Institute of Anatomy

Chair of Functional and Clinical Anatomy

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Research focus
- Temperature sensitive Transient Receptor Potential channels at the ocular surface
- Pathomechanisms of the Meibom Gland Dysfunction
- Influence of Osteopontin (OPN) to neurodegenerative changes in the eye
- HistoDigital® and cinematic rendering
- The role of effector T-cells during experimental autoimmune encephalomyelitis
- Surfactant proteins
- Test anxiety among medical and dental students
- Urea transporters at the ocular surface and within the lacrimal system
- Ocular tissue interactions of a refractive UV femtosecond laser

Structure of the Chair

Professorships: 2
Personnel: 26
- Doctors (of Medicine): 3
- Scientists: 11 (thereof funded externally: 3)
- Graduate students: 25

Special structural features
- Lecture room for lessons in histology with 160 microscopes
- Electron microscopy unit

Both chairs collegially lead the Institute of Anatomy.

Research

For many years, the Chair of Functional and Clinical Anatomy has been working on scientific topics about the development and diseases of the eye (basic research). In addition, topics about the upper and lower respiratory tract, joints and medical education are part of the research record of the Chair.

Temperature sensitive Transient Receptor Potential channels at the ocular surface
PI: PD Dr. F. Garreis, Prof. Dr. F. Paulsen
The Transient Receptor Potential (TRP) proteins belong to the group of membrane-bound, ligand-gated cation channels. They serve as multiple sensors. A functional subgroup of the TRP family is the temperature-sensitive TRP channels (thermo TRP). They primarily serve the perception of temperature changes, but are also activated by different physical stimuli (pH value, mechanical stimuli) and by a number of different endogens and exogenous substances, e.g. capsaicin (chillies). Here, the expression of thermo-TRP is not limited to neurons (fibers), but is also common in non-neuronal cells. TRP channels play a significant role in maintaining the intracellular calcium homeostasis as well as in different physiological and pathophysiological cellular processes. In cooperation with PD Dr. S. Mergler (Charité, Berlin), we were able for the first time to demonstrate the functional expression of individual thermo-TRP subtypes in various cells of the human eye. Current research projects are examining the functional expression and regulation of the thermo-TRP channels and their interaction with growth factors and their receptors in different inflammatory and non-inflammatory diseases at the ocular surface.

Pathomechanisms of the Meibom Gland Dysfunction
PI: Prof. Dr. F. Paulsen, PD Dr. F. Garreis
Meibomian gland dysfunction (MGD), a term used to describe a diffuse abnormality of the meibomian glands, which are specialized sebaceous glands in the eyelids, is considered the most common cause of dry eye syndrome (DES), a disease with an estimated prevalence of 12 million people alone in Germany. It is currently thought that MGD is caused primarily by terminal duct obstruction due to hyperkeratinization of the ductal epithelium and an increased viscosity of meibum. However, the molecular mechanisms that underlie this process are unclear. We investigate the influence of different hormones on the keratinization process, the importance of the formation of adhesion contacts (Desmosomes) for the maturation process of the meibozytes and the influence of various proteins which contribute to a hyperkeratinization of the ducts and the increasing viscosity of the meibum. Our goal is to gain deeper insights into the pathophysiology of MGD. To this end, experiments will be carried out in an established mouse model of the DED as well as in two and three-dimensional cultivation models with human meibomian epithelial cells. This serves to determine factors that could possibly be used as therapeutic treatment options in MGD.

Influence of Osteopontin (OPN) to neurodegenerative changes in the eye
PI: Prof. Dr. M. Scholz, Prof. Dr. F. Paulsen, PD Dr. F. Garreis
In close cooperation with the Department of Ophthalmology, we performed morphological, molecular, and electrophysiological studies on the structure and function of the retina of the osteopontin knockout (OPN-/-) mouse. Retinal ganglion cells (RGCs) are the only neuronal cell type of the retina, which are able to express OPN under physiological conditions. In different experimental approaches, the morphological and physiological characterization of OPN-/ mouse was performed. The results of validated analyses will give evidence about the effects due to the absence (OPN-/-) or pathological overexpression of OPN (DBA/2J) with regard to neurodegenerative changes within the eye.

HistoDigital® and cinematic rendering
PI: Prof. Dr. M. Scholz, Prof. Dr. F. Paulsen
In close cooperation with Chimaera GmbH (Erlangen), HiD, a digital application is being developed that enables the user to create a digital volumetric reconstruction of the anatomical tissue structures from the data sets of histological section series. The goal is the future use of this application in research and teaching.
The cinematic rendering (CR) technology was originally developed by Dr. K. Engel (Siemens Healthineers) as a medical image visualization technology. It enables the generation of 3D photorealistic images of the human body. Existing imaging methods (CT, MRT etc.) provide the raw data for the volumetric representations. In direct cooperation with Siemens, this technology is to be made applicable in order to produce amazing images for teaching and learning the human anatomy.

The role of effector T-cells during experimental autoimmune encephalomyelitis
PI: Prof. Dr. C. Flügel-Koch, Prof. Dr. F. Paulsen
The central nervous system (CNS) that includes brain, spinal cord and eye has an exceptional and privileged immunological position due to

the fact that cells and factors of the immune system are incapable of easily penetrating into the nervous tissue from the blood.
In autoimmune diseases like multiple sclerosis (MS), this immunological privilege is suspended, leading to structural and functional pathological alterations.
In collaboration with Prof. A. Flügel from the Institute for Neuroimmunology and Multiple Sclerosis Research of the University of Göttingen, we study the behavior of pathogenic effector T cells in various rodent models of MS, in particular of experimental autoimmune encephalomyelitis (EAE). Our focus is on how these pathogenic T cells can enter the CNS and on the morphological pathological changes they bring about.

Surfactant proteins

PI: Dr. M. Schicht, Prof. Dr. L. Bräuer, Prof. Dr. F. Paulsen
The ongoing and continuous characterization of surfactant proteins (in particular surfactant associated 3 (SFTA3), recently described by us) shows the immense spectrum of activity of these proteins in the human organism. Within recent experiments, we were able to demonstrate that SFTA3 has stimulating effects on the activity of alveolar macrophages and in addition leads to an increased phagocytic activity. These and other studies suggest that SFTA3 may play an important role during inflammatory processes within the lung. The previously described properties make SFTA3 a potential candidate for the diagnosis, prevention, and possibly treatment of lung diseases.

Test anxiety among medical and dental students

PI: PD Dr. C.M. Hammer, Prof. Dr. M. Scholz, Prof. Dr. F. Paulsen
Test anxiety is a common phenomenon among students, often affecting academic performance. To date, there is a scarcity of valid data concerning prevalence, severity, and types of test anxiety among German medical and dental students. Hence, there are only few reports on effective therapeutic or preventive strategies tackling the problem of test anxiety. Repetitive application of a validated psychological test anxiety questionnaire yielded more than 50% of the evaluated students showing pronounced signs of test anxiety. Moreover, it revealed medical hypnosis as a potent intervention to significantly alleviate test anxiety. Medical hypnosis was proved especially effective in the amelioration of the test anxiety subtype “lack of confidence”.

Urea transporters at the ocular surface and within the lacrimal system

PI: PD Dr. C.M. Hammer, Prof. Dr. F. Paulsen
Urea is an integral component of the tear film. Patients suffering from dry eye disease (keratoconjunctivitis sicca) show reduced urea levels within their tear fluid. The urea transporters UT-A and UT-B may be of significance in this respect, because they have not only been detected in kidney, but also in a variety of other tissues. The present study demonstrated the expression of UT-A and UT-B in the glands of the lacrimal system (lacrimal gland, Meibomian glands, Moll glands, Zeiss glands) and in the corneal epithelium of humans, pigs, and mice. Future research is aimed at the question whether changes in the expression of urea transporters are linked to the pathomechanism of dry eye disease.

Ocular tissue interactions of a refractive UV femtosecond laser

PI: Dr. C.M. Hammer, Prof. Dr. F. Paulsen
The already established cooperation with the Department of Ophthalmology and WaveLight GmbH was further intensified with regard to this project. Intraoperative gas production and interface quality after extraction of refractive lenticules from porcine eyes was examined and compared between the novel UV-laser and an infrared laser system already established for this procedure (VisuMax). Histological investigations demonstrated the superiority of the UV laser as far as gas production is concerned. Since the UV laser produces significantly less gas than the VisuMax system, it may also have the potential to achieve a much higher degree of surgical precision. Comparative scanning electron microscopical examinations showed similar interface properties with respect to surface smoothness and regularity. This is supportive of the assumption that the UV laser may be as well suited for refractive lenticule extractions as the clinical VisuMax system.

Teaching

The Chair of Functional and Clinical Anatomy is involved in the teaching of macroscopic anatomy at the Institute of Anatomy. Each semester a variety of elective subjects can be offered for medical and dental students in the preclinical semesters. Virtual courses of histology, macroscopy, and embryology are offered in cooperation with the virtual university of Bavaria (vhb).
Moreover, Bachelor’s and Master’s theses as well as MD and PhD are supervised.

Selected publications

Asano N, Hampel U, Garreis F, Schröder A, Schicht M, Hammer C, Paulsen F. Differentiation patterns of immortalized human meibomian gland epithelial cells in three-dimensional culture. Invest Ophthalmol Vis Sci 2018, 59:1343-1353

Hampel U, Garreis F, Burgermeister F, Eßel N, Paulsen F. Effect of intermittent shear stress on corneal epihelial cells using a in vitro flow culture model. Ocular Surf 2018, 16:341-351

Binder J, Krautz C, Engel K, Grützmann R, Fellner FA, Burger PHM, Scholz M. Leveraging medical imaging for medical education - A cinematic rendering-featured lecture. Ann Anat. 2018, Dec 23;222:159-165

Yu D, Yogesh Y, Chen G, Ghio A, Dang H, Burns K, Wang Y, Davis R, Randell S, Esther C, Paulsen F, Boucher RC. Loss of ßENaC function in Meibomian glands produces prseudohypoaldosteronism 1-like sex-biased ocular disease in mice. Am J Pathol 2018, 188:95-110

Schicht M, Garreis F, Hartjen N, Beileke S, Jacobi C, Sahin A, Holland D, Schröder H, Hammer CM Paulsen F, Bräuer L. SFTA3 – a novel surfactant protein of the ocular surface and its role in corneal wound healing and tear film surface tension. Sci Rep 2018, 8:9791

Scholz M, Burger P, Paulsen F. Sollen, können – und aushalten. Auswahl von Medizinstudierenden. Deutsch Ärztebl 2018, 115:A1799-1800

International cooperations

Prof. S. Weber, Medical School, State University São Paulo, UNESP, Botucatu: Brazil

Prof. D. Zoukhri, Tufts University School of Dental Medicine, Boston: USA

Dr. Dr. P. Burger, Psychiatrische Universitätsklinik Zurich: Switzerland

Dr. J. Ali, FAU Humboldt Fellow, Hyderabad: India

N. Asano, PhD Santen Pharmaceuticals. Co. Ltd: Japan

Prof. R.C. Boucher, MD, Marsico Lung Institute/UNC Fibrosis Center, Chapel Hill NC: USA