Department of Surgery
Division of Pediatric Surgery

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Research Focus
- Preliminary results of enteral surface stimulation (ESS/EO S) 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 erosion in congenital pectus excavatum (PE)

Structure of the Division
Professorships: 1
Personnel: 24
- Doctors (of Medicine): 3
- Graduate students: 5

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/EO S) in constipation in children and adolescents
PI: Dr. M. Besendorfer
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 sufficiently treated. 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 effect. 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/EO S) 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 Dr. 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 electromagnetic field (voltage between 5V and 8V at a frequency of 15 Hz) in order to improve intestinal peristalsis and relieve constipation. 18 patients were chosen for the study, aged 3 – 13 years who were treated between 2013 - 2015. Symptomatic changes were evaluated by using questionnaires and observing changes in clinical examination. At a median stimulation magnitude of 5.9 V for an average of 9.6 hours daily over a median period of 13.2 weeks, satisfaction levels of 67% were achieved. 77% of patients experienced a persisting improvement of constipation after their EOS-treatment had finished. The average patient was aged 8.3 and male. 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 non-invasive 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/EO S seems to be a new auspicious therapy, completing and enriching the existing options.

Device-support in ESCR of congenital chest wall deformities
Pt: 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. Titanics 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 surgical instrumental developers (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.
Quantification of costal arch eversion in cononal pectus excavatum (PE)

Pt: 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 measur-
ing method was searched with a derived index of costal arch which could separate deformed from not deformed archs. A costal arch index (RI) for diagnostics and indication has been in-augurated.

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 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/postop 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.

International Cooperations

Prof. Dr. A. Fischer, Biochemical Center of Research, Weizmann 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

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 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

