cells. He is currently working as PhD candidate on development methods for regeneration of dentin pulp region through bioprinting cell encapsulated materials promoter Prof. V. Bloemen, co-promoter Prof. dr. R. Jacobs.

Eman SHAHEEN

Eman (Emmy) Shaheen was born on July 12th, 1982 in Giza, Egypt. She graduated with honor from the faculty of Computer Sciences and Information Technology (2003), Cairo University, Egypt where she also worked as a teaching assistant from 2003 till 2007 with major in Image Processing. Meanwhile, she obtained her Master's Degree in Video Processing (2007) from Cairo University. In 2008, she joined the team of Medical Physics where she finished with distinction her pre-doctoral studies about mammography and breast cancer (2009) in Biomedical Sciences at the KU Leuven, Belgium. She was granted a PhD scholarship from the OPTIMAM project (UK) in 2010 to develop, simulate and validate 3D models of breast lesions and tools to optimize the performance of breast tomosynthesis. She obtained her doctoral degree in 2014, KU Leuven, Belgium. In the same year, she started working in the department of Maxillofacial surgery, University hospitals Leuven (Belgium) with Prof. dr. Constantinus Politis as clinical engineer with focus on 3D planning of orthognathic surgeries. Next to the patient related work, she is part of the research group of the OMFS-IMPATH research group (KU Leuven, Belgium) where she supervises students, supports different research projects related to 3D printing and 3D simulations. She is also collaborating with Materialise (Leuven, Belgium) as consultant to improve the CMF software for orthognathic surgeries next to other research related projects.

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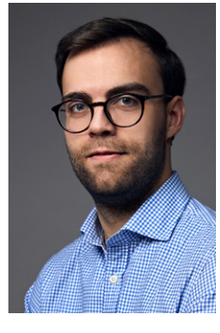
Team

Sohaib SHUJAAT

Sohaib Shujaat was born on November 29th, 1985. He achieved his degree in Bachelor of Dental Surgery (B.D.S) from Lahore Medical and Dental College, Lahore, Pakistan (2004 - 2008). After his graduation, he worked as an Internee in all clinical departments of dentistry at Lahore Medical and Dental College, Lahore, Pakistan (2009-2010). He obtained his Master of Science (MSc. Dent Sci) degree in Oral and Maxillofacial Surgery (360 credits) with merit from Glasgow Dental School and Hospital, University of Glasgow, Glasgow, United Kingdom, under the guidance of Professor Ashraf Ayoub (2010-2012). During his Masters, he worked on 4-Dimensional facial soft tissue changes in oncology patients. From March 2013 till September 2017, he worked as a Lecturer in the Department of Oral and Maxillofacial Surgery and Course Director of Internal Medicine and Comprehensive Patient Management (CPM) for dental students at Imam AbdulRahman Bin Faisal University (Formerly University of Dammam), Dammam, Kingdom of Saudi Arabia. At the same instance, he served as a Specialist (Registrar) in the Department of Oral and Maxillofacial Surgery, King Fahd Hospital of the University. Currently he is a PhD candidate (OMFS-IMPATH research group, KU Leuven) with Professor Reinhilde Jacobs as his promotor. His research topic for PhD is related to three-dimensional analysis of hard and soft tissue changes in orthognathic surgery patients and to develop a start of art predictive model for treatment planning.

Maximiliaan SMEETS



Maximiliaan Smeets graduated from the Catholic University of Leuven in June 2018 as a Medical Doctor and is now an active Oral and Maxillofacial trainee at the University Hospital of Leuven. His research interests include oral oncology and Oral and Maxillofacial Surgery in general. Since 2020 Maximiliaan Smeets is a PhD candidate at the OMFS-IMPATH Research Group, and he focuses on the onset, etiology, and treatment of persistent trismus after oral oncology treatment. His research is mentored by Prof. dr. Constantinus Politis, Prof. dr. Reinhilde Jacobs, dr. Michel Bila, and Jeroen Van Dessel.

Dandan SONG

Dandan Song was born on March 11th, 1990. She achieved her degrees in both Bachelor and Master of Oral Medicine from Dalian Medical University, China. During her Master, she worked on the effect of the different implant placement and loading protocols on the osseoperception around the implant. Currently she is a PhD Candidate in OMFS-IMPATH Research Group, KU Leuven, with professor Reinhilde Jacobs as her promoter. She is studying the effect of the bisphosphates and radiation on the jaw bone and blood vessel changes.

Yi SUN

Yi Sun obtained his PhD in Biomedical Sciences, Master of Medical imaging and Bachelor in Electronic Engineering. Since 2007, he worked in the field of computer assistant surgery planning, with focus on oral and maxillofacial surgery. His main professional interest is template-based and image-guided solution for dental implant placement, design of digital splint for orthognathic surgery, orofacial reconstruction using fibular or DCIA flap. Currently he is responsible for the 3D surgical simulation team in the department of oral and maxillofacial surgery (UZ Leuven). His current research interest are: design of patient specific implant, tissue engineering by using 3D printed titanium scaffold and development of image-guided surgical simulation system (navigation system).

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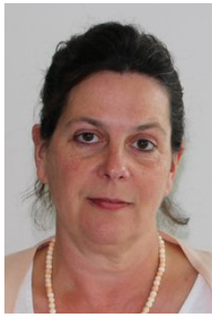
Team

Kostas SYRIOPOULOS

Kostas Syriopoulos is dentist specialized in oral and maxillofacial radiology. He graduated as dentist from the University of Athens, Greece. He has a MSc degree (University of London) as well as a PhD degree (VU, Amsterdam) in Dental Radiology. He had an internship in the Dept. of Oral Radiology (Stellenbosch University, Cape Town). Further, he received the diploma in Health Physics level 3 (TU Delft). In the Netherlands Level 3 is a higher expert level of health physics, necessary for supervising in radionuclide laboratories or working in a medical profession with higher risk or responsibility, like clinical physics and nuclear medicine. From 2001 to 2016 he was a staff-member in the department of Dentomaxillofacial Radiology, ACTA, Amsterdam. Since February 2015 he has been a staff member in the Department of Imaging & Pathology, KU Leuven. His main professional interests are Diagnostic Radiology, Radiography Education and Radiation Protection.

Els TIJSKENS



Els Tijskens graduated as a dentist in 1984 at KU Leuven. She has been working as an endodontist since 2000, and has a second line practice for paediatric endodontics and traumata. In 2011 she obtained a license to use N2O-sedation, which she is applying on indication. She is a Certified Member of the European Society for Endodontology (ESE), Fellow of the International Association for Dental Traumatology (IADT), founding board member and President of the Flemish Society for Endodontology (FSfE vzw). She has been lecturing to GP's at NIVVT for more than a decade. She is involved in reading the CBCT images at UZLeuven, and has been teaching Medical Imaging at UCLL opleiding Mondzorgkunde until August 2019.

Andres TORRES

Andres Torres was born on July 4th, 1988 in Bogota, Colombia. He obtained his degree as General Dentist in 2012 from the University of Los Andes, Santiago, Chile. During the training in Dentistry, he participated twice in a research internship on CBCT in Endodontics at the KU Leuven, Leuven, Belgium, led by Professor Reinhilde Jacobs. In March 2014 he achieved the equivalence of foreign diploma "Titulo de Cirujano Dentista" with the Flemish degree of "Master of Science in Dentistry". In 2015 he obtained the diploma of Postgraduate studies in Advance Medical Imaging at the KU Leuven, Leuven, Belgium. Further, he obtained a specialization degree in Endodontics in July 2017, under the guidance of Professor Paul Lambrechts at the KU Leuven, Leuven, Belgium.
He works as an Endodontic specialist in private practice. He is instructor of the Endodontic postgraduate at KU Leuven, Leuven, Belgium and visiting instructor of the Endodontic postgraduate at KI, Stockholm, Sweden. Currently he is a PhD candidate (OMFS-IMPATH research group, KU Leuven, Belgium) with Professor Reinhilde Jacobs as his promoter and Professor Paul Lambrechts as his co-promoter. His research topics are: 3-Dimensional Guided Endodontics, 3-Dimensional Assessment of Apical Radiolucencies, Characterisation of Root and Canal Morphology and Maxillary Sinus and Endodontics.

Arne VANDEMEULEBROUCKE

Arne Vandemeulebroucke is a master thesis student in Forensic Biomedical Sciences at the OMFS-IMPATH Research Group at KU Leuven under promotorship of Prof. dr. Reinhilde Jacobs, and under daily guidance of PhD candidate Myrthel Vranckx and PhD candidate Dr. Pieter-Jan Verhelst. He followed internships at Forensic Medicine (UZ Leuven), International Centre for Reproductive Health (UGent) and the Medical Imaging Research Centre (UZ Leuven). At OMFS-IMPATH research group, his research is focused on the 3D-image conversion of third molar pathologies using artificial intelligence and the follow-up of condylar remodelling in orthognathic surgery.

Fréderic VAN DER CRUYSSEN

Fréderic Van der Cruyssen is a PhD candidate at OMFS-IMPATH research group under promotorship of Prof. dr. Constantinus Politis, Prof. dr. Reinhilde Jacobs and Prof. dr. Tara Renton (Oral Surgery, King's College, Londen, UK). He received his Medical Degree from the Catholic University of Leuven in June 2017 with a Master's thesis on trigeminal nerve physiology. Currently he is an oral and maxillofacial trainee at the University Hospitals Leuven. His research is focused on traumatic trigeminal nerve injuries.
Some of his current projects are:

- Development and validation of magnetic resonance neurography to visualize peripheral trigeminal nerve anatomy and trauma
- Improving current diagnostic methods in assessing post-traumatic trigeminal neuropathy & implementing treatment protocols with attention for Quality of Life
- Prediction of post-traumatic trigeminal neuropathy using multimodal factors
- Costs and burden of disease in post-traumatic trigeminal neuropathy in Belgium
- Orofacial quantitative sensory testing

Jeroen VAN DESSEL

Jeroen Van Dessel has an MSc in Biomedical Sciences (KU Leuven) and Msc in Advanced Medical Imaging (KU Leuven). He was a PhD FWO aspirant at the Center for Developmental Psychiatry, KU Leuven. Besides his PhD in the psychiatry domain, he remained active in dental radiology field as a researcher at the OMFS-IMPATH research group. Currently, he works as clinical support and research manager at the department of Oral MaxilloFacial Surgery, UZ Leuven (Belgium) with Prof. dr. Constantinus Politis and coordinates the start-up of the Institute for MaxilloFacial Training and Education (IMFTE). He has received the COB Oral Research award (2013), EADMFR Oral Research Award (2012; 2014), the EUNETHYDIS Sagvolden Award (2015), the EADMFR Research Fellowship (2016), EADMFR Poster Research Award (2018) and the ECNP Junior Research Award (2018). He was a visiting researcher at University of São Paulo (Brazil), Pontifical Catholic University of Paraná (Brazil) and Karolinska Institutet (Sweden). His research topics include developing and validating tools for standardized bone quality assessment on CBCT, micro-CT analysis, finite element analysis, computer-aided predictions and oral oncology.

Pieter-Jan VERHELST

Dr. Pieter-Jan Verhelst is a PhD candidate at the OMFS-IMPATH research group at the University of Leuven under promotorship of Prof. dr. Reinhilde Jacobs, Prof. dr. Constantinus Politis, Prof. dr. Hilde Peeters and Prof. dr. Gwen Swennen. He graduated at the University of Leuven in Medicine (MD, magna cum laude) in 2017 with a master's thesis on the fibula free flap in facial reconstruction. Currently, he is an Oral and Maxillofacial trainee at the department of Oral and Maxillofacial Surgery at the University Hospitals of Leuven. His research focusses on dentocraniofacial deformities, orthognathic surgery and condylar resorption. Some of his current projects are:

- Development and validation of an analysis protocol for condylar remodeling
- Etiological factors in condylar resorption
- Bridging the gap between 3D craniofacial phenotyping and genotyping

Laurence VERSTRAETE

Laurence Verstraete is a PhD candidate at the OMFS-IMPATH research group at the University of Leuven under promotorship of Prof. dr. Constantinus Politis, Prof. dr. Reinhilde Jacobs and Dr. Ir. Eman Shaheen. She obtained her Medical Degree at the University of Ghent in June 2018. Currently, she is an Oral and Maxillofacial surgery trainee at the University Hospitals of Leuven. Her research is focused on the three-dimensional planning, evaluation and follow-up of orthognathic surgery with special interest in soft tissue analysis.

Myrthel VRANCKX

Myrthel Vranckx is a PhD candidate at the OMFS-IMPATH research group under promotorship of Prof. dr. Reinhilde Jacobs and Prof. dr. Constantinus Politis (Department Imaging and Pathology, KU Leuven). She graduated in June 2016 as MSc in Biomedical Sciences with a Master's Thesis in the use of CT imaging in Forensic Medicine (Faculty of Medicine, KU Leuven). Her research is mainly focused on third molar pathology and postoperative complications associated with third molar surgery. Her multicentric research project is ongoing in different hospitals in Belgium. More info on www.m3mka.be. Moreover, she is involved in multiple radiological studies with regard to third molar pathology and anatomical variations of the mandibular canal. Currently, she is also following Postgraduate Studies in Advanced Medical Imaging.

Xiaotong WANG

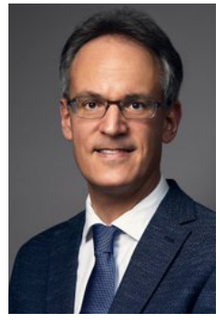
Xiaotong Wang received her degrees in both Bachelor and Master of Dental Medicine from Harbin Medical University, China. After her graduation, she worked as an Oral and Maxillofacial Surgeon in the First Affiliated Hospital of Harbin Medical University. Currently, she is a PhD candidate at OMFS-IMPATH research group with Prof. dr. Reinhilde Jacobs as her promoter. Her research is focused on Digital dentistry: development of AI-driven prediction and CBCT-based biomodels.

Isti Rahayu SURYANI

Isti Rahayu Suryani was born on November 20th, 1980. She obtained her Doctor of Dental Medicine (2006) from Faculty of Dentistry, UGM-Indonesia, Master of Biomedical Engineering (2012) from Graduate School of UGM-Indonesia and Specialist in Oral Radiology (2016) from Padjajaran University-Indonesia. She has worked as lecturer in Departement of Dentomaxillofacial Radiology, Faculty of Dentistry, UGM and also as Oral Radiologist at UGM Dental Hospital. Currently, she is PhD candidate in OMFS-IMPATH research group, KU Leuven from Desember 2019 with Professor Reinhilde Jacobs as her promotor. Her research focus on Imaging of Medication-related osteonecrosis of the jaw.

C. VISITING PROFESSORS

Michael BORNSTEIN



Michael Bornstein has been appointed in 2016 as Clinical Professor in Oral and Maxillofacial Radiology at the Faculty of Dentistry, The University of Hong Kong, Hong Kong SAR, China. In December 2018 he has been appointed as Associate Dean of "Research and Innovation" of the Faculty of Dentistry. He is a Visiting Professor at the OMFS-IMPATH research group, Department of Imaging and Pathology, University of Leuven, Belgium. Since January 2020 he holds the position as professor and chair of the Departement of Oral Health & Medicine at the University Center for Dental Medicine Basel (UZB) of the University of Basel, Switzerland. He obtained his dental degree (1998) and thesis (Dr. med. dent., 2001) at the University of Basel. He continued with a specialisation in oral surgery and stomatology in Basel (1998-1999, Prof. dr. J. Th. Lambrecht) and Bern (2000-2002, Prof. dr. D. Buser). In 2004, he was visiting assistant professor at the Department of Periodontics (Prof. dr. D. Cochran) at the University of Texas Health Science Center at San Antonio, USA. In 2009, he obtained the Habilitation (Privatdozent / PhD) and in 2014 he became Asscociate Professor in the field of Oral Surgery and Stomatology.

André LEITE

André Leite is an Associate Professor at the University of Brasília, Brazil, in the field of Oral Radiology. He has been teaching at the University since 2003. He has obtained his dental degree at the same university (2000). He is specialist in Oral Radiology (Brazilian Association of Dentistry, 2002), Master in Health Sciences (University of Brasília, Brazil, 2007), PhD in Health Sciences (University of Brasília, Brazil, 2009). He is a member of two postgraduate programs (Dentistry and Health Sciences) in which he supervises master's and doctoral students. His field of research is focused on oral diagnosis and imaging research, with emphasis on the following topics: osteoporosis, medication-related osteonecrosis of the jaws, oral cancer, dental imaging education and artificial intelligence. Currently, he is collaborating with OMFS-IMPATH research group, Leuven, Belgium (Prof. dr. Reinhilde Jacobs) where he will stay one year supported by a FAP-DF scholarship (postdoctoral internship).

Krisztian NAGY

Krisztian Nagy is a Maxillofacial Surgeon with special interest and experience in cleft surgery. He has been working as the head and leading surgeon of the newly formed Centre for Reconstruction of Facial Deformities, at the 1st Department of Paediatrics, Semmelweis University, Budapest, Hungary. He has been also working as a Consultant Maxillofacial Surgeon, in AZ St-Jan Bruges-Oostende Hospital, Belgium since March 2012. He became Fellow of the European Board of Oro-Maxillofacial Surgery & Head and Neck Surgery (FEBOMS) in September 2012. He is currently Guest Professor at Leuven University, KU Leuven, Belgium. He graduated at the Semmelweis University Budapest, Hungary in medicine (MD, summa cum laude) and in dentistry (DDS, magna cum laude). He specialized in oral and Maxillofacial surgery at the Semmelweis University, at the KU Leuven and in AZ SInt Jan in Bruges, Belgium. His postgraduate training was additionally followed by clinical experiences in Bruges, Minden, Vienna, Wellington, Zürich and Taipei. He is now member of the European Association for Cranio-Maxillofacial Surgery (EACMFS), the European Academy of Facial Plastic Surgery (EAFPS) and the Craniomaxillofacial Section, Arbeitsgemeinschaft für Osteosynthesefragen (AO). He is acknowledged PhD tutor of 3 PhD students. He defended his doctoral thesis on the subject of “Objective methods for evaluation of surgical outcomes in cleft lip and palate surgery” (PhD). His professional field of interest is in orthognathic, cleft and craniofacial surgery. At this moment he is supervising 4 PhD students.

2
Team

Erich RAUBENHEIMER

Erich Raubenheimer joined Medunsa in 1982 as Head of Oral Pathology and Acting Head of Anatomical Pathology. During the first years of appointment at this fledgling health sciences University he was responsible for the histopathology services rendered to the medical- and dental hospitals and regional community clinics. He obtained a PhD, DSc, FCP (SA) and CBCT certification with the American Academy of Oral and Maxillofacial Radiology, supervised 7 PhD degrees and a large number of Master’s degrees. His research interests are in head and neck diseases and pathology of mineralized tissues, particularly the diagnosis of metabolic diseases of bone. Erich authored 139 papers in peer reviewed scientific journals (eight of which were on invitation) and contributed to three chapters of the 4th edition of the World Health Organizations’ book on head and neck tumours. He was key note speaker at five international conferences and presented 99 invited scientific talks to specialist groups. Erich has a passion for the African elephant and regularly presents talks to interesting societies based on his scientific work on ivory and experience as an elephant tracker in Africa. Erich is presently employed as a senior consultant at Ampath, a large pathology practice in South Africa, holds an extraordinary professorship at the University of Pretoria and a guest professorship at KU Leuven.

Claudia NOFFKE

Claudia Noffke grew up and matriculated in Germany. She obtained her under-graduate training as a Dentist at the University of Pretoria and managed her own private practice for several years. She completed her postgraduate training in Maxillofacial and Oral Radiology in 1992 and served as Lecturer in the Departments of Radiology and Diagnostics, University of Pretoria, and Oral Pathology at the Medical University of Southern Africa where she was appointed as Head of Maxillofacial and Oral Radiology in June 2001, a position from which she retired as a Full Professor in 2016. She participated actively in 46 international congresses and refresher courses and authored or co-authored an equal number of scientific papers in peer-reviewed journals. She is on the editorial boards of several distinguished journals in her field of expertise including the Radiology Section of the Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology (Triple “O”) and the Journal of Chinese Clinical Medicine. She recently co-edited the proceedings of the 2017 21st Congress of the International Association of Dentomaxillofacial Radiology in Kaohsiung, Taiwan. In recognition for her role as reviewer for Triple “O” she received the Lincoln Manson-Hing Award for distinguished service in Scientific Review from the American Academy of Oral and Maxillofacial Radiology and Elsevier Publisher. Claudia supervised- and served as external examiner for several Master’s and PhD degrees. She is currently on the Board of Directors and Regional Director (Africa) of the IADMFR and appointed since May 2018 as Guest Professor in the Department of Imaging & Pathology at the KU of Leuven. Her field expertise include ethics and legislation pertaining to radiation protection, fibro osseous disease and the radiological interpretation of gnathial tumours and cysts.

2
Team

D. VISITING RESEARCHERS

Tamara Trad ALZOUBI

Tamara Trad Alzoubi is a Jordanian Specialist in restoration and conservative dentistry. Graduated from the University of Jordan from where she obtained here Bachelor degree in Dental Surgery and Medicine. She then joined the Jordanian Armed Forces -The Royal Medical Services working as a dentist and where she did her internship and later on received her specialty in Restotive and Conservative Dentistry (Jordanian National Board).
She is a visiting researcher in OMFS-IMPATH research group and her fields of interests are Esthetic, Restoration, and Digital dentistry.

Victor Aquino WANDERLEY

Victor Aquino Wanderley is Dentist (2010 – 2015), graduated by University of Pernambuco – Brazil, Master in Oral Radiology (2016 – 2018) and PhD student at University of Campinas – Brazil (2018 – currently) with Prof. dr. Matheus Lima Oliveira as promoter. He is doing part of his PhD in the OMFS-IMPATH research group at KU Leuven with Prof. dr. Reinhilde Jacobs as co-promoter. His research topic for PhD is related to blooming artifact in several Cone-Beam Computed Tomography units.

Marta CRISTALDI

Marta Cristaldi was born in Palermo, Italy, in 1990. She obtained my Bachelor's Degree in Biological Sciences in 2013 and Master's Degree in Molecular and Medical Biotechnology in 2016 from University of Palermo, Italy. During the last year of her Master's, Marta did an internship at the Department of Biosciences of the University of Helsinki where she wrote a Master thesis on the molecular interactions involved in brain inflammation after injury. She am currently (2016/2017) doing a PhD in "Oncology and Experimental Surgery" at the University of Palermo with a project that aimes to develop an oral stem cell system able to regenerate bone in periodontal patients and combined with the research work at the OMFS-IMPATH research group.

Annelore DE GRAUWE

Annelore De Grauwe was born on May 9th, 1977. She graduated as a dentist in 2001 at the University of Ghent, Belgium. After one year in private practice, she decided to obtain a Master degree in Paediatric Dentistry and Special Care at the University of Ghent, which she obtained in 2005, summa cum laude. She works as a paediatric dentist in her own private practice, and performs narcodontics in the hospitals of Bruges and Dendermonde. She is an active board member of the Belgian Academy of Paediatric Dentistry since 2005. She is also active member of the EAPF, IAPD, EADMFR, IADMFR, IADR and NVDMFR. From 2016 on, she works as a researcher at OMFS-IMPATH research group, with special interest in paediatric dentistry and imaging.

2
Team

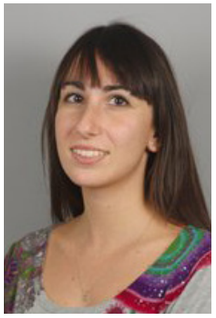
Hugo Gaêta ARAUJO

Hugo Gaêta Araujo is a dentist (University of Sao Paulo – 2015), Master in Oral Radiology (University of Campinas – 2018), and PhD student in Oral Radiology (University of Campinas). Currently, he was granted by the Brazilian government to do an internship in the OMFS-IMPATH research group, to develop part of his thesis under the supervision of Prof. dr. Reinhilde Jacobs. His main research topics are: gubernacular canal, digital imaging, osteonecrosis of the jaws.

Natália Siqueira LOBO

Natália Siqueira Lobo is a dentist (2009 – 2015), graduated by the State University of Pernambuco – Brazil. During this period, she participated in the program Science without Borders with a CNPq fellowship at Brock University – Canada (2013 – 2014). For completion of this grade she performed a research internship at the Department of Physics - Brock University, under the supervision of Prof. dr. Thad Harroun. She is a Specialist in Endodontics (2016 – 2018; State University of Campinas – Brazil) and has worked in private dentistry clinics. At the present moment she is a Master student in Restorative Dentistry - Endodontics area (State University of Campinas – Brazil) performing a sandwich period with a FAPESP fellowship at KU Leuven (2018/25051-0), under the supervision of Prof. dr. Alexandre Augusto Zaia and co-supervision of Prof. dr. Reinhilde Jacobs.

Denise MURGIA



Denise Murgia was born in Petralia Sottana, Italy, in 1992. She graduated in Pharmacy and Industrial Pharmacy in 2016 at the University of Palermo. During the thesis, she worked in a laboratory of Pharmaceutical Technology specialized in the design, development and characterization of new Drug Delivery Systems for the treatment of oral cavity diseases. After graduation, she worked as a high school teacher of chemistry, biology and science.
She is a PhD student in “Oncology and Experimental Surgery” at the University of Palermo as a pharmaceutical technologist with a project that aims to promote a new protocol of Guided Bone Regeneration using the Non Transfusional Hemo-Components. Now she is doing an internship as a member of the OMFS-IMPATH research group.

3

Research

3
Research

A. PROJECTS

National funding

M3-OBSERVATORIUM

Epidemiological study on the surgical removal of third molars.

In samenwerking met Vlaams Ziekenhuisnetwerk KU Leuven

Extern

COMPUTER-ASSISTED MAXILLOFACIAL SURGERY

The development and clinical application of a computer assisted oral and maxillofacial surgery system.

- in collaboration with Materialise

FWO

TOOTH AUTOTRANSPLANTATION

The development and clinical application of CBCT-based tooth auto transplantation.

- FWO

TREASURE

Dentomaxillofacial paediatric imaging: an investigation towards low dose radiation induced risks

- FWO SCK – CEN Dimitra

EXTRACT-NOAC

Use of new oral anticoagulants in oral surgery

BOF

BOF CELSA/18/038

Harmonization of the use of cone-beam computed tomography for developmental disorders in the maxillofacial region.

BOF C24/18/065

Beeldkwaliteitsoptimalisatie van dentale cone-beam CT

B. AWARDS

September 2019
HONORABLE ORAL PRESENTATION AT SBPQO

Fernanda Ferrarri Torres

August 2019
H. CLINE FIXOTT SR. ORATION 2019 AWARD

Reinhilde Jacobs

August 2019
TOP REVIEWER RECOGNITION AWARD 2019

Kaan Orhan

August 2019
THIRD PRIZE ORAL PRESENTATION IADMFR
RESEARCH AWARD 2019

Myrthel Vranckx

C. PUBLICATIONS

INTERNATIONAL PEER-REVIEWED PUBLICATIONS

Adisa, A.O., Osayomi, T., Effiom, O.A., Kolude, B., Lawal, A.O., Soyele, O.O., Omitola, O.G., Babajide, A., Okiti, R.O., Saiki, T.E., Fomete, B., Ibikunle, A.A., Okwuosa, C.U., Olajide, M.A., Ladeji, A.M., Adebiyi, K., Emmanuel, M., Lawal, H.S., Uwadia, E., Fakuade, B.O., Abdullahi, Y., Politis, C., Agbajel, J.O. (2019). A geographical analysis of ethnic distribution of jaw ameloblastoma in Nigerians. *AFRICAN HEALTH SCIENCES, 19* (1), 1677-1686.

Al-Rimawi, A., Shaheen, E., Albdour, E.A., Shujaat, S., Politis, C., Jacobs, R. (2019). Trueness of cone beam computed tomography versus intra-oral scanner derived three-dimensional digital models: An ex vivo study. *CLINICAL ORAL IMPLANTS RESEARCH, 30* (6), 498-504.

Al-Rimawi, A., EzEldeen, M., Schneider, D., Politis, C., Jacobs, R. (2019). 3D Printed Temporary Veneer Restoring Autotransplanted Teeth in Children: Design and Concept Validation Ex Vivo. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH, 16* (3), Art.No. ARTN 496.

Awarun, B., Blok, J., Pauwels, R., Politis, C., Jacobs, R. (2019). Three-dimensional imaging methods to quantify soft and hard tissues change after cleft-related treatment during growth in patients with cleft lip and/or cleft palate: a systematic review. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (2), Art.No. ARTN 20180084.

Barbier, L., Pottel, L., De Ceulaer, J., Lamoral, P., Duyck, J., Jacobs, R., Abeloos, J. (2019). Evaluation of Quality of Life After Mandibular Reconstruction Using a Novel Fixed Implant-Supported Dental Prosthesis Concept: A Pilot Study. *INTERNATIONAL JOURNAL OF PROSTHODONTICS, 32* (2), 162-173.

Belmans, N., Gilles, L., Virag, P., Hedesiu, M., Salmon, B., Baatout, S., Lucas, S., Jacobs, R., Lambrichts, I., Moreels, M. (2019). Method validation to assess in vivo cellular and subcellular changes in buccal mucosa cells and saliva following CBCT examinations. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (6), Art.No. ARTN 20180428.

Bernard, L., Vercruyssen, M., Duyck, J., Jacobs, R., Teughels, W., Quirynen, M. (2019). A randomized controlled clinical trial comparing guided with nonguided implant placement: A 3-year follow-up of implant-centered outcomes. *JOURNAL OF PROSTHETIC DENTISTRY, 121* (6), 904-910.

Boelen, G-J., Boute, L., d'Hoop, J., EzEldeen, M., Lambrichts, I., Opdenakker, G. (2019). Matrix metalloproteinases and inhibitors in dentistry. *CLINICAL ORAL INVESTIGATIONS, 23* (7), 2823-2835.

Bornstein, M.M., Ho, J.K C., Yeung, A.W K., Tanaka, R., Li, J.Q., Jacobs, R. (2019). A Retrospective Evaluation of Factors Influencing the Volume of Healthy Maxillary Sinuses Based on CBCT Imaging. *INTERNATIONAL JOURNAL OF PERIODONTICS & RESTORATIVE DENTISTRY, 39* (2), 187-194.

Bornstein, M.M., Fernandez-Martinez, M., Guirao, J.L G., Gomez-Garcia, F.J., Guerrero-Sanchez, Y., Lopez-Jornet, P. (2019). On the Symmetry of the Bone Structure Density over the Nasopalatine Foramen via Accurate Fractal Dimension Analysis. *SYMMETRY-BASEL, 11* (2), Art.No. ARTN 202.

INTERNATIONAL PEER-REVIEWED PUBLICATIONS

Brasil, D.M., Pauwels, R., Coucke, W., Haiter-Neto, F., Jacobs, R. (2019). Image quality optimization of a narrow detector dental computed tomography for paediatric patients. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (5), Art.No. 20190032.

Brasil, D.M., Pauwels, R., Coucke, W., Haiter-Neto, F., Jacobs, R. (2019). Image quality optimization using a narrow vertical detector dental cone-beam CT. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (3).

Brijs, K., Miclotte, I., Vermeire, S., Darche, V., Politis, C. (2019). Osteonecrosis of the jaw in patients with inflammatory bowel disease treated with tumour necrosis factor alpha inhibitors. *INT J ORAL MAXILLOFAC SURG. 49* (3).

Celikten, B., Jacobs, R., De Faria Vasconcelos, K., Huang, Y., Shaheen, E., Nicolielo, L., Orhan, K. (2019). Comparative evaluation of Cone Beam CT and Micro CT on volumetric distortion artefactin human teeth filled with bioceramic sealers. *CLINICAL ORAL INVESTIGATIONS*, 3267-3273.

Chen, X-J., Hu, J-L., Zhou, Q-L., Politis, C., Sun, Y. (2019). An automatic optimization method for minimizing supporting structures in additive manufacturing. *ADVANCES IN MANUFACTURING, 8* (1), 49-58.

De Bruyn, L., Vranckx, M., Jacobs, R., Politis, C. (2019). A retrospective cohort study on reasons to retain third molars. *INT J ORAL MAXILLOFAC SURG.* doi: 10.1016/j.ijom.2019.10.003

De Grauwe, A., Ayaz, I., Shujaat, S., Dimitrov, S., Gbadegbegnon, L., Vande Vannet, B., Jacobs, R. (2019). CBCT in orthodontics: a systematic review on justification of CBCT in a paediatric population prior to orthodontic treatment. *EUROPEAN JOURNAL OF ORTHODONTICS, 41* (4), 381-389.

De Tobel, J., Parmentier, G.I L., Phlypo, I., Descamps, B., Neyt, S., Van de Velde, W.L., Politis, C., Verstraete, K.L., Thevissen, P.W. (2019). Magnetic resonance imaging of third molars in forensic age estimation: comparison of the Ghent and Graz protocols focusing on apical closure. *INTERNATIONAL JOURNAL OF LEGAL MEDICINE, 133* (2),

De Mulder, D., de Llano-Perula, M.C., Jacobs, R., Verdonck, A., Willems, G. (2019). Three-dimensional radiological evaluation of secondary alveolar bone grafting in cleft lip and palate patients: a systematic review. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (1), Art.No. ARTN 20180047.

Ducommun, J., Bornstein, M.M., Wong, M.C M., von Arx, T. (2019). Distances of root apices to adjacent anatomical structures in the anterior maxilla: an analysis using cone beam computed tomography. *CLINICAL ORAL INVESTIGATIONS, 23* (5), 2253-2263.

EzEldeen, M., Wyatt, J., Al-Rimawi, A., Coucke, W., Shaheen, E., Lambrichts, I., Willems, G., Politis, C., Jacobs, R. (2019). Use of CBCT Guidance for Tooth Autotransplantation in Children. *JOURNAL OF DENTAL RESEARCH, 98* (4), 406-413.

Fan, S., Hung, K., Bornstein, M.M., Huang, W., Wang, F., Wu, Y. (2019). Effect of the Configurations of Fiducial Markers on the Accuracy of Surgical Navigation in Zygomatic Implant Placement: An In Vitro Study. *INTERNATIONAL JOURNAL OF ORAL & MAXILLOFACIAL IMPLANTS, 34* (1), 85-90.

3
Research

Freire, B.B., Leandro Nascimento, E.H., Vasconcelos, K.D F., Freitas, D.Q., Haiter-Neto, F. (2019). Radiologic assessment of mandibular third molars: an ex vivo comparative study of panoramic radiography, extraoral bitewing radiography, and cone beam computed tomography. *ORAL SURGERY ORAL MEDICINE ORAL PATHOLOGY ORAL RADIOLOGY, 128* (2), 166-175.

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Virag, P., Hedesiu, M., Soritau, O., Perde-Schrepler, M., Brie, I., Pall, E., Fischer-Fodor, E., Bogdan, T., Lucaciu, O., Belmans, N., Moreels, M., Salmon, B., Jacobs, R. (2019). Low-dose radiations derived from cone-beam CT induce transient DNA damage and persistent inflammatory reactions in stem cells from deciduous teeth. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (1), Art.No. ARTN 20170462.

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Willaert, R., Maly, T., Ninclaus, V., Huvenne, W., Vermeersch, H., Brusselaers, N. (2020). Efficacy and complications of orbital fat decompression in Graves' orbitopathy: a systematic review and meta-analysis. *Int J Oral Maxillofac Surg, 49* (4), 496-504.

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Yeung, A.W K., Colsoul, N., Montalvao, C., Hung, K., Jacobs, R., Bornstein, M.M. (2019). Visibility, location, and morphology of the primary maxillary sinus ostium and presence of accessory ostia: a retrospective analysis using cone beam computed tomography (CBCT). *CLINICAL ORAL INVESTIGATIONS, 23* (11), 3977-3986.

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Yeung, A.W K., Tanaka, R., Ho, J.K C., Li, J.Q., Jacobs, R., Bornstein, M.M. (2019). Patient-, software-, and observer-related factors associated with the time required for semi-automated measurements of the maxillary sinus volume using cone beam computed tomography (CBCT). *SWISS DENT J, 129* (7-8), 562-570.

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BOOK (CHAPTER) PUBLICATIONS

Bornstein MM, Yeung WKA, Montalvao C, Colsoul N, Parker QA, Jacobs R (2019)
Facts and Fallacies of Radiation Risk in Dental Radiology, Faculty of Dentistry, University of Hong Kong.
ISBN: 978-988-79680-0-9

Politis C, Peeters H (2019)
Het gezicht tussen beeld en werkelijkheid: Maatschappelijke verwachtingen
Lessen voor de eenentwintigste eeuw, Chapt 25, (pp215-241)
Leuven University Press
ISBN: 9462701768

D. CHAIRS

THE ALEAMED & KLS MARTIN CHAIR FOR OMFS
3 YEARS (2019-2022)

To support research in the field of trigeminal neuropathy in OMFS.

ANTHOGRY CHAIR FOR ORAL AND MAXILLOFACIAL SURGERY
3 YEAR (2018-2021)

The purpose of the Chair is prevention and treatment of nerve damage following implant surgery.

DENTSPLY SIRONA CHAIR FOR ORALAND MAXILLOFACIAL SURGERY
3 YEARS (2018-2021)

The purpose of the Chair is prevention and treatment of nerve damage following implant surgery. Professor Politis is the chair holder and professor Jacobs is the co-chair holder.

NOBEL BIOCARE CHAIR FOR ORAL AND MAXILLOFACIAL SURGERY
YEARLY (2019-2020)

To support the research concerning the damage of the inferior alveolar nerve during mandibular surgery.

UEG CHAIR FOR NEW ADVANCES IN THREEDIMENSIONAL IMAGING FOR MAXILLOFACIAL DIAGNOSTICS AND THERAPY
3 YEAR (2017-2019)

To help to cover the teaching and/or research expenses in oral rehabilitation after oncology therapy and treatment modalities after iatrogenic damage of the inferior alveolar nerve.

BICON CHAIR FOR ORAL AND MAXILLOFACIAL SURGERY
3 YEARS (2016-2019)

To help to cover the teaching and/or research expenses in oral rehabilitation after oncology therapy and treatment modalities after iatrogenic damage of the inferior alveolar nerve.

STRAUMANN CHAIR FOR ORAL AND MAXILLOFACIAL SURGERY
3 YEARS (2016-2019)

The purpose of the Chair is prevention and treatment of nerve damage following implant surgery. Professor Politis is the chair holder and professor Jacobs is the co-chair holder.

4

Lecturing

A. SCIENTIFIC CONTRIBUTIONS AT CONGRESSES

- Oral presentations
- Poster presentations

B. INVITED LECTURES

A. SCIENTIFIC CONTRIBUTIONS AT CONGRESSES

ORAL PRESENTATIONS

Orhan K (2019)
PR and CBCT reading session
6th Junior Meeting of EADFMR, 3-7 February 2019, Istanbul, Turkey

Orhan K (2019)
Radiation dose from DMFR
6th Junior Meeting of EADFMR, 3-7 February 2019, Istanbul, Turkey

Merken K, Bosmans H, Zhang G, Politis C, Maes F, Blaschko M (2019)
Clinical image quality targets in dental cone-beam CT
SPIE 2020 medical imaging conference, 15-20 February 2019 in Houston, Texas

Orhan K, Różyło-Kalinowska I (2019)
Clues at your fingertips: 1-day ultrasound hands-on course
11th DMFR congress, Oral Maxillofacial Radiology Congress, 21-23 February 2019, Tehran, Iran

Orhan K (2019)
The T in the TMJ
11th DMFR congress, Oral Maxillofacial Radiology Congress, 21-23 February 2019, Tehran, Iran

Noffke C (2019) Soft tissue calcifications on dental radiographs
Ampath Continuing Professional Development Course, 9 March 2019, Pretoria, South Africa

De Tobel J, Hillewig E, Phlypo I, Van wijk M, de Haas M, Politis C, Fieuws S, Verstraete K, Thevissen P (2019)
Multi-factorial age estimation: a Bayesian approach combining dental and skeletal magnetic resonance imaging 22nd Meeting of the Study Group on Forensic Age Diagnostics, 15 Mar 2019, Berlin, Germany

Nys M, Dormaar T, Bila T, Willaert R, Coropciuc R, Legrand P, Politis C (2019)
Unfavourable sequelae of surgically treated and conservatively managed condylar fractures
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Van Camp Ph, Bila M, Dormaar T, Coropciuc R, Willaert R, Legrand P, Politis C, Peeters H (2019)
Genetic influences in hypermobility of the temporomandibular joint
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Smeets M, De Cuyper B, Bila M, Coropciuc R, Dormaar T, Legrand P, Willaert R, Politis C (2019)
Tumors of the condyle and temporomandibular joint: diagnostic and therapeutic implications
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Denoiseux B, Shaheen E, Dormaar T, Coropciuc R, Bila M, Legrand P, Willaert R, Politis C (2019)
TMJ function and neocondylar remodelling after vascularised free fibula flap reconstruction
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Verhelst P, Shaheen E, Shujaat S, Swennen G, Jacobs R, Politis C (2019)
TMJ remodelling analysis protocol: a validated registration and segmentation workflow
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

ORAL PRESENTATIONS

Verstraete L, Aerden T, Dormaar T, Coropciuc R, Bila M, Willaert R, Legrand P, Politis C (2019)
Condylectomy and orthognatic surgery in patients with unilateral condylar hyperplasia: a pilot study
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Declerck T, Dormaar T, Bila M, Coropciuc R, Willaert R, Legrand P, Politis C (2019)
TMJ symptoms and need for TMJ surgery in 630 orthognathic cases
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Govaers L, Bila M, Coropciuc R, Dormaar T, Legrand P, Willaert R, Politis C (2019)
Outcome in TMJ arthroscopy
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Verquin M, Dormaar T, Coropciuc R, Bila M, Willaert R, Legrand P, Politis C (2019)
Treatment of ankylosis of the temporomandibular joint with costochondral grafts: a review of 23 grafts
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Orhan K, Różyło-Kalinowska I (2019)
TMJ anatomy, pathologies, imaging and therapies
Orofacial Pain and Temporomandibular joint (TMJ) Disorders course, 10-11 May 2019, Krakow, Poland

Orhan K (2019)
CBCT in TMJ imaging
CBCT course, 15 May 2019, Leuven, Belgium

Orhan K (2019)
Role of CBCT imaging in head/neck radiology
CBCT course, 15 May 2019, Leuven, Belgium

Vranckx M (2019) Wisdom teeth: to extract or not to extract
VVT-MKA Congress, 17 May 2019, Antwerpen, Belgium

Sun Y, Hu X, Du Y, Vanrumste B, Politis C (2019)
Development of an application to evaluate the maxilla positioning after computer assisted orthognathic surgery
CARS 2019 Computer Assisted Radiology and Surgery, 18-21 June 2019, Le Couvent des Jacobins, Rennes, France

Van der Cruyssen F, de Faria Vasconcelos K, Verhelst PJ, Shujaat S, Delsupehe AM, Hauben E, Orhan K, Politis C, Jacobs R (2019)
Metal debris after dental implant placement: A proof-of-concept study in fresh frozen cadavers using MRI and histological analysis
IADMFR 2019, 26-29 August 2019, Philadelphia, USA (Oral Presentation)

Ozdiler O, Orhan K, Cesur E, Köklü A, Algın O (2019)
Evaluation of temporomandibular joint, masticatory muscle, and brain cortex activity in patients treated by removable functional appliances: a prospective fMRI study
IADMFR 2019, 26-29 August 2019, Philadelphia, USA (Oral Presentation)

Bayrak S, Orhan K, Çakmak K, Görürgöz C, Odabaşı O, Yilmaz D, Atakan C (2019)
Comparison of the Optimization Filters in the Estimation of Peri-implant Dehiscence Defects Using Cone Beam Computed Tomography: An In-Vitro Study
IADMFR 2019, 26-29 August 2019, Philadelphia, USA (Oral Presentation)

Ocak M, Akkus O, Orhan K, Bilecenoğlu B (2019)
Evaluation of mandibular trabecular microstructure of rat mandible and dry human mandible by using micro-computed tomography
IADMFR 2019, 26-29 August 2019, Philadelphia, USA (Poster Presentation)

Vranckx M, Lauwens L, Moreno Rabie C, Politis C, Jacobs R (2019)
Radiological prediction of postsurgical recovery after wisdom tooth removal
IADMFR Conference, 22 August 2019 Philadelphia USA, Awarded with 3rd prize
(Oral presentation)

Orhan K (2019)
Contemporary imaging techniques in pediatric dentistry with interactive case discussions
The 25th European Dental Materials Conference (EDMC), 28-30 August, 2019, Brussels, Belgium

Castro AB, Cortellini S , de Faria Vasconcelos K , Vangansewinkel T , Duyck J , Jacobs R , Quirynen M (2019)
Peri-implant bone structure and microvessel density after implant functionalization with L-PRF
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon (Abstract n°15744)

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Oud V, Van Der Veken D, Van Kerckhoven K, Jacobs R, Quirynen M (2019)
The effect of bone quality and bone mineral density on dental implant failures – A systematic review
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Vitosyte M, Gendviliene I, Simoliunas E, Alksne M, Rekstyte S, Jacobs R, Bukelskiene V, Rutkunas V (2019)
Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon (Poster-CI-032)

Rodrigues CT, Lamira A, Chaves JFM , Sousa-Neto MD, Duarte MAH, Buls N , Vasconcelos KF, Jacobs R (2019)
Accuracy of CBCT images in detecting the isthmus in mandibular molars
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Verhelst PJ, Politis C, Devriendt K, Peeters H (2019)
Facial characteristics in BMP2 truncating sequence variants or deletions
30th European Dysmorphology Meeting 2019, 11- 13 Sep 2019 Strasbourg, France

Politis C (2019)
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IBRA, Advanced Fellow Course Orthognathic Surgery, 20 - 21 September 2019, Basel, Switzerland

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Svensk Förening för Radiologi, 14 November 2019, Karolinska University, Sweden

Orhan K, Jacobs R, Pauwels R, Eray Kolsuz M, Stratis A, Bosmans H, Sagsöz ME, Akif Sümbüllü M (2019)
Comparison of organ and effective doses between low-dose Multi-slice CT and Cone-beam CT protocols for paediatric dental exposures
Svensk Förening för Radiologi, 14 November 2019, Karolinska University, Sweden

Orhan K, Jacobs R, Pauwels R, Eray M, Kolsuz A, Stratis A, Bosmans H, Erdem M, Sağsöz M, Akif M, Sümbüllü M (2019)
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De Koek L, Smeets M, Grisar K, Craeynest A, Bila M, Coropciuc R, Dormaar T, Legrand P, Willaert R, Politis C (2019)
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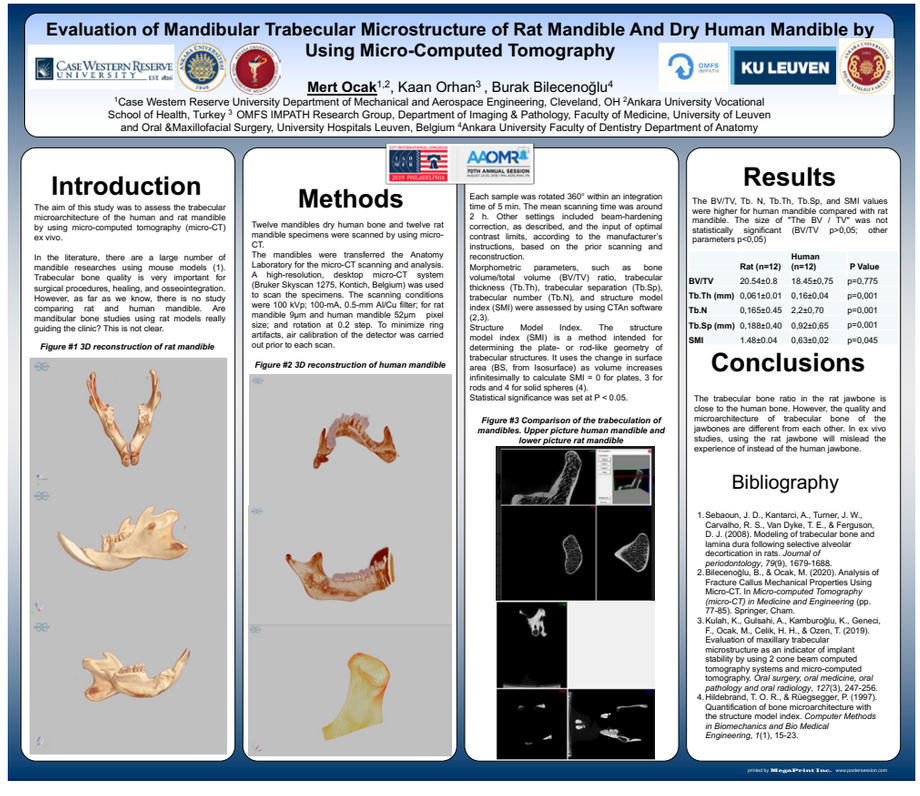
POSTER PRESENTATIONS

Ocak M, Akkus O, Orhan K, Bilecenoğlu B (2019)
Evaluation of mandibular trabecular microstructure of rat mandible and dry human mandible by using micro-computed tomography
IADMFR 2019, 26-29 August 2019, Philadelphia, USA



Evaluation of Mandibular Trabecular Microstructure of Rat Mandible And Dry Human Mandible by Using Micro-Computed Tomography

Mert Ocak[1,2], Kaan Orhan[3] , Burak Bilecenoğlu[4]
[1]Case Western Reserve University Department of Mechanical and Aerospace Engineering, Cleveland, OH [2]Ankara University Vocational School of Health, Turkey [3] OMFS IMPATH Research Group, Department of Imaging & Pathology, Faculty of Medicine, University of Leuven and Oral &Maxillofacial Surgery, University Hospitals Leuven, Belgium [4]Ankara University Faculty of Dentistry Department of Anatomy

Introduction

The aim of this study was to assess the trabecular microarchitecture of the human and rat mandible by using micro-computed tomography (micro-CT) ex vivo.

In the literature, there are a large number of mandible researches using mouse models (1). Trabecular bone quality is very important for surgical procedures, healing, and osseointegration. However, as far as we know, there is no study comparing rat and human mandible. Are mandibular bone studies using rat models really guiding the clinic? This is not clear.

Figure #1 3D reconstruction of rat mandible

Methods

Twelve mandibles dry human bone and twelve rat mandible specimens were scanned by using micro-CT.
The mandibles were transferred the Anatomy Laboratory for the micro-CT scanning and analysis. A high-resolution, desktop micro-CT system (Bruker Skyscan 1275, Kontich, Belgium) was used to scan the specimens. The scanning conditions were 100 kVp; 100-mA, 0.5-mm Al/Cu filter; for rat mandible 9µm and human mandible 52µm pixel size; and rotation at 0.2 step. To minimize ring artifacts, air calibration of the detector was carried out prior to each scan.

Figure #2 3D reconstruction of human mandible

Each sample was rotated 360° within an integration time of 5 min. The mean scanning time was around 2 h. Other settings included beam-hardening correction, as described, and the input of optimal contrast limits, according to the manufacturer's instructions, based on the prior scanning and reconstruction.
Morphometric parameters, such as bone volume/total volume (BV/TV) ratio, trabecular thickness (Tb.Th), trabecular separation (Tb.Sp), trabecular number (Tb.N), and structure model index (SMI) were assessed by using CTAn software (2,3).
Structure Model Index. The structure model index (SMI) is a method intended for determining the plate- or rod-like geometry of trabecular structures. It uses the change in surface area (BS, from Isosurface) as volume increases infinitesimally to calculate SMI = 0 for plates, 3 for rods and 4 for solid spheres (4).
Statistical significance was set at $P < 0.05$.

Figure #3 Comparison of the trabeculation of mandibles. Upper picture human mandible and lower picture rat mandible

Results

The BV/TV, Tb. N, Tb.Th, Tb.Sp, and SMI values were higher for human mandible compared with rat mandible. The size of "The BV / TV" was not statistically significant (BV/TV p>0,05; other parameters p<0,05)

	Rat (n=12)	Human (n=12)	P Value
BV/TV	20.54±0.8	18.45±0,75	p=0,775
Tb.Th (mm)	0,061±0.01	0,16±0,04	p=0,001
Tb.N	0,165±0.45	2,2±0,70	p=0,001
Tb.Sp (mm)	0,188±0,40	0,92±0,65	p=0,001
SMI	1.48±0.04	0,63±0,02	p=0,045

Conclusions

The trabecular bone ratio in the rat jawbone is close to the human bone. However, the quality and microarchitecture of trabecular bone of the jawbones are different from each other. In ex vivo studies, using the rat jawbone will mislead the experience of instead of the human jawbone.

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Oud V, Van Der Veken D, Van Kerckhoven K, Jacobs R, Quirynen M (2019)
The effect of bone quality and bone mineral density on dental implant failures – A systematic review
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon

The effect of bone quality and bone mineral density on dental implant failures: a systematic review

Authors :

Name	Email	Country
Oud Valérie *	valerie.oud@gmail.com	Belgium
Van Der Veken Dominique	dominique.vanderveken@kuleuven.be	Belgium
Van Kerckhoven Karolien	karolien.vankerckhoven@student.kuleuven.be	Belgium
Jacobs Reinhilde	reinhilde.jacobs@kuleuven.be	Belgium
Quirynen Marc	marc.quirynen@kuleuven.be	Belgium

Background (500 characters maximum)

Success and survival of dental implants are affected by the alveolar bone quality and bone mineral density (BMD) of the implant bed. These parameters are considered key factors for primary implant stability and influence the load-bearing capacity of the implant. Studies on the effect of bone quality and bone mineral density on the long-term outcome of dental implants are limited. A review was initiated to evaluate their effect on dental implant failures.

Aim/Hypothesis (300 characters maximum)

A systematic review of the literature was conducted to evaluate the effect of bone quality and bone mineral density on early and late implant failures. Implant failures were defined as peri-implantitis and implant loss.

Materials and Methods (1000 characters maximum)

A literature search was performed using the electronic databases PubMed/MEDLINE, EMBASE, Cochrane Library and Web of Science to identify studies published in English between 1990 and January 2018. Clinical trials reporting on patients who underwent dental implant placement at various locations in the mandible and maxilla were included. Bone quality and/or density had to be evaluated clinically, radiologically or with Dual-energy X-ray absorptiometry (DXA) before, during or after implant placement. Differences between healthy patients versus patients with impaired bone quality or bone mineral density due to systemic diseases were also compared.
A bias and methodology quality assessment was performed using the Checklist for Health Care Interventions Studies as proposed by Downs and Black. The review protocol was registered at the PROSPERO database.

Results (1000 characters maximum)

In this review 16 non-randomized retrospective studies and 3 prospective cohort studies involving 5422 patients were included. Eleven studies reported on the outcome of implant therapy in relation to bone quality and BMD in healthy patients. Eight studies assessed the bone quality or mineral density in patients with bone-affecting systemic diseases. Due to the heterogeneity of the studies and outcome variables meta-analysis of the data was not possible.
Peri-implantitis was an outcome measure in three studies. All included studies investigated implant loss. Lower BMD measurements and bone quality type 4 appear to be associated with lower implant stability and more early implant loss. No long-term data were available to evaluate the effect of bone quality and BMD on late implant failures. The studies that investigated patients with bone-affecting systemic diseases did not find a relationship between systemic BMD and local density of the alveolar bone.

Conclusions and Clinical Implications (500 characters maximum)

Dental implants in patients with bone-affecting systemic diseases are a predictable treatment for oral rehabilitation. The included studies did not show a relationship between the systemic bone mineral density and the local density of the implant bed. Clinically this implies that in sites with low local bone mineral density, adaptation of the surgical technique and an extended submerged healing period are recommended.

Vitosyte M, Gendviliene I, Simoliunas E, Alksne M, Rekstyte S, Jacobs R, Bukelskiene V, Rutkunas V (2019)
Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon

P-CI-032

CLINICAL INNOVATIONS

Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation

Vitosyte Milda[1], Gendviliene I[1], Simoliunas E[2], Alksne M[2], Rekstyte S[3], Reinhilde J[4], Bukelskiene V[2], Rutkunas V[1]

1 Institute of Odontology, Faculty of Medicine, Vilnius University, Lithuania
2 Department of Biological Models, Institute of Biochemistry, Life Sciences Center, Vilnius University, Lithuania
3 Laser Research Center, Department of Quantum Electronics, Faculty of Physics, Vilnius University, Lithuania
4 Omfs Impath Research Group, Department of Imaging and Pathology, Faculty of Medicine, University of Leuven and Department of Oral and Maxillofacial Surgery, University Hospitals Leuven, Leuven, Belgium

Abstract

More than 2 million bone transplant procedures are carried out each year, making bone the second most commonly transplanted tissue in the world. 3D structured and individually fabricated bone scaffolds are promising treatment strategy. Cell-laid mineralised extracellular matrix (ECM) was shown to be potential for improving the cellular responses and drive osteogenesis of stem cells.

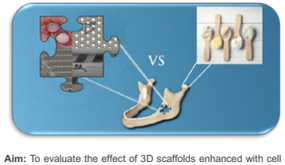
There were 6 groups in the study (n=8/gp): negative control, Geistlich Bio-Oss®, pure polylactic acid (PLA), PLA/hydroxyapatite (HAP), PLA/HAP cellularized with dental pulp stem cells (PLA/HAP cells) and their decellularized scaffolds (PLA/HAP ECM). Scaffolds were fabricated using FFF 3D printer. The filament for printing was produced by Filabot extruder system. Dental pulp stem cells were isolated from dental pulp of incisors of adult Wistar rats. All materials were implanted in critical-size Wistar rat's calvarial defect model in vivo to evaluate materials' osteoregenerative potential. The defects were evaluated by micro-computed tomography and histological analysis eight weeks after surgery. All procedures were approved by License of Animal Research Ethics Committee No G2-40, 2016-03-18. Shapiro-Wilk test was used to test for normality in groups. For normally distributed data parametric statistics data analysis methods were used and for non-normally distributed data - nonparametric.

Histometric measurements showed that 3D printed PLA scaffolds had more pronounced inflammation reaction during biodegradation, however scaffolds with HAP showed appropriate inflammatory responses. Micro-CT results showed no significant difference between different scaffold groups (p>0.05), however PLA scaffolds displayed poorer results (2.63±1.28 mm³) in new bone formation. Nevertheless, decellularized PLA/HAP scaffolds had more pronounced osteoregenerative potential (4.05±1.48 mm³) compared to other experimental groups, close to Geistlich Bio-Oss® results (4.04±0.44 mm³). There was a significant difference between the (p <0.05) gender groups in PLA and PLA/HAP cells groups.

We concluded that 3D printed scaffolds with HAP improve biodegradation. PLA/HAP and PLA/HAP ECM scaffolds have the potential of being used in bone tissue engineering.

Background and Aim

The concept of bone regeneration is described as a process by which a bone defect is filled with a donor bone tissue or a bone substitute [1]. Existing substitutes in clinical practice do not meet all the criteria required for an ideal scaffold, so new materials are being sought. Thus, 3D structured and individually fabricated bone scaffolds, enhanced with extracellular matrix (ECM) or its specific proteins are promising treatment strategy [2], which would allow to shorten the time and lower the extent of the surgery.



Aim: To evaluate the effect of 3D scaffolds enhanced with cell produced ECM on the formation of new bone *in vivo* and to compare it with the Bio-oss.

Methods and Materials

There were 6 groups in the study (n=8/gp): negative control, Bio-oss, PLA, PLA/HAP, PLA/HAP cells and PLA/HAP ECM scaffolds.
Raw materials used in this study were polylactic acid (PLA) (STP Chem Solutions Co., Ltd., Thailand) – particle size of 100 – 800 µm and a molecular weight of 42 – 700 (g/mol) µm, hydroxyapatite (Hap) (Riga Technical University, Latvia) - particle size 50 µm and Geistlich Bio-Oss® (Geistlisch Pharmaceutical, Wolhusen, Switzerland) particles. The composite filament for printing was produced by Filabot Original filament extruder system (Filabot HQ, Barre VT, USA) from the PLA and HAP powders at the ratio of 9:1 (w/w).

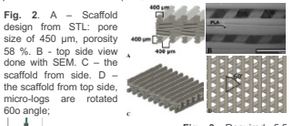


Fig. 2. A – Scaffold design from STL: pore size of 450 µm, porosity 58 %. B - top side view done with SEM. C – the scaffold from side. D – the scaffold from top side, micro-logs are rotated 60o angle;

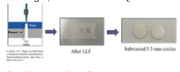


Fig. 3. Required 5.5 mm circles were obtained with laser light filament fabrication technology.

Sterilization of scaffolds was done with ethylene oxide gas. The aeration lasted 4 days.

All procedures were approved by License of Animal Research Ethics Committee No G2-40, 2016-03-18.
Dental pulp stem cells (DPSC) (Fig. 4) were isolated from dental pulp of incisors of adult Wistar rats and purified with magnetic beads coated with antibodies against cell surface marker CD44. Cells were seeded onto the prepared PLA/HAP scaffolds (density 10,000 cell/cm²) and grown in osteoinductive medium. The medium was changed every 3 days up to 21 days.

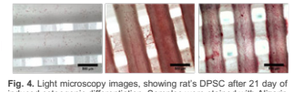


Fig. 4. Light microscopy images, showing rat's DPSC after 21 day of induced osteogenic differentiation. Samples were stained with Alizarin Red S.

The DPSC were removed from the scaffolds after 21 days of osteogenic differentiation, leaving the resulting extracellular matrix.

Twenty-four 3 months old Wistar rats (weight ~300 g) were used in this study. The sample size counted with Gpower software (one- way ANOVA test with a priori analysis: α – 0.05, power 0.8, effect size f – 0.75). The animals were divided randomly, there were 4 female and 4 male animals in each group. During the whole experimental period the rats were kept in a monitored environment (21°C; 12:12 light cycle) and received a standard diet and water ad libitum.

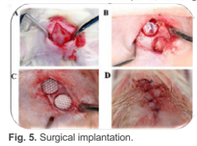


Fig. 5. Surgical implantation.
A – the incision was made in the middle of the posterior part of the cranium. B - 5.5 mm critical size defects (2 per animal) C - scaffolds placed as inlay-onlay grafts. D – sutured flap.

Results

Histometric measurements showed that 3D printed PLA. had more pronounced inflammation during biodegradation but scaffolds with HAP showed appropriate inflammatory responses.

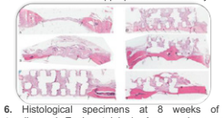
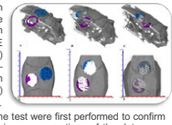


Fig. 6. Histological specimens at 8 weeks of healing (Hematoxylin and Eosin staining). Arrows show new bone edges. A – Negative control; B – Bio-Oss particles. C – PLA group; D – PLA/HAP group; E – PLA/HAP cells; F –PLA/HAP ECM scaffolds.

Fig. 7. New bone formation *in vivo*. A – D Negative control (blue) and Geistlich Bio-Oss® (purple). B, E Pure PLA scaffolds (blue) and PLA/HAP (purple). C – F PLA/HAP cellularized with dental pulp stem cells (blue) and ECM scaffolds (purple).



Shapiro-Wilk test and Levene test were first performed to confirm the normality and equal variance assumptions of the data were not violated. One-way analysis of variance (ANOVA) was performed to analyze BV. Each group was compared using the Tukey post hoc test when a significant result was presented. The level of significance was set to 0.05.

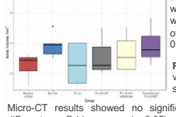
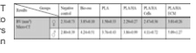


Fig. 8. Bone volume amount of the six different groups.

Micro-CT results showed no significant difference between different scaffold groups (p>0.05), however PLA scaffolds (2.63±1.27 mm³) displayed poorer results in new bone formation. Nevertheless, decellularized PLA/HAP scaffolds (4.05±1.48 mm³) had more pronounced osteoregenerative potential and cellular ingrowth compered to other experimental groups.

Table 1. Micro-CT results according to gender. All parameters are presented as mean ± single SD.



Conclusion

Within the limits of this study we concluded that 3D printed PLA/HAP and decellularized scaffolds have potential applications in bone tissue engineering, especially combined with the decellularization technique. Further research is needed to analyze the effect of decellularization and HAP for new bone regeneration *in vitro* and *in vivo*.

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Presented at EAO CONGRESS Lisbon 2019

Rodrigues CT, Lamira A, Chaves JFM , Sousa-Neto MD, Duarte MAH, Buls N , Vasconcelos KF, Jacobs R (2019)
Accuracy of CBCT images in detecting the isthmus in mandibular molars
19th European Society of Endodontology Biennial Congress, 12-14 September, 2019, Vienna

Accuracy of CBCT images in detecting the isthmus in mandibular molars

Rodrigues CT[1], Lamira A[2], Chaves JFM[2], Sousa-Neto MD[2], Duarte MAH[1], Buls N[3], Vasconcelos KF[4], Jacobs R[4]

[1]Department of Dentistry, Endodontics and Dental Materials., Bauru School of Dentistry, University of São Paulo., Bauru - SP, Brazil,
[2]Department of Restorative Dentistry., School of Dentistry of Ribeirão Preto, University of São Paulo., Ribeirão Preto - SP, Brazil,
[3]Department of Radiology., Universitair Ziekenhuis Brussel (UZ Brussel), Vrije Universiteit Brussel (VUB)., Brussels, Belgium
[4]OMFS IMPATH Research Group, Department of Imaging and Pathology, and Department of Oral and Maxillofacial Surgery., Faculty of Medicine, University Hospitals Leuven, University of Leuven., Leuven, Belgium

Introduction

The isthmuses remain inaccessible areas to instruments, resulting in the accumulation of debris, the maintenance of necrotic pulp tissue and microorganisms inside the root canal system, affecting three-dimensional filling and consequently clinical outcomes.

Aim

To compare the sensitivity and accuracy of CBCT images in the visualization of root canal anatomy of mandibular molars with an isthmus using the microCT as validation.

Methodology

Fourteen mandibular molars with an isthmus in the mesial root were selected for this study. The teeth were scanned with microCT and three CBCT devices, applying High Resolution (0.08 – 0.1 mm³) and small FOV (4X4 – 6X6 cm) in all CBCT devices.

Figure 1: MicroCT device SkyScan 1173 (Bruker, Kontich, Belgium). The parameters used were 12µm, 130kV and 61mA.

Figure 2: Sample preparation for the microCT scanning. (A) Hydration of the specimen with saline solution. (B) Specimen wrapped in paraffin film to prevent dehydration, which could lead to fracture of the specimen. (C) Group of five specimens inside the Styrofoam attached to the microCT holder.

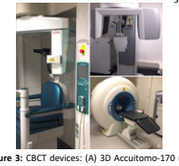


Figure 3: CBCT devices: (A) 3D Accuitomo-170 (J Morita, Kyoto, Japan). (B) NewTom VGi evo (NewTom, Verona, Italy). (C) NewTom 5G (NewTom, Verona, Italy).

Figure 4: Human mandible coated with mixD mixture positioned for scanning in a CBCT device. MixD is used to simulate sof tissue during the scanning.

The CBCT images were used for qualitative evaluation of the mesial root anatomy according to Vertucci´s classification; isthmus classification according to Hsu & Kim (1997) in the cervical, middle and apical thirds, and quantitative analysis of the area, perimeter, circularity, major and minor diameter.

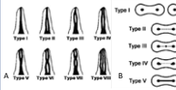


Figure 5: (A) Vertucci´s classification (1984) and (B) Hsu & Kim isthmus´s classification (1997).

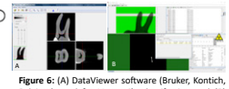


Figure 6: (A) DataViewer software (Bruker, Kontich, Belgium) used for Vertucci´s classifcation and (B) CTAn software (Bruker, Kontich, Belgium) used for quantitative analysis.

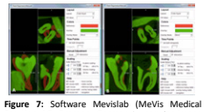


Figure 7: Software Mevislab (MeVis Medical Solution AG, Bremen, Germany) used for image registration. (A) Images before registration. (B) Superimposed images after registration.

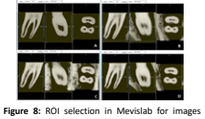


Figure 8: ROI selection in Mevislab for images obtained by (A) microCT, (B) Accuitomo, (C) NewTom 5G and (D) NewTom VGi evo.

Qualitative data were analysed statistically using the Kappa test, and the quantitative data by ANOVA and Tukey test. The concordance between the data was verified by the intraclass correlation coefficient (ICC) and simple linear regression.

Results

For Vertucci´s classification, the Kappa test revealed a moderate agreement (k=0.41) between microCT and the CBCT devices and almost perfect agreement (k=0.91) between CBCT devices.

Types I, III, IV and V were the most prevalent in all devices, and 2 types not included in Vertucci´s classification were observed (Table 1).

It was possible to observe the presence of types II and VII only in the evaluation by CBCT.

Device	Vertucci classification							
	Type I	Type II	Type III	Type IV	Type V	Type VII	II-I-II-I	I-II-I-II-I
microCT	5(35.8)	-	2(14.3)	2(14.3)	3(21.4)	-	1(7.1)	1(7.1)
ACC	3(21.4)	1(7.1)	3(21.4)	2(14.3)	2(14.3)	2(14.3)	1(7.1)	-
NSG	3(21.4)	1(7.1)	3(21.4)	2(14.3)	2(14.3)	2(14.3)	1(7.1)	-
NEVO	3(21.4)	1(7.1)	3(21.4)	2(14.3)	2(14.3)	1(7.1)	1(7.1)	1(7.1)

Table 1: Morphological classification of the root canal systems of the mesial roots of lower molars [n (%)] according to Vertucci for the different devices.

For isthmus present in cervical and middle thirds, the classification as type I (absence of isthmus) was greater in CBCT images compared to microCT, which indicates that the isthmus may be missed in CBCT images. Types IV and V were the most classified in microCT and the CBCTs.

Third	Device	Isthmus's classification					
		One canal	Type I	Type II	Type III	Type IV	Type V
Cervical	microCT	0 (0.0)	0 (0.0)	2 (14.3)	2 (14.3)	4 (28.6)	6 (42.9)
	ACC	0 (0.0)	4 (28.6)	1 (7.1)	0 (0.0)	3 (21.4)	6 (42.9)
	NSG	0 (0.0)	2 (14.3)	1 (7.1)	0 (0.0)	5 (35.7)	6 (42.9)
	NEVO	0 (0.0)	2 (14.3)	0 (0.0)	0 (0.0)	6 (42.9)	6 (42.9)
Middle	microCT	0 (0.0)	1 (7.1)	2 (14.3)	1 (7.1)	4 (28.6)	6 (42.9)
	ACC	0 (0.0)	4 (28.6)	1 (7.1)	0 (0.0)	3 (21.4)	6 (42.9)
	NSG	0 (0.0)	5 (35.7)	1 (7.1)	0 (0.0)	2 (14.3)	6 (42.9)
	NEVO	0 (0.0)	4 (28.6)	1 (7.1)	0 (0.0)	3 (21.4)	6 (42.9)
Apical	microCT	2 (14.3)	5 (35.7)	0 (0.0)	0 (0.0)	2 (14.3)	5 (35.7)
	ACC	2 (14.3)	6 (42.9)	0 (0.0)	0 (0.0)	1 (7.1)	5 (35.7)
	NSG	2 (14.3)	6 (42.9)	0 (0.0)	0 (0.0)	2 (14.3)	4 (28.6)
	NEVO	2 (14.3)	7 (50.0)	0 (0.0)	0 (0.0)	1 (7.1)	4 (28.6)

Table 2: Morphological classification of the type of isthmus present in the mesial roots of lower molars [n (%)] by the various devices.

For the values of area, roundness and minor diameter there was no difference between the evaluated devices. For perimeter, the microCT presented higher values compared to the CBCTs ($p < 0.05$).

Device	Parameters				
	Area	Perimeter	Roundness	Major diameter	Minor diameter
microCT	0.51 (0.46) A	3.68 (2.14) A	0.41 (0.24) A	1.44 (0.94) A	0.47 (0.26) A
ACC	0.43 (0.54) A	2.40 (2.27) B	0.36 (0.29) A	0.95 (0.97) B	0.38 (0.30) A
NSG	0.45 (0.50) A	2.57 (2.13) B	0.37 (0.26) A	1.01 (0.90) AB	0.43 (0.28) A
NEVO	0.39 (0.52) A	2.16 (2.19) B	0.31 (0.26) A	0.85 (0.02) B	0.35 (0.30) A
p value	0.59	0.01	0.35	0.05	0.1

* Different letters indicate statistical difference by the Tukey test ($p < 0.05$) for the various parameters evaluated.

Table 3: Mean values (standard deviation) for the area data (mm²), perimeter (mm), roundness (mm), major diameter (mm) and minor diameter (mm) for the different devices.

For quantitative analysis, there was satisfactory reproducibility between microCT and CBCT, as shown by the values of perimeter, roundness, major and minor diameters ($0.41 < ICC > 0.74$), and this correlation/reproducibility was lower for roundness.

Devices	Parameters				
	Area	Perimeter	Roundness	Major diameter	Minor diameter
microCT X ACC	0.90	0.73	0.41	0.72	0.76
microCT X NSG	0.93	0.73	0.41	0.74	0.77
microCT X NEVO	0.91	0.69	0.42	0.69	0.68
ACC X NSG	0.91	0.85	0.80	0.86	0.82
ACC X NEVO	0.96	0.87	0.57	0.87	0.81
NSG X NEVO	0.92	0.86	0.62	0.87	0.75

Table 4: Intraclass correlation values between the different devices for area, perimeter, roundness, major diameter and minor diameter of the root canal anatomy.

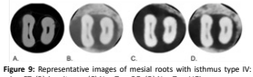


Figure 9: Representative images of mesial roots with isthmus type IV: (A) microCT; (B) Accuitomo; (C) NewTom 5G; (D) NewTom VGi evo.

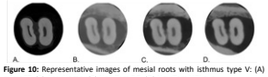


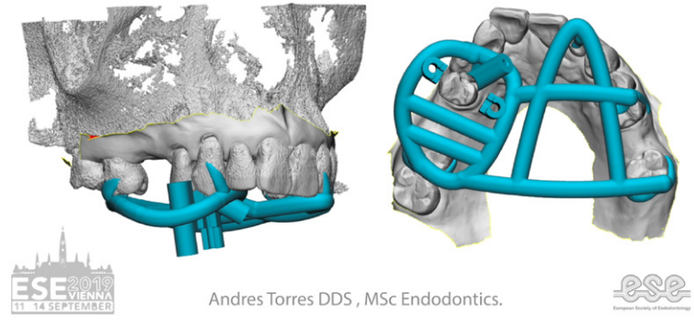
Figure 10: Representative images of mesial roots with isthmus type V: (A) microCT; (B) Accuitomo; (C) NewTom 5G; (D) NewTom VGi evo.

Conclusions

The CBCTs devices presented sufficient sensitivity and accuracy in the detection of isthmus, however they did not provide accurate classification. CBCT images aid in the diagnosis and planning of root canal treatment, however it is important to know their limitations in order to improve the prognosis of treatment.

Acknowledgements *This study was supported by National Council for Scientific and Technological Development - CNPq (process number 150046/2018-9).*

Torres A (2019)
A novel guided endodontics method for the treatment of a maxillary premolar with pulp canal obliteration and apical periodontitis 19th European Society of Endodontology Biennial Congress, 12-14 September, 2019, Vienna, (clinical video)



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Int Endod J. 2019 Apr;52(4):540-549

Piluso S, Patterson J (2019)
Engineered PEG hydrogels with transient gelatin fragments for tissue engineering and biofabrication
Biomedical Engineering Society (BMES) Annual Meeting, 16-19 October 2019, Philadelphia, USA

Engineered PEG Hydrogels with Transient Gelatin Fragments for Tissue Engineering and Biofabrication

Susanna Piluso[1,2], Jennifer Patterson[1,2,3]

[1]Department of Materials Engineering; [2]Prometheus, Division of Skeletal Tissue Engineering; [3]Department of Imaging and Pathology, KU Leuven, Belgium

KU LEUVEN

INTRODUCTION

Tissue engineering seeks to provide a therapeutic option for tissue and organ damage by creating 3D constructs composed of cells, bioactive factors, and a biomaterial scaffold. Improvements in synthetic hydrogel biomaterials and biofabrication technologies are advancing the field, and yet most bioprinting studies are performed using naturally derived biomaterials such as gelatin, hyaluronic acid, or alginate. More limited studies using synthetic materials such as polyethylene glycol (PEG) create non-degradable hydrogels or utilize PEG as a crosslinking molecule. In this study, we set out to develop a novel molecularly engineered PEG hydrogel formulation that transiently incorporates low molecular weight gelatin fragments. We envision this combination can provide tunable rheological properties compatible with biofabrication methodologies without interfering with the formation of a covalently crosslinked, enzymatically degradable, and functionalized PEG network.

MATERIALS & METHODS

Low molecular weight gelatin fragments were prepared using degradation by hydroxylamine.[1] Michael-type addition PEG hydrogels were prepared by reacting a 4-arm, 20 kDa PEG macromer that was end-functionalized with vinyl sulfone groups (PEG-VS) with RGD and a protease-sensitive crosslinker (Ac-GCREGPQGIWGQERCG-NH_2).[2] The low molecular weight gelatin fragments were added to the precursor solutions prior to crosslinking. Hydrogels were labeled with 5-carboxyfluorescein (5-FAM) and imaged with confocal microscopy to evaluate their homogeneity. The release of gelatin was measured using a BCA assay after swelling the hydrogels at 37 °C, and the rheological properties of the precursor solutions and crosslinked hydrogel were measured using a stress-controlled rheometer. L929 fibroblasts or mouse periosteum-derived cells (mPDCs) were encapsulated in 3D in the hydrogels and cultured under standard conditions. Cell behavior was assessed using a Live/Dead assay, PrestoBlue assay, DNA quantification assay, and phalloidin and DAPI staining. Finally, the hydrogel formulation was 3D printed using an Inkredible+ bioprinter from CellInk. The printed hydrogel was incubated at 37 °C for 30 min for further crosslinking and then soaked in PBS to confirm its integrity.

MATERIALS CHARACTERIZATION

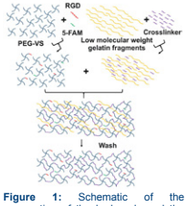

Figure 1: Schematic of the preparation of the hydrogels and the diffusion of the low molecular weight gelatin fragments from the hydrogels.

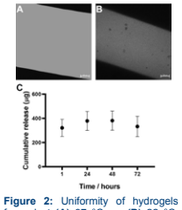

Figure 2: Uniformity of hydrogels formed at **(A)** 37 °C vs. **(B)** 22 °C. **(C)** Release of low molecular weight gelatin fragments at 37 °C.

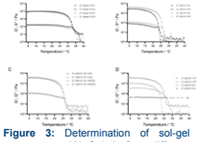

Figure 3: Determination of sol-gel temperature. **(A)** Gelatin from different suppliers. **(B)** Low molecular weight gelatin fragments from different suppliers. **(C)** Effect of buffer. **(D)** Effect of concentration.

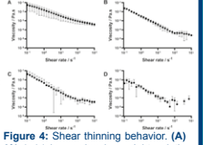

Figure 4: Shear thinning behavior. **(A)** 6% (w/v) low molecular weight gelatin fragments. 13% (w/v) PEG with **(B)** 0% (w/v), **(C)** 6% (w/v), and **(D)** 3% (w/v) low molecular weight gelatin fragments.

BIOLOGICAL CHARACTERIZATION

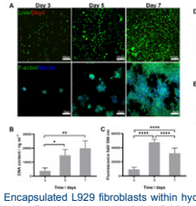

Figure 5: Encapsulated L929 fibroblasts within hydrogels after 1, 4, and 7 d of culture. **(A)** Live/Dead (top) and phalloidin/DAPI (bottom) confocal microscopy images. **(B)** DNA content. **(C)** Metabolic activity. **(D)** Viability. **(E)** Circularity.

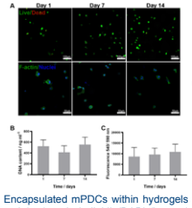

Figure 6: Encapsulated mPDCs within hydrogels after 1, 4, and 7 d of culture. **(A)** Live/Dead (top) and phalloidin/DAPI (bottom) confocal microscopy images. **(B)** DNA content. **(C)** Metabolic activity. **(D)** Viability. **(E)** Circularity.

CONCLUSIONS

The transient incorporation of low molecular weight gelatin fragments in a molecularly engineered PEG hydrogel formulation both supports the viability and proliferation of cells encapsulated in 3D and can be formed into stable 3D constructs using extrusion-based bioprinting. This study brings advances in synthetic hydrogel design together with advances in biofabrication and could lead to the production of tunable and patterned PEG-based hydrogel constructs.

REFERENCES AND CONTACTS

[1]Piluso S *et al. Macromolecular Symposia* 2011; 309-310:199-204.
[2]Patterson J and Hubbell JA. *Biomaterials*. 2010; 31:7836-7845.

Present affiliations: Jennifer Patterson, BIOFABICS LDA
jennifer.patterson@biofabics.com
Susanna Piluso, UMC Utrecht
s.piluso@umcutrecht.nl

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Salar Amoli M, Annand R, EzEldeen M, Jacobs R, Bloemen V (2019)
The Development of a 3D printed Chitosan Based Hydrogel Scaffold for the Regeneration of Dental Pulp
BSTE 2019, 14-15 November, 2019, Hasselt University, Belgium

The Development of a 3D printed Chitosan Based Hydrogel Scaffold for Regeneration of Dental Pulp

Mehdi Salar Amoli[1,2], Resmi Anand[1,3], Mostafa EzEldeen[2], Reinhilde Jacobs[2], Veerle Bloemen[1,3]
1 Materials Technology TC, Campus Group T, KU Leuven, Andreas Vesaliusstraat 13, 3000 Leuven, Belgium
2 Dept Imaging & Pathology/ OMFS-IMPATH Research Group, KU Leuven, Leuven, Belgium
3 Prometheus, Division of Skeletal Tissue Engineering Leuven, KU Leuven, Leuven, Belgium

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Introduction

The ability of hydrogels to entrap different biological factors and to mimic the natural cell microenvironment has made them attractive as scaffolds for tissue engineering. Chitosan and gelatin are biocompatible, biodegradable natural polymers that are used widely in different tissue engineering approaches. This study focuses on synthesis of a water-soluble form of chitosan to be combined with gelatin and crosslinked with genipin, a crosslinker known to promote odontoblastic differentiation (Kwon et al, 2014), in order to create a 3D printable hydrogel to act as a scaffold for dental pulp regeneration.

Materials and Methods

A water soluble chitosan derivative was synthesized by esterification of chitosan with maleic anhydride in presence of methanol/pyridine mixture and the chemical structure of modified chitosan was characterized by Fourier-transform infrared spectroscopy (FTIR). The solubility of reaction product in neutral pH was evaluated and 15 mg/mL of chitosan was mixed with 15 mg/mL and 30 mg/mL gelatin. Five different concentrations of genipin starting from 0.5 % (w/w) to 2.5 % (w/w) were used to produce the hydrogels. Printability of different concentrations was evaluated using a BIO X bioprinter (CELLINK®). The amount of unreacted genipin in the samples was calculated to anticipate possible toxicity. The degree of crosslinking in different samples was evaluated by a ninhydrin assay and the rate of hydrolytic degradation was measured. Surface morphology of the hydrogels was evaluated by Scanning Electron Microscopy (SEM). Viability of dental pulp stem cells was measured using a Live/Dead assay and an Alamar blue assay.

Results

Material Characterization

FTIR

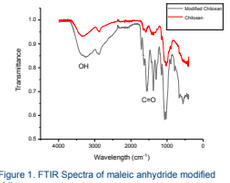

Figure 1. FTIR Spectra of maleic anhydride modified chitosan.

The presence of C=O and OH peaks on maleic anhydride modified chitosan represent the presence of ester group and prove effective functionalization of the chitosan.

Solubility Test

Figure 2. Solubility assessment of maleic anhydride modified chitosan in water

The solubility assessment shows that the modified chitosan is soluble in water up to 18 mg/mL. To ensure full solubility, a concentration of 15 mg/mL was used throughout this study.

Hydrogel Characterization

Evaluation of printability

Figure 3. Evaluation of gel printability. 24 h after addition of crosslinker. 5 layers of material are printed.

Samples containing 1.5 % (w/v) water soluble chitosan and 3 % (w/v) gelatin are capable of producing more uniform strands and replicate the model more precisely than the gels containing 1.5 % (w/v) chitosan and 1.5 % (w/v) gelatin, in which analysis of filament thickness showed a significant difference between filaments with a p-value of <0.0001 while there was no significant difference in filament thickness in samples containing 3 % (w/v) gelatin.

Measurement of unreacted genipin

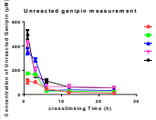

Figure 4. Amount of unreacted genipin after different crosslinking periods

It can be seen that as the time of crosslinking increases, the amount of unreacted genipin in the sample is reduced. There is a significant difference in amount of unreacted genipin observed at all timepoints. These results indicate that after 12h of crosslinker addition, the amount of unreacted genipin in the samples is approximately 0.1 mM. Cells are added after 24 h of crosslinking.

Measurement of crosslinking degree

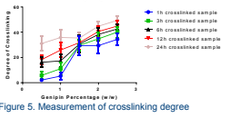

Figure 5. Measurement of crosslinking degree

The results indicate that extending the time of crosslinking results in higher amount of amine groups reacting with genipin and thus, higher crosslinking degree. Similarly, increasing genipin concentration results in higher crosslinking degree. The maximum crosslinking degree observed results from 2.5 % (w/w) genipin and 24 h of crosslinking and it is approximately 50 %. This crosslinking concentration allows for acceptable printability of the hydrogels.

Measurement of hydrolytic degradation rate

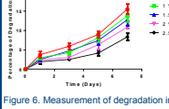

Figure 6. Measurement of degradation in PBS

The rate of hydrolytic degradation decreases as the percentage of genipin in the sample increases. A maximum weekly degradation observed was close to 15 % for the lowest amount of genipin while an average degradation of approximately 7 % was observed for 2.5 wt% genipin concentration.

Scanning Electron Microscopy characterisation

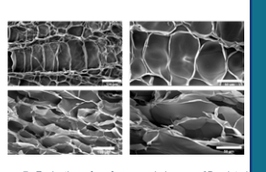

Figure 7. Evaluation of surface morphology on 3D printed gels crosslinked with 2.5 % (w/w) genipin using scanning electron microscopy, a. horizontal plane b. vertical plane

Scanning electron microscopy indicates the surface morphology of the gels. It can be concluded from SEM images that the 3D printing could be a useful tool to generate porous shapes and direct the cells in every part of the scaffold with desired design

Cell Response

Cell viability using live/dead staining

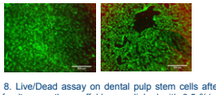

Figure 8. Live/Dead assay on dental pulp stem cells after 7 days of culture on the scaffolds crosslinked with 0.5 %(w/w) genipin (left) and 2.5 % (w/w) genipin (right)

The calcein AM/ ethidium homodimer-1 assay shows that cells are well attached to the gel surface with maximum genipin concentration used and are alive after 7 days of culture.

Cell viability measurement via Alamar Blue assay

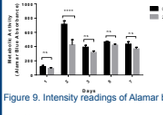

Figure 9. Intensity readings of Alamar blue assay

The Alamar blue assay measures the metabolic activity of the cells. It can be seen that the activity increases from day 1 to day 2 and remains relatively constant from day 3 up to day 7.

CONCLUSION

In general, these data show that chitosan can be effectively modified to be soluble in neutral pH and used as a base for production of scaffolds aimed at dental pulp regeneration. The hydrogels are 3D pintable which makes them favourable in producing custom made scaffolds and contains enough amount of unreacted genipin to promote odontoblastic differentiation. Additionally, assessment of cell attachment and cell viability prove that the material is biocompatible and can be used as a scaffold for biofabrication.

This work is part of KU Leuven
Contact: mehdi.salaramoli@kuleuven.be

B. INVITED LECTURES

R. Jacobs	07/01/19	Het gezicht tussen beeld en werkelijkheid: maatschappelijke uitdagingen Reeks: Lessen voor de XXIe eeuw	KU Leuven, Belgium
C. Politis	26/01/19	Actuele beleidsthema's in het vakgebied MKA, upgrade MKA	St. Niklaas, Belgium
C. Politis	27/04/19	LUTV aan de kust: 3D en verder	Casino Kursaal, Oostende, Belgium
C. Politis	26/02/19	Extracties onder locale anesthesie: durven en doen	VVT Stiemerheide Genk, Belgium
C. Politis	27/02/19	Schisis	UHasselt Faculty of Medicine, Belgium
R. Jacobs	07/03/19	Theory and Method of Science in Dentistry	Karolinska Institutet, Sweden
C. Politis	01/03/19	MRONJ grade III – treatment - systematic review	IAOFR, Barcelona, Spain
C. Politis	16/03/19	Onderkennen van andere infecties in de mond(focal infection) bij het goed behandelen van de oncologische patiënt/ endocarditis/orgaantransplantatie/nierin-suffiëntie Voorjaarssymposium: Dentes sani in corpore sano	NIVVT – KLTV – Hasselt, Belgium
C. Politis	16/03/19	Medische dentale interactie en genees-middelengebruik : wat richt ons (mis) gebruik van antibiotica aan "verderop"? Welke geneesmiddelen hebben hun invloed in de mond of zorgen voor een droge mond ? Welke geneesmiddelen beperken ons handelen, zodat overleg met de behandelend arts(huisarts) nodig is Voorjaarssymposium: Dentes sani in corpore sano	NIVVT – KLTV – Hasselt, Belgium
C. Politis	23/04/19	Lokale anesthesie voor tandartsen	Biznis Hotel Lokeren, NIVVT, Belgium
C. Politis	27/04/19	LUTV aan de kust: Mucosaletsels: diag-nostiek en behandeling	Casino Kursaal, Oostende, Belgium
R. Jacobs	27/04/19	LUTV aan de kust: 3D en verder	Casino Kursaal, Oostende, Belgium
C. Politis	27/04/19	LUTV aan de Kust: Mucosaletsels	Casino Kursaal, Oostende, Belgium
C. Politis	30/04/19	Iatrogene problemen in de mond	Hotel Stiemerheide Genk, NIVVT, Belgium
R. Jacobs	06/05/19	Modern Radiology in Dentistry	Karolinska Institutet, Sweden
A. Torres	16/05/19	Cone Beam CT in de endodontie: diagnose, behandelingsplanning en follow-up	KU Leuven Belgium

M. Vranckx	17/05/19	M3-Observatorium indicaties en complicaties bij de chirurgische verwijdering van wijsheidstanden	3de VVT MKA Congress Brussels, Belgium
R. Jacobs	23/05/19 24/05/19	2 days inter-university programme on the use of cone beam CT for dentomaxillofacial diagnostics	KU Leuven Belgium
K. Orhan	23/05/19	Role of cone-beam CT in head and neck Radiology	KU Leuven Belgium
R. Jacobs	23/05/19	Justification of CBCT Imaging	KU Leuven Belgium
R. Jacobs	23/05/19	The sedentexCT files	KU Leuven Belgium
R. Pauwels	23/05/19	CBCT Utopia? Creating and using the perfect CBCT device	KU Leuven Belgium
M. Bornstein R. Jacobs	2/06/19	Diagnostic challenges - case discussions	3D & beyond - Diagnostic Imaging in the Oral and Maxillofacial Region The Prince Philip Dental Hospital, Lecture Theatre I, Hong Kong
R. Jacobs	02/06/19	Novel low dose protocols and CBCT imaging: when & how?	3D & beyond - Diagnostic Imaging in the Oral and Maxillofacial Region The Prince Philip Dental Hospital, Lecture Theatre I, Hong Kong
C. Politis	28/06/19	Orthognatische heelkunde bij systeemaandoeningen	Ziekenhuis Rijnstate Arnhem, the Netherlands Afscheidscongres John Brouns Arnhem
R. Jacobs	01/07/19	Workshop cone beam CT in de praktijk: diagnostiek	KU Leuven Belgium
R. Jacobs	02/07/19	Workshop cone beam CT in de praktijk: basis	KU Leuven Belgium
R. Jacobs	17/08/19	The Challenging Dimensions of CBCT	XI Conabro, São Paolo-SP, Brazil
R. Jacobs	24/08/19	Imaging Beyond Imagination	IADMFR AAOMR congress Philadelphia, US
R. Jacobs	02/09/19 03/09/19	Two days course for radioprotection certification in dentistry	KU Leuven Belgium
R. Jacobs	06/09/19	Workshop cone beam CT in de praktijk: presentatie van eigen casus	KU Leuven Belgium
R. Jacobs	14/09/19	Osseoperception et aspect fonctionnel des implants dentaires	CNEPO, Paris, France
R. Jacobs	26/09/19	Klinische tips voor een stralend beeld	Postuniversitaire vorming Tandheelkunde Brugge, Belgium
C. Politis	05/10/19	Het gelaat tussen beeld en werkelijkheid: maatschappelijke uitdagingen	NiVVT Opatija, Croatia

R. Jacobs	04/10/19	CBCT: the art of scanning	Baden-Baden, Germany
C. Politis	04/10/19	Odontogene tumoren	NiVVT Opatija, Croatia
C. Politis	04/10/19	Goedaardige maar agressieve letsels	NiVVT Opatija, Croatia
C. Politis	05/10/19	Locale anesthesie in bijzondere omstandigheden	NiVVT Opatija, Croatia
C. Politis	11/10/19	MRONJ Grade III : treatment recommendations	IAOFR meeting, Haarlem, the Netherlands
R. Jacobs	19/10/19	Predicting failures: to see or not to see	11th congress BVOI-SBIO, Brussels, Belgium
C. Politis	24/10/19	Zwellingen in mond en gelaat	Tandartsenvereniging, Aalst, Belgium
C. Politis	05/11/19	Locale anesthesie in de tandheelkunde	VVT, Brussels, Belgium
R. Jacobs	15/11/19	Update Radiologie & Radioprotectie: Stralend door het leven	Goes Zeeland, the Netherlands
C. Politis	16/11/19	Kaakbeentumoren	KLTV Stiemerheide - Tandartsen, Belgium
R. Jacobs	05/12/19	3D CBDT imaging as a liason between research and clinic: potentials and limitaions	Karolinska Institutet, Sweden
C. Politis	05/12/19	Budget Financiële Middelen en MKA	LOK groep MKA, Belgium
R. Jacobs	12/12/19	Cone beam CT bekijken om een diagnose te stellen	KU Leuven Belgium
R. Jacobs	14/12/19	Radiologische diagnostiek en opvolging van MRONJ	KU Leuven Belgium
C. Politis	14/12/19	Pre- post-orthognathic orthodontic planning	Faculty of Dentistry, Ainshams University, Cairo, Egypt
C. Politis	14/12/19	Stability of orthognathic surgery	Faculty of Dentistry, Ainshams University, Cairo, Egypt
C. Politis	14/12/19	Complications of orthognathic Surgery	Faculty of Dentistry, Ainshams University, Cairo, Egypt
M. Bornstein	19/12/19	Diagnostic and therapeutic challenges in dental practice	KU Leuven, Belgium

5

3D lab

The 3D lab facility was officially introduced in autumn 2014, as an integrated part of the Department of Oral and Maxillofacial surgery at UZ Leuven. Together with the maxillofacial imaging center, the 3D-lab facility is fully integrated in the workflow of the daily clinic. The work started from simple segmentation and 3D printing of anatomical structures to 3D planning of complex surgeries. Currently, the 3D lab works in a multidisciplinary team that brings together the expertise of doctors, scientists, engineers to improve care for each individual patient. This closed cooperation enabled the surgeon and patient to maximize the benefits from 3D technology. The focus of our 3D lab is how to integrate 3D technologies in the clinical workflow to develop new medical treatment methods and to carry out clinical research in the field of oral and maxillofacial surgery. This involves computer assisted surgical planning, 3D printing of anatomic models and surgical templates, 3D metal printing of patient specific implant and image-guided surgery. Besides Oral and Maxillofacial surgery, the 3D lab is collaborating internally within UZ Leuven departments, and externally with 9th People Hospital Shanghai, 4th Military Medical University Xi'an China, Department of Mechanical Engineering Jiao Tong University, Karolinska University Hospital Stockholm, etc.

A. TEAM

Constantinus POLITIS

Constantinus Politis is Oral and Maxillofacial Surgeon. He is currently Professor and Chairperson of the Department of Oral and Maxillofacial Surgery at KU Leuven, Belgium. He is an invited Lecturer at the EHSAL in Brussels. He graduated at the Catholic University of Leuven in medicine (MD, summa cum laude), in dentistry (DDS, magna cum laude). He specialized in oral and maxillofacial surgery at the Catholic University of Leuven. Postgraduate training was additionally followed in Arnhem (Stoelinga), Aachen (Koberg), Copenhagen (Pindborg), Göteborg (Bränemark) and San Francisco (Marx). He also holds a master degree in management (MM) from the Applied Economic Scienes at the University of Hasselt and a master degree in Hospital Management (MHM) from the KU Leuven. He became a recognition as medical specialist in management of health care data and is now member of the National Council of Hospital Facilities. He is Secretary General of the Professional Union of Belgian Oral and Maxillofacial Surgeons. He is acknowledged trainer of OMFS trainees. He defended his doctor's thesis on the subject of complications of orthognathic surgery (PhD). His professional field of intrest is in orthognathic and orthodontic surgery and trigeminal nerve dysfunction. Clinical research projects include prevention and repair of iatrogenic trigeminal nerve injury.

Reinhilde JACOBS

Reinhilde Jacobs is dentist, Doctor in Dental Sciences (PhD University of Leuven), periodontologist (KU Leuven) and Master in Dental Radiology (University of London). She is full professor at the University of Leuven and visiting professor at Karolinksa Institutet, Stockholm, Sweden and the Dalian Medical University in China. R. Jacobs is heading the OMFS-IMPATH research group of the KU Leuven (omfsimpath.be), being responsible for research, education and clinical activities in the field of dentomaxillofacial radiology. She is Secretary General of the International Association of DentoMaxilloFacial Radiology, past president of the European Academy of DentoMaxilloFacial Radiology as well as DDS board member. She is section editor of Clinical Oral Investigations, International Journal of Oral Implantology, European Journal of Radiology and Oral Radiology meanwhile being editorial board member of Clinical Oral Implant Research, Journal of Oral Rehabilitation, Imaging Science in Dentistry, Oral Surgery Oral Medicine Oral Pathology Oral Radiology, Revista Odonto Ciencia and Archives of Oral research. She has received the D Collen Research Travel Award (1994), a postdoctoral fellowship of the European Commission (1994), the IADR Young Investigators Award (1998) and the Belgian Joachim Award in the Odontostomatology (1999). In 2013, she received a Dr Honoris Causa at the "Iuliu Hatieganu" University of Medicine and Pharmacy in Cluj-Napoca. She is involved in many multidisciplinary and interuniversity research collaborations, with a specific focus on oral implant physiology and imaging research. She has been actively participating in European projects (ref. Minosquare, Osteodent, SedentexCT, Dimitra). She is (co-)author of 5 books and more than 410 publications in peer-reviewed journals besides multiple invited lectures and publications in other journals or books. Web of Science (2018): h:62

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3D Lab

Eman SHAHEEN

Eman (Emmy) Shaheen was born on July 12th, 1982 in Giza, Egypt. She graduated with honor from the faculty of Computer Sciences and Information Technology (2003), Cairo University, Egypt where she also worked as a teaching assistant from 2003 till 2007 with major in Image Processing. Meanwhile, she obtained her Master's Degree in Video Processing (2007) from Cairo University. In 2008, she joined the team of Medical Physics where she finished with distinction her pre-doctoral studies about mammography and breast cancer (2009) in Biomedical Sciences at the KU Leuven, Belgium. She was granted a PhD scholarship from the OPTIMAM project (UK) in 2010 to develop, simulate and validate 3D models of breast lesions and tools to optimize the performance of breast tomosynthesis. She obtained her doctoral degree in 2014, KU Leuven, Belgium. In the same year, she started working in the department of Maxillofacial surgery, University hospitals Leuven (Belgium) with Prof. dr. Constantinus Politis as clinical engineer with focus on 3D planning of orthognathic surgeries. Next to the patient related work, she is part of the research group of the OMFS-IMPATH research group (KU Leuven, Belgium) where she supervises students, supports different research projects related to 3D printing and 3D simulations. She is also collaborating with Materialise (Leuven, Belgium) as consultant to improve the CMF software for orthognathic surgeries next to other research related projects.

Yi SUN

Yi Sun obtained his PhD in Biomedical Sciences, Master of Medical imaging and Bachelor in Electronic Engineering. Since 2007, he worked in the field of computer assistant surgery planning, with focus on oral and maxillofacial surgery. His main professional interest is template-based and image-guided solution for dental implant placement, design of digital splint for orthognathic surgery, orofacial reconstruction using fibular or DCIA flap. Currently he is responsible for the 3D surgical simulation team in the department of oral and maxillofacial surgery (UZ Leuven). His current research interest are: design of patient specific implant, tissue engineering by using 3D printed titanium scaffold and development of image guided surgical simulation system (navigation system).

Sohaib SHUJAAT

Sohaib Shujaat was born on November 29th, 1985. He achieved his degree in Bachelor of Dental Surgery (B.D.S) from Lahore Medical and Dental College, Lahore, Pakistan (2004 - 2008). After his graduation, he worked as an Internee in all clinical departments of dentistry at Lahore Medical and Dental College, Lahore, Pakistan (2009-2010). He obtained his “Master of Science” (MSc. Dent Sci) degree in Oral and Maxillofacial Surgery (360 credits) with merit from Glasgow Dental School and Hospital, University of Glasgow, Glasgow, United Kingdom, under the guidance of Professor Ashraf Ayoub (2010-2012). During his Masters, he worked on 4-Dimensional facial soft tissue changes in oncology patients. From March 2013 till September 2017, he worked as a Lecturer in the Department of Oral and Maxillofacial Surgery and Course Director of Internal Medicine and Comprehensive Patient Management (CPM) for dental students at Imam Abdul Rahman Bin Faisal University (Formerly University of Dammam), Dammam, Kingdom of Saudi Arabia. At the same instance, he served as a Specialist (Registrar) in the Department of Oral and Maxillofacial Surgery, King Fahd Hospital of the University. Currently he is a PhD candidate (OMFS-IMPATH research group, KU Leuven) with Professor Reinhilde Jacobs as his promotor. His research topic for PhD is related to three-dimensional analysis of hard and soft tissue changes in orthognathic surgery patients and to develop a start of art predictive model for treatment planning.

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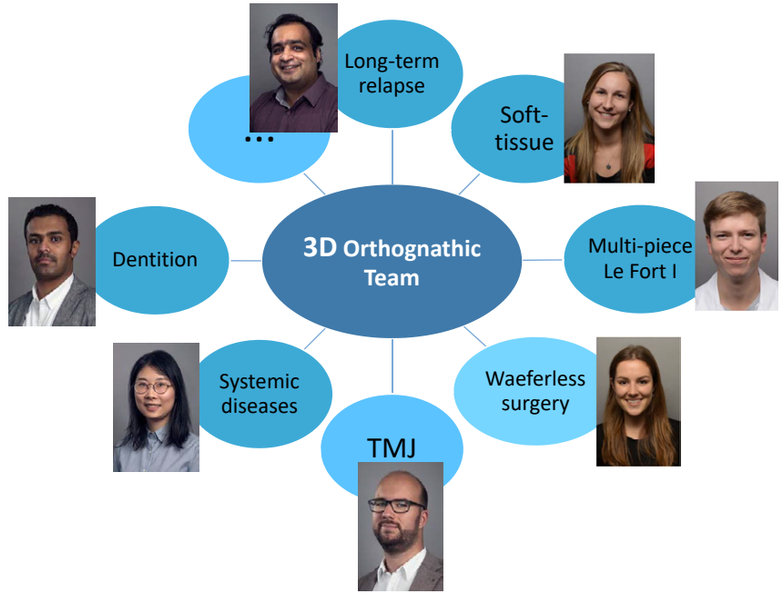
3D Lab

B. PROJECTS

- Long-term bone relapse: maxillary relapse and mandibular remodeling
- Soft tissue changes after orthognathic surgery
- Multiple pieces Le Fort I accuracy and stability
- Waferless surgery: new technologies to improve Le Fort I surgery
- Condylar changes after orthognathic surgery
- Systemic diseases related to orthognathic surgery
- Dental changes evaluation in 3D after orthognathic surgery



C. PUBLICATIONS

INTERNATIONAL PEER-REVIEWED PUBLICATIONS

Chen, X-J., Hu, J-L., Zhou, Q-L., Politis, C., Sun, Y. (2019). An automatic optimization method for minimizing supporting structures in additive manufacturing. *ADVANCES IN MANUFACTURING, 8* (1), 49-58.

Verhelst, P-J., Shaheen, E., Vasconcelos, K.D F., Van der Cruyssen, F., Shujaat, S., Coudyzer, W., Salmon, B., Swennen, G., Politis, C., Jacobs, R. (2019). Validation of a 3D CBCT-based protocol for the follow-up of mandibular condyle remodeling. *DENTOMAXILLOFACIAL RADIOLOGY, 49* (3), Art. No. ARTN 20190364.

Willaert, R., Nevens, D., Laenen, A., Batstone, M., Politis, C., Nuyts, S. (2019). Does intensity-modulated radiation therapy lower the risk of osteoradionecrosis of the jaw? A long-term comparative analysis. *INTERNATIONAL JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY, 48* (11), 1387-1393.

Geusens, J., Sun, Y., Luebbers, H-T., Bila, M., Darche, V., Politis, C. (2019). Accuracy of Computer-Aided Design/Computer-Aided Manufacturing-Assisted Mandibular Reconstruction With a Fibula Free Flap. *JOURNAL OF CRANIOFACIAL SURGERY, 30* (8), 2319-2323.

Goormans, F., Sun, Y., Bila, M., Schoenaers, J., Geusens, J., Luebbers, H-T., Coucke, W., Politis, C. (2019). Accuracy of computer-assisted mandibular reconstructions with free fibula flap: Results of a single-center series. *ORAL ONCOLOGY, 97, 69-75*.

Huang, Y., Li, Z., Van Dessel, J., Salmon, B., Huang, B., Lambrichts, I., Politis, C., Jacobs, R. (2019). Effect of platelet-rich plasma on peri-implant trabecular bone volume and architecture: A preclinical micro-CT study in beagle dogs. *CLINICAL ORAL IMPLANTS RESEARCH. 30* (12), 1190-1199

Piccart, F., Dormaar, J.T., Coropciuc, R., Schoenaers, J., Bila, M., Politis, C. (2019). Dog Bite Injuries in the Head and Neck Region: A 20-Year Review. *CRANIOMAXILLOFACIAL TRAUMA & RECONSTRUCTION, 12* (3), 199-204.

Verhelst, P-J., Dons, F., Van Bever, P-J., Schoenaers, J., Nanhekhan, L., Politis, C. (2019). Fibula Free Flap in Head and Neck Reconstruction: Identifying Risk Factors for Flap Failure and Analysis of Postoperative Complications in a Low Volume Setting. *CRANIOMAXILLOFACIAL TRAUMA & RECONSTRUCTION, 12* (3), 183-192.

Shujaat, S., Jacobs, R., Shaheen, E., Michiels, S., Politis, C. (2019). Three-dimensional treatment planning and treatment protocol in embryonal rhabdomyosarcoma and orthognathic surgery: A case report. *Oral and Maxillofacial Surgery Cases, 5* (3), Art.No. 100111.

Al-Rimawi, A., Shaheen, E., Albdour, E.A., Shujaat, S., Politis, C., Jacobs, R. (2019). Trueness of cone beam computed tomography versus intra-oral scanner derived three-dimensional digital models: An ex vivo study. *CLINICAL ORAL IMPLANTS RESEARCH, 30* (6), 498-504.

Torres, A., Shaheen, E., Lambrechts, P., Politis, C., Jacobs, R. (2019). Microguided Endodontics: a case report of a maxillary lateral incisor with pulp canal obliteration and apical periodontitis. *Int Endod J, 52* (4), 540-549.

INTERNATIONAL PEER-REVIEWED PUBLICATIONS

EzEldeen, M., Wyatt, J., Al-Rimawi, A., Coucke, W., Shaheen, E., Lambrichts, I., Willems, G., Politis, C., Jacobs, R. (2019). Use of CBCT Guidance for Tooth Autotransplantation in Children. *JOURNAL OF DENTAL RESEARCH, 98* (4), 406-413.

Willaert, R., Opdenakker, Y., Sun, Y., Politis, C., Vermeersch, H. (2019). New Technologies in Rhinoplasty: A Comprehensive Workflow for Computer-assisted Planning and Execution. *PLASTIC AND RECONSTRUCTIVE SURGERY-GLOBAL OPEN, 7* (3), Art.No. ARTN e2121.

Adisa, A.O., Osayomi, T., Effiom, O.A., Kolude, B., Lawal, A.O., Soyele, O.O., Omitola, O.G., Babajide, A., Okiti, R.O., Saiki, T.E., Fomete, B., Ibikunle, A.A., Okwuosa, C.U., Olajide, M.A., Ladeji, A.M., Adebiyi, K., Emmanuel, M., Lawal, H.S., Uwadia, E., Fakuade, B.O., Abdullahi, Y., Politis, C., Agbajel, J.O. (2019). A geographical analysis of ethnic distribution of jaw ameloblastoma in Nigerians. *AFRICAN HEALTH SCIENCES, 19* (1), 1677-1686.

Qin, C., Cao, Z., Fan, S., Wu, Y., Sun, Y., Politis, C., Wang, C., Chen, X. (2019). An oral and maxillofacial navigation system for implant placement with automatic identification of fiducial points. *INTERNATIONAL JOURNAL OF COMPUTER ASSISTED RADIOLOGY AND SURGERY, 14* (2), 281-289.

Al-Rimawi, A., EzEldeen, M., Schneider, D., Politis, C., Jacobs, R. (2019). 3D Printed Temporary Veneer Restoring Autotransplanted Teeth in Children: Design and Concept Validation Ex Vivo. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH, 16* (3), Art.No. ARTN 496.

Shaheen, E., Shujaat, S., Saeed, T., Jacobs, R., Politis, C. (2019). Three-dimensional planning accuracy and follow-up protocol in orthognathic surgery: a validation study. *INTERNATIONAL JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY, 48* (1), 71-76.

Awarun, B., Blok, J., Pauwels, R., Politis, C., Jacobs, R. (2019). Three-dimensional imaging methods to quantify soft and hard tissues change after cleft-related treatment during growth in patients with cleft lip and/or cleft palate: a systematic review. *DENTOMAXILLOFACIAL RADIOLOGY, 48* (2), Art.No. ARTN 20180084.

Politis, C., Van de Vyvere, G., Agbaje, J.O. (2019). Condylar Resorption After Orthognathic Surgery. *JOURNAL OF CRANIOFACIAL SURGERY, 30* (1), 169-174.

Smeets, M., Da Costa Senior, O., Eman, S., Politis, C. (2019). A retrospective analysis of the complication rate after SARPE in 111 cases, and its relationship to patient age at surgery. *J CRANIOMAXILLOFAC SURG*. Volume 48, Issue 5, May 2020, Pages 467-471.

Vandeput, A-S., Verhelst, P-J., Jacobs, R., Shaheen, E., Swennen, G., Politis, C. (2019). Condylar changes after orthognathic surgery for class III dentofacial deformity: a systematic review. *INT J ORAL MAXILLOFAC SURG, 48* (2), 193-202.

Celikten, B., Jacobs, R., De Faria Vasconcelos, K., Huang, Y., Shaheen, E., Nicolielo, L., Orhan, K. (2019). Comparative evaluation of Cone Beam CT and Micro CT on volumetric distortion artefactin human teeth filled with bioceramic sealers. *CLINICAL ORAL INVESTIGATIONS*, 3267-3273.

5
3D Lab

ORAL PRESENTATIONS

Denoiseux B, Shaheen E, Dormaar T, Coropciuc R, Bila M, Legrand P, Willaert R, Politis C (2019)
TMJ function and neocondylar remodelling after vascularised free fibula flap reconstruction
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Verhelst P, Shaheen E, Shujaat S, Swennen G, Jacobs R, Politis C (2019)
TMJ remodelling analysis protocol: a validated registration and segmentation workflow
KBVSMFH meeting, 16 March 2019, Brussels, Belgium

Vitosyte M, Gendviliene I, Simoliunas E, Alksne M, Rekstyte S, Jacobs R, Bukelskiene V, Rutkunas V (2019)
Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon (Poster-CI-032)

Sun Y, Hu X, Du Y, Vanrumste B, Politis C (2019)
Development of an application to evaluate the maxilla positioning after computer assisted orthognathic surgery CARS 2019 Computer Assisted Radiology and Surgery, 18-21 June 2019, Le Couvent des Jacobins, Rennes, France

Van der Cruyssen F, de Faria Vasconcelos K, Verhelst PJ, Shujaat S, Delsupehe AM, Hauben E, Orhan K, Politis C, Jacobs R (2019)
Metal debris after dental implant placement: A proof-of-concept study in fresh frozen cadavers using MRI and histological analysis
IADMFR 2019, 26-29 August 2019, Philadelphia, USA Oral Presentation

van Luijn R, Baan F, Shaheen E, Bergé S, Politis C, Maal T, Xi T (2019)
Three-dimensional analysis of condylar remodelling and skeletal relapse following LeFort-I osteotomy
KBVSMFH meeting, 16 November 2019, Brussels, Belgium

POSTER PRESENTATIONS

Vitosyte M, Gendviliene I, Simoliunas E, Alksne M, Rekstyte S, Jacobs R, Bukelskiene V, Rutkunas V (2019)
Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation
EAO 28th annual scientific meeting, 26-28 September, 2019, Lisbon

P-CI-032

CLINICAL INNOVATIONS

Effect of 3D printed PLA/HAP and their decellularized scaffolds on new bone formation

Vitosyte Milda[1], Gendviliene I[1], Simoliunas E[2], Alksne M[2], Rekstyte S[3], Reinhilde J[4], Bukelskiene V[2], Rutkunas V[1]

1 Institute of Odontology, Faculty of Medicine, Vilnius University, Lithuania

2 Department of Biological Models, Institute of Biochemistry, Life Sciences Center, Vilnius University, Lithuania

3 Laser Research Center, Department of Quantum Electronics, Faculty of Physics, Vilnius University, Lithuania

4 Omfs Impath Research Group, Department of Imaging and Pathology, Faculty of Medicine, University of Leuven and Department of Oral and Maxillofacial Surgery, University Hospitals Leuven, Leuven, Belgium

Abstract

More than 2 million bone transplant procedures are carried out each year, making bone the second most commonly transplanted tissue in the world. 3D structured and individually fabricated bone scaffolds are promising treatment strategy. Cell-laid mineralised extracellular matrix (ECM) was shown to be potential for improving the cellular responses and drive osteogenesis of stem cells.

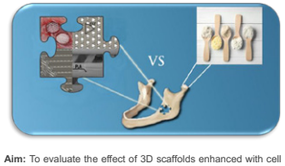
There were 6 groups in the study (n=8/gp): negative control, Geistlich Bio-Oss®, pure polylactic acid (PLA), PLA/hydroxyapatite (HAP), PLA/HAP cellularized with dental pulp stem cells (PLA/HAP cells) and their decellularized scaffolds (PLA/HAP ECM). Scaffolds were fabricated using FFF 3D printer. The filament for printing was produced by Filabot extruder system. Dental pulp stem cells were isolated from dental pulp of incisors of adult Wistar rats. All materials were implanted in critical-size Wistar rat's calvarial defect model in vivo to evaluate materials' osteoregenerative potential. The defects were evaluated by micro-computed tomography and histological analysis eight weeks after surgery. All procedures were approved by License of Animal Research Ethics Committee No G2-40, 2016-03-18. Shapiro-Wilk test was used to test for normality in groups. For normally distributed data parametric statistics data analysis methods were used and for non-normally distributed data - nonparametric.

Histometric measurements showed that 3D printed PLA scaffolds had more pronounced inflammation reaction during biodegradation, however scaffolds with HAP showed appropriate inflammatory responses. Micro-CT results showed no significant difference between different scaffold groups (p>0.05), however PLA scaffolds displayed poorer results (2.63±1.28 mm^3) in new bone formation. Nevertheless, decellularized PLA/HAP scaffolds had more pronounced osteoregenerative potential (4.05±1.48 mm^3) compared to other experimental groups, close to Geistlich Bio-Oss® results (4.04±0.44 mm^3). There was a significant difference between the (p <0.05) gender groups in PLA and PLA/HAP cells groups.

We concluded that 3D printed scaffolds with HAP improve biodegradation. PLA/HAP and PLA/HAP ECM scaffolds have the potential of being used in bone tissue engineering.

Background and Aim

The concept of bone regeneration is described as a process by which a bone defect is filled with a donor bone tissue or a bone substitute [1]. Existing substitutes in clinical practice do not meet all the criteria required for an ideal scaffold, so new materials are being sought. Thus, 3D structured and individually fabricated bone scaffolds, enhanced with extracellular matrix (ECM) or its specific proteins are promising treatment strategy [2], which would allow to shorten the time and lower the extent of the surgery.



Aim: To evaluate the effect of 3D scaffolds enhanced with cell produced ECM on the formation of new bone *in vivo* and to compare it with the Bio-oss.

Methods and Materials

There were 6 groups in the study (n=8/gp): negative control, Bio-oss, PLA, PLA/HAP, PLA/HAP cells and PLA/HAP ECM scaffolds.

Raw materials used in this study were polylactic acid (PLA) (STP Chem Solutions Co., Ltd., Thailand) – particle size of 100 – 800 µm and a molecular weight of 42 – 700 (g/mol) µm, hydroxyapatite (Hap) (Riga Technical University, Latvia) - particle size 50 µm and Geistlich Bio-Oss® (Geistlisch Pharmaceutical, Wolhusen, Switzerland) particles. The composite filament for printing was produced by Filabot Original filament extruder system (Filabot HQ, Barre VT, USA) from the PLA and HAP powders at the ratio of 9:1 (w/w).

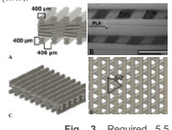


Fig. 2. A – Scaffold design from STL: pore size of 450 µm, porosity 58 %. B - top side view done with SEM. C – the scaffold from side. D – the scaffold from top side, micro-logs are rotated 60o angle;

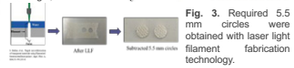


Fig. 3. Required 5.5 mm circles were obtained with laser light filament fabrication technology.

Sterilization of scaffolds was done with ethylene oxide gas. The aeration lasted 4 days.

All procedures were approved by License of Animal Research Ethics Committee No G2-40, 2016-03-18.

Dental pulp stem cells (DPSC) (Fig. 4) were isolated from dental pulp of incisors of adult Wistar rats and purified with magnetic beads coated with antibodies against cell surface marker CD44. Cells were seeded onto the prepared PLA/HAP scaffolds (density 10,000 cell/cm^2) and grown in osteoinductive medium. The medium was changed every 3 days up to 21 days.

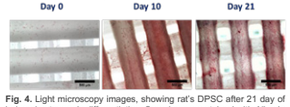


Fig. 4. Light microscopy images, showing rat's DPSC after 21 day of induced osteogenic differentiation. Samples were stained with Alizarin Red S.

The DPSC were removed from the scaffolds after 21 days of osteogenic differentiation, leaving the resulting extracellular matrix.

Twenty-four 3 months old Wistar rats (weight ~300 g) were used in this study. The sample size counted with Gpower software (one- way ANOVA test with a priori analysis: α – 0.05, power 0.8, effect size f – 0.75). The animals were divided randomly, there were 4 female and 4 male animals in each group. During the whole experimental period the rats were kept in a monitored environment (21°C, 12:12 light cycle) and received a standard diet and water ad libitum.

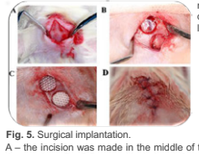


Fig. 5. Surgical implantation.
A – the incision was made in the middle of the posterior part of the cranium. B - 5.5 mm critical size defects (2 per animal) C - scaffolds placed as inlay-onlay grafts. D – sutured flap.

Results

Histometric measurements showed that 3D printed PLA. had more pronounced inflammation during biodegradation but scaffolds with HAP showed appropriate inflammatory responses.

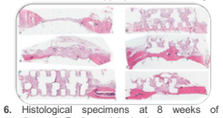
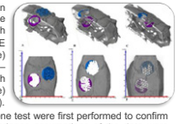


Fig. 6. Histological specimens at 8 weeks of healing (Hematoxylin and Eosin staining). Arrows show new bone edges. A – Negative control; B – Bio-Oss particles. C – PLA group; D – PLA/HAP group; E – PLA/HAP cells; F –PLA/HAP ECM scaffolds.

Fig. 7. New bone formation *in vivo*. A – D Negative control (blue) and Geistlich Bio-Oss® (purple). B, E Pure PLA scaffolds (blue) and PLA/HAP (purple). C – F PLA/HAP cellularized with dental pulp stem cells (blue) and ECM scaffolds (purple).



Shapiro-Wilk test and Levene test were first performed to confirm the normality and equal variance assumptions of the data were not violated. One-way analysis of variance (ANOVA) was performed to analyze BV. Each group was compared using the Tukey post hoc test when a significant result was presented. The level of significance was set to 0.05.

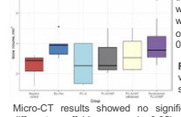
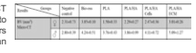


Fig. 8. Bone volume amount of the six different groups.

Micro-CT results showed no significant difference between different scaffold groups (p>0.05), however PLA scaffolds (2.63±1.27 mm^3) displayed poorer results in new bone formation. Nevertheless, decellularized PLA/HAP scaffolds (4.05±1.48 mm^3) had more pronounced osteoregenerative potential and cellular ingrowth compered to other experimental groups.

Table 1. Micro-CT results according to gender. All parameters are presented as mean ± single SD.



Conclusion

Within the limits of this study we concluded that 3D printed PLA/HAP and decellularized scaffolds have potential applications in bone tissue engineering, especially combined with the decellularization technique. Further research is needed to analyze the effect of decellularization and HAP for new bone regeneration *in vitro* and *in vivo*.

References

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Presented at EAO CONGRESS Lisbon 2019

INVITED LECTURES

C. Politis H. Peeters	18/02/19	Het gezicht tussen beeld en werkelijkheid: maatschappelijke uitdagingen Reeks: Lessen voor de XXIe eeuw	KU Leuven, Belgium
C. Politis	27/02/19	Schisis	UHasselt Faculty of Medicine, Belgium
R. Jacobs	27/04/19	LUTV aan de kust: 3D en verder	Casino Kursaal, Oostende, Belgium"
C. Politis	28/06/19	Orthognatische heelkunde bij systeem-aandoeningen	Ziekenhuis Rijnstate Arnhem, the Netherlands Afscheidscongres John Brouns Arnhem
R. Jacobs	17/08/19	The Challenging Dimensions of CBCT	XI Conabro, São Paolo-SP, Brazil
R. Jacobs	24/08/19	Imaging Beyond Imagination	IADMFR AAOMR congress Philadelphia, US
R. Jacobs	04/10/19	CBCT: the art of scanning	Baden-Baden, Germany
C. Politis	05/10/19	Het gelaat tussen beeld en werkelijkheid: maatschappelijke uitdagingen	NiVVT Opatija, Croatia
C. Politis	14/12/19	Pre- post-orthognathic orthodontic planning	Faculty of Dentistry, Ainshams University, Cairo, Egypt
C. Politis	14/12/19	Stability of orthognathic surgery	Faculty of Dentistry, Ainshams University, Cairo, Egypt
C. Politis	14/12/19	Complications of orthognathic Surgery	Faculty of Dentistry, Ainshams University, Cairo, Egypt
E. Shaheen	14/12/19	Basics and advances in virtual planning of orthognathic surgery	Faculty of Dentistry, Ainshams University, Cairo, Egypt
E. Shaheen	18/12/19	Virtual 3D planning workshop	Faculty of Dentistry, Ainshams University, Cairo, Egypt

University of Leuven
Department of Imaging & Pathology
OMFS IMPATH Research Group
Kapucijnenvoer 7 blok a - box 7001
3000 Leuven
BELGIUM
+32 16 33 24 52
+32 16 33 27 48
www.omfsimpath.be

v.u. Constantinus Politis - Reinhilde Jacobs - Gabriela Casteels