

# Department of Surgery

## Division of Pediatric Surgery

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### Head of Division

Prof. Dr. med. Robert Grützmann, MBA  
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### Research focus

- Preliminary results of enteral surface stimulation (ESS) in constipation in children and adolescents
- Device-support in ESCR of congenital chest wall deformities
- Protective negative pressure wound therapy in open correction of chest wall deformities
- Quantification of costal arch eversion in congenital pectus excavatum (PE)

### Structure of the Division

Professorship: 0  
Personnel: 12  
• Doctors (of Medicine): 8  
• Graduate students: 3

### Clinical focus areas

- Surgical treatment of congenital malformations, especially in the thoracic, abdominal, skeletal, and integumental areas in newborn and children
- Surgical treatment of chest deformities (pectus excavatum and carinatum)
- Special techniques to resolve recurrences after chest wall repair
- Minimally invasive pediatric surgery (laparoscopy, thoracoscopy, rendez-vous procedures)

### Research

#### Preliminary results of enteral surface stimulation (ESS) in constipation in children and adolescents

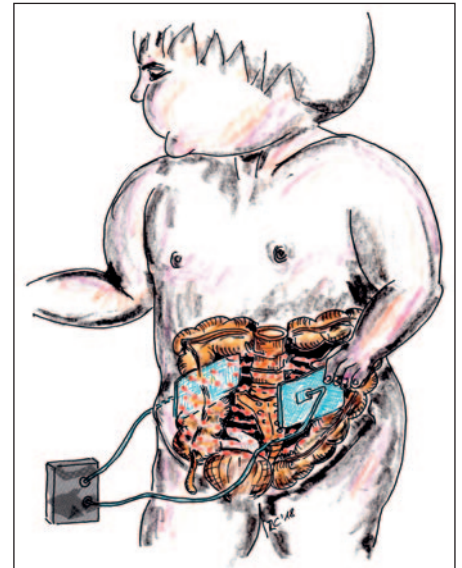
PI: Dr. M. Besendörfer

Constipation is a common problem in children and adolescents. Short-term and mild episodes can mostly be treated effectively. In contrast,

a long-term course of constipation can frequently not be treated sufficiently. Since curative therapies are rarely available, treatment algorithm is usually the same, irrespectively of etiology. It is based on a multi-level algorithm which is stepwise escalated until the respective treatment phase shows effects. In terms of chronic constipation, even the highest treatment phase is often not sufficient. Hence, it seems advisable to present a new therapy option, which complements and extends the so far existing therapies. Enteral Surface Stimulation (ESS) therapy aims at supporting intestinal activity and improving constipation through exposing the abdomen to local electromagnetic fields. This therapy principle, known as neuromodulation, was first introduced by E. Tanagho (San Francisco) for urological reasons and further developed by Prof. Dr. K. Matzel (Erlangen) for enteric indications. Up to now, neuromodulation for pediatric patients with chronic constipation still has not been established.

A self-adhesive electrode was applied ventrally to the left lower abdominal quadrant, another in the right paravertebral-lumbar region. Both were connected to a stimulation device which generated an electric field (voltage between 5V and 8V at a frequency of 15 Hz) in order to improve intestinal peristalsis and relieve constipation. 18 patients, aged 3 – 13 years, were treated between 2013 and 2015. Symptomatic changes were evaluated by using questionnaires and observing changes in clinical examination. Satisfaction levels of 67% were achieved. 77% of patients experienced a persisting improvement of constipation after their ESS-treatment had finished. Chronic constipation of unknown origin was the most common etiology. 83% of patients had already been treated with other therapies, 21.4% previously had gastrointestinal tract surgery. 27.3% of patients experienced minor complications, which can all be attributed to local problems with self-adhesive electrodes.

ESS-application represents an innovative noninvasive therapy option for chronic pediatric constipation, which shows high symptomatic improvement at a low complication rate. High efficiency seems to occur particularly in schoolchildren until puberty, because after a phase of a few weeks, stimulation leads to a lasting learning effect with reconditioning of enteral and perineal muscular mobility. Given its efficiency, its uncomplicated application and high subjective levels of satisfaction, ESS seems to be a new auspicious therapy, completing and enriching the existing options.



Enteral Surface Stimulation (ESS): 2 self-adhesive electrodes (blue), connected to a stimulator device, generate an electric field with impact to the enteric nerve system and consecutive stimulation of the bowel

#### Device-support in ESCR of congenital chest wall deformities

PI: Prof. Dr. S. Schulz-Drost

Major questions are epidemiology and therapeutic options of congenital and acquired deformities of the anterior chest wall, e.g. the pectus excavatum and carinatum as well as their recurrences. Special challenges are complex and extended deformities with regard to surgical correction. Elastic Stable Chest Repair (ESCR) which had been developed at the Division of Pediatric Surgery has already shown numerous clinical findings in stabilization of the corrected chest wall which show excellent results from this method. Titanic implants, especially developed for ESCR in collaboration with partners of industry, have meanwhile been internationally validated and are available on the market. The working group is currently conducting an observation study on long-term results.

Furthermore, an additional key point was the operative correction of breast deformities the actual corrections on the ribs and the sternum. For example a standardized CT-based, preoperative operation planning had been developed and validated on the basis of previous patients. This planning concept has been discussed worldwide and is under consideration for further development. The clinical challenge, however, is to be able to implement the planned incisions precisely onto the human surgical anatomy. Therefore, in collaboration with a surgical instrumental developer (Lettenbauer, Erlangen), we created an angle-accurate thoracic

saw-cutting gauge TCD (thoracic cutting device) for the sternum and the ribs. This allows the precise incision for the osteo- and chondrotomias with safe protection of the underlying thoracic organs. The saw aid for the sternum is aligned with the curvature apex, the sternum thickness, and the corpus deviation, which may be corrected and then temporarily fixed at the sternum. In the case of pectus carinatum deformity, a posteriorly open bone wedge is performed by means of a so-called zero-point undercut while maintaining the depth limit. On the ribs, a fast and easy positioning of the saw gauge at the curvature crest is achieved by an integrated elevator in the subperiosteal layer. The saw cut is also made possible by means of pre-assembled angle positioning devices with depth limitation and with protection of the inner rib cortex.

In this connection, the foundations for a precisely plannable and optimally operable breast wall correction were created, analogous to the usual practice of orthopedic correction osteotomies e.g. on the long bones.

### **Protective negative pressure wound therapy in open correction of chest wall deformities**

PI: Dr. K. Simon

Following denudation of tissues and trouble in perfusion, open surgery in chest wall deformities can cause tremendous wound healing complaints. Purpose of this study was to determine if preventive negative pressure wound therapy could reduce wound complications after open pectus surgery. Retrospectively, 100 patients after open procedure for the treatment of pectus excavatum or pectus carinatum in 2010-2012 were analyzed. 50 patients, treated by vacuum technology (PREVENA™), were compared with 50 patients whose wounds were covered by transparent dealing foil (OPSITE™). Wound closure was performed following a standard procedure as well as the placement of subcutaneous drains. Therefore, two comparable groups of patients were formed and analyzed by standardized parameters. The wound dressing was placed epicutaneously immediately after wound closure in the operating room and removed in each case after five days. Follow-ups were performed immediately after removal of the wound dressing, at the time of discharge from hospital as well as six and 12 weeks after operation. The wounds were checked for tenderness, pain, secretion, redness, and fistulas. The vacuum-group showed 10% wound complications, which needed operative treatment, whereas the foil-group showed complications in

24%. Some patients who were treated by vacuum showed superficial skin lesions at the rim of the foam and the film. All of these lesions healed well. Postoperative wound management with the preventive measure of negative pressure wound therapy showed a remarkable reduction of wound complications ( $p=0.074$ ) following open pectus surgery.

### **Quantification of costal arch eversion in congenital pectus excavatum (PE)**

PI: Prof. Dr. S. Schulz-Drost

Regarding indication for correction of PE, indices are used to scale severity with Haller index (HI) being the most popular one. HI should be investigated and compared with the newer Correction index (CI). Costal arch eversion is a frequent comorbidity of PE and shows a major esthetic problem. Therefore, a measuring method was searched with a derived index of costal arch which could separate deformed from not deformed arches. A costal arch index (RI) for diagnostics and indication has been inaugurated. Considering the HI, the overlapping of values between PE-patients and controls was higher than with CI. Concerning the measurement of the costal arch, a reliable and independent method from the basic shape of the thorax has been found. The cartilage-bone transition zones of costa VIII, which can be found more medial at the anterior chest wall in PE than in controls, served as a lateral fixation point. A statistically significant negative correlation was found between the RI and CI: Higher CI tends to lower RI. Patients with recurrent PE without former correction of the costal arch showed higher values of costal arch height and RI as compared to patients with primary PE.

The CI is more appropriate in evaluating PE as it separates more sharply patients with PE from controls. It is suitable for diagnosis as well as operative planning and pre-/postoperative comparison. The theory of PE-origin in shifted relation between the cartilaginous and bony portion of the ribs is supported. Excessive growth of the bony portion appears to be an elementary part of PE-origin. The extent of eversion of costal arch correlates inversely with the severity of CI. Origin of eversion of costal arch can be derived: Stronger pathological growth of the caudal costal pairs in connection with less deformed sternum and cranial ribs. Furthermore, eversion plays an important role in development of PE-recurrences: RI shows the recommendation of simultaneously performed costal arch correction. For preoperative diagnostics, the calculation of RI is recommended and index of 0.9 can be the guideline for correction.

## **Teaching**

The Division of Pediatric Surgery engages in the curricular teaching according to IMPP (general guidelines for medical studies in Germany). Academic events take place in cooperation with vocational schools at FAU (pediatric nursing, pediatric intensive care medicine, school for operational and technical assistants, physiotherapy, massage), as interdisciplinary lectures and seminars, and in form of practical education in phantom-courses for minimally invasive pediatric surgery in skills lab and hands-on courses. The Division of Pediatric Surgery supervises PhD theses.

### **Selected publications**

Ewert F, Syed J, Kern S, Besendörfer M, Carbon RT, Schulz-Drost S. Symptoms in pectus deformities: A scoring system for subjective physical complaints. *Thorac Cardiovasc Surg* 2017, 65: 43-49

Ewert F, Syed J, Wagner S, Besendörfer M, Carbon RT, Schulz-Drost S. Does an external chest wall measurement correlate with a CT-based measurement in patients with chest wall deformities? *J Pediatr Surg* 2017, 52: 1583-1590

Grupp S, Fürst V, Buder T, Fichte A, Krinner S, Carbon RT, Hennig FF, Langenbach A, Schulz-Drost S. Comparative studies of different types of osteosynthesis on the human corpse preparation in bilateral antero-lateral flail chest. *Injury* 2017, 48: 2709-2716

Schulz-Drost S, Lubert AM, Simon K, Schulz-Drost M, Syed J, Carbon RT, Besendörfer M. Elastic stable chest repair and its hybrid variants in 86 patients with pectus excavatum. *J Thorac Dis* 2018, 10: 5736-5746

Jabari S, Carbon R, Besendörfer M, Hartmann A, Rompel O, Hoerning A, Söder S. Asymmetric Omphalopagus in a triplet after in vitro fertilization: A rare case of conjoined twinning. *Case Rep Pediatr* 2018, 23:2018:9349606

Horn-Hofmann C, Scheel J, Dimova V, Parthum A, Carbon R, Griessinger N, Sittl R, Lautenbacher S. Prediction of persistent post-operative pain: Pain-specific psychological variables compared with acute post-operative pain and general psychological variables. *Eur J Pain* 2018, 22: 191-202

### **International cooperations**

Prof. Dr. A. Fisher, Biochemical Center of Research, Weizman Institute of Science, Rehovot: Israel

Prof. Dr. G. Berci, Endoscopic Research, Cedars-Sinai Medical Center, Los Angeles: USA

AO Foundation. TK Thoracic Surgery Expert Group, Davos: Switzerland

M. Gasparri, MD, Froedtert Hospital, Cardiothoracic Surgery, Milwaukee: USA

J. Edwards, MD, PhD, Northern General Hospital, Department of Thoracic Surgery, Sheffield: UK