Реконструкция больших дефектов конечностей
Reconstruction of Large Bone Defects of the Limbs

Комбинированные лапароскопически-эндоскопические колоректальные резекции
Combined Laparoscopic-Endoscopic Colorectal Resections

Megaendoprostheses
Мегаэндопротезы

Мегаэндопротезы
Germany takes a leading position in medicine.

German hospitals, clinics and medical doctors enjoy an excellent reputation. The continuously rising number of patients, who come to Germany to receive medical treatment and support, strongly confirms this fact.

Patients from the Gulf States gladly come to Germany to receive medical treatment because they regard Germany as a safe place and rely on German clinics and physicians. They feel welcome as guests and enjoy that they are encountered in an open-minded and friendly way.

German Medical Council, partner of renowned German hospitals, clinics and specialized practices, organizes the best medical treatment for patients from all over the world and offers them a full service package.

Германия занимает лидирующую позицию в области медицины.

Германские больницы, клиники и врачи имеют прекрасную репутацию. Постоянно растущее число иностранных пациентов, которые приезжают в Германию на лечение, подтверждает этот факт.

Пациенты со всего мира с удовольствием едут в Германию на лечение, поскольку рассматривают Германию как безопасную страну и доверяют немецким клиникам и врачам. Они чувствуют себя желанными гостями и наслаждаются местным гостеприимством.

Германский Медицинский Совет является партнером известных немецких клиник, медицинских центров, специалистов и организует самое лучшее лечение для пациентов со всего мира, предлагая им весь спектр услуг.
Dear Reader,

The German Medical Journal can now look back on 10 years of history. 10 years which have flown by and in which we continuously kept learning. And we are also a bit proud of the development of this “German Medical Journal” project over these years.

From the very first issue, outstanding authors, predominantly physicians and specialists from German university hospitals, have published highly interesting and excellent specialist articles. By now, every German university hospital has probably been represented in the German Medical Journal. The list of specialist articles and authors in the German Medical Journal is quite respectable. At this point, we would like to seize the opportunity to express our sincere thanks to our authors. They have made every issue of the German Medical Journal unique in its own way.

The German Medical Journal quickly became known around the world for its premium quality. It has readers on all continents – by now in 108 countries. The Russian-English edition is steadily catching up. In 2015, 265,000 readers downloaded the GMJ Russ/Engl, among them 53% from Russian-speaking countries. Boasting a total of 336,000 readers, the Arabic-English version of the German Medical Journal has an even higher language-specific readership of 66% in Arabic-speaking countries.

At the beginning, we would not have expected such a huge coverage even in our wildest dreams, but we quickly anticipated that the conversion to an online journal and the use of the Internet, as an ultrafast and effective channel of communication, would be the right way to go for our professional publication. It has enabled the German Medical Journal to become one of the first digital professional journals of its kind.

What’s next? Our next project will be the visual modernisation of the German Medical Journal website. In terms of contents, it still works perfectly, always meeting the highest requirements. After all, it was state-of-the-art when it was launched. After 10 years of tireless work, however, it’s time for a visual facelift. Wait and see for your- self! Enjoy your German Medical Journal.

Nadine Baume
Managing Director

http://www.facebook.com/GermanMedicalJournal
https://twitter.com/GermanMedicalJo

Nadine Baume
Managing Director

Дорогие читатели!

Немецкий Медицинский Журнал в настоящий момент уже может оглядеться на свою 10-летнюю историю. Десять лет, которые быстро пролетели, многому нас научили. Поэтому мы гордимся успешным развитием нашего проекта «Немецкий Медицинский Журнал» за эти годы.

С самого первого выпуска выдающиеся авторы, преимущественно врачи и специалисты из немецких университетских клиник, публиковали превосходные специализированные статьи. К настоящему времени, в Немецком Медицинском Журнале, вероятно, были представлены все университетские клиники Германии. Перечень специализированных статей и авторов в Немецком Медицинском Журнале выглядит внушительно. И мы хотели бы воспользоваться этой возможностью, чтобы выразить нашу искреннюю благодарность нашим авторам. Они сделали каждый выпуск Немецкого Медицинского Журнала уникальным в своем роде.

Немецкий Медицинский Журнал быстро получил известность во всем мире, благодаря своему премиум качеству. Он имеет читателей на всех континентах – уже в 108 странах мира. Русско-английское издание журнала по своей популярности скоро сравнится с остальными вариантами. В 2015 году 265,000 читателей загрузили русско-английскую версию журнала, среди них 53% - из русскоязычных стран. Охватывая в общей сложности 336,000 читателей, арабско-английский вариант журнала имеет более высокую 66%-ую читаемость в арабоязычных странах.

Вначале мы не ожидали столь огромный охват даже в наших самых смелых мечтах, однако быстро осознали, что преобразование нашего издания в онлайн-журнал и использование Интернета, как ультрабыстрого и эффективного канала коммуникаций, является правильным направлением для распространения наших профессиональных публикаций. Это позволило Немецкому Медицинскому Журналу стать одним из первых профессиональных журналов в электронном формате.

Что же дальше? Нашим следующим шагом станет визуальная модернизация сайта Немецкого Медицинского Журнала. С точки зрения содержания, он по-прежнему соответствует самому высокому уровню, отвечает самым высоким требованиям. Но не стоит забывать о том, что и в момент своего запуска он был сверхсовременным проектом. После 10 лет неустанный работы пришло время и для его визуального усовершенствования! Скоро вы это увидите!

Получите удовольствие от Немецкого медицинского журнала!

Nadine Baume
Managing Director
BIHE

22nd AZERBAIJAN INTERNATIONAL HEALTHCARE EXHIBITION

www.bihe.az

19–21 SEPTEMBER 2016
Baku, Azerbaijan

Organisers

Iteca Caspian LLC (Baku)
Tel.: +994 12 404 10 00
Fax: +994 12 404 10 01
E-mail: healthcare@iteca.az
www.iteca.az

Venue

BAKUA EXPO CENTER

in incorporating

AZERBAIJAN STOMATOLOGY

www.facebook.com/BIHEAzerbaijan
IMPRINT

GERMAN MEDICAL JOURNAL
www.german-medical-journal.eu
80637 München
Tel. +49 / (0)89 / 57 87 57 89
Fax. +49 / (0)89 / 13 16 30
info@gmjournal.com

SENIOR EDITOR
Nadine Baume
nb@gmjournal.com

EDITORIAL BOARD
Prof. Dr. rer. nat. Hans Fritz
Prof. Dr. med. Christian Sommerhoff

ADVISORY BOARD
Prof. Dr. med. Andreas B. Imhoff
Prof. Dr. med. Wiener Knopf
Prof. Dr. med. Alfred Königrainer
Prof. Dr. med. Rüdiger Lange
Prof. Dr. med. Dr. (Lond.) Chris P. Lohmann
Prof. Dr. med. Petra-Maria Schummm-Dräger
Prof. Dr. med. Jörg-Christian Tonn
Prof. Dr. med. Volker Tonnier
Univ.-Prof. Dr. med. Dr. h.c. D. Tschöpe

TRANSLATIONS
English:
Valeria Alic
Russian:
Dr. Erica Igonina

ART DIRECTION / PRODUCTION
Linea Nova Ltd.
info@linea-nova.com
www.linea-nova.com

ADVERTISEMENTS
www.german-medical-journal.eu
adverts@gmjournal.com
Tel. +49 / (0)89 / 57 87 57 89
Fax. +49 / (0)89 / 13 16 30

SUBSCRIPTION
www.german-medical-journal.eu
subscription@gmjournal.com
Fax. +49 / (0)89 / 13 16 30

Neither the editors nor the publisher can guarantee that all publications are correct. As soon as the author hands over his/her manuscript and illustrations, he/she authorizes their editing and publication. Unmarked photos and illustrations were given to the publisher by the respective authors. No guarantee for unsolicited manuscripts, photos and illustrations. Re-prints or reproduction of any kind – even in parts – may only be made with written permission of the publishing house and are subject to remuneration. In case of force majeure or disturbance of the industrial labour peace no claims for shipment or reimbursement arise.

Copyright 2016
All rights reserved
ISSN 1869-7836
peer-reviewed
The 6th

Oman Health Exhibition & Conference

OMAN INTERNATIONAL EXHIBITION CENTER
Muscat, Sultanate of Oman

In partnership with Ministry of Health

Oman’s Biggest Health Platform

FACTS ABOUT OMAN’S HEALTHCARE MARKET

- One of Oman’s biggest projects is the US$ 1.5-billion world-class Medical City, a 5-million square-meter landmark, aimed at making Oman a destination for medical tourism.

- Projects that are seen to contribute to the sector’s growth are the US$ 200- million integrated multi-use health complex Al Madina International Hospital, and 27 primary healthcare institutions.

- The market size is forecast to grow US$ 2.6 billion in 2016 and seen to be worth US$ 4.3 billion by 2020.

Exhibition Profile

Hospital and Medical infrastructure  Healthcare  Pharmaceuticals  Medical Tourism

Supporting Association  Media Partners

For more information on participation and sponsorship, contact:

Ahmed Sayed
+968 24660128  +968 96709378
omanhealth@omanexpo.com
www.omanhealthexpo.com

The Organizer
<table>
<thead>
<tr>
<th>Article Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconstruction of Large Bone Defects of the Limbs Using Megaendoprostheses in Children and Adults</td>
<td>10</td>
</tr>
<tr>
<td>Combined Laparoscopic-Endoscopic Colorectal Resections</td>
<td>22</td>
</tr>
<tr>
<td>Total Elbow Arthroplasty – Indication and Therapeutic Approach</td>
<td>32</td>
</tr>
<tr>
<td>Spectrum of Practical Application of Indocyanine Green Fluorescence Angiography in General and Thoracic Surgery</td>
<td>42</td>
</tr>
<tr>
<td>Anterior Cruciate Ligament Reconstruction and Cartilage Damage - Current Therapy Concepts</td>
<td>52</td>
</tr>
<tr>
<td>Quantification of the Prognostic Impact of Lymphovascular Space Involvement (LVI) in Early Stage Cervical Cancer: a Review of Literature</td>
<td>64</td>
</tr>
<tr>
<td>A New Device for Long-Term Recording of Wheezing and Cough in Patients with Asthma and Other Respiratory Diseases</td>
<td>70</td>
</tr>
</tbody>
</table>
Содержание

Реконструкция крупных дефектов конечностей с использованием мегаэндопротеза у детей и взрослых  
10

Комбинированные лапароскопически - эндоскопические колоректальные резекции  
22

Тотальное эндопротезирование локтя: показания и терапевтический подход  
32

Спектр практического применения индицианин-зеленой флуоресцентной ангиографии в общей и торакальной хирургии  
42

Реконструкция передней крестообразной связки и хряща при повреждениях - современная концепция лечения  
52

Количественное определение прогностического значения инвазии лимфоваскулярного пространства (LVSI) на ранних стадиях рака шейки матки: обзор литературы  
64

Новое устройство для долгосрочной регистрации хрипов и кашля у пациентов с астмой и другими респираторными заболеваниями  
70
Reconstruction of Large Bone Defects of the Limbs Using Megaendoprostheses in Children and Adults

Реконструкция крупных дефектов конечностей с использованием мега-эндопротеза у детей и взрослых
Introduction

Primary or metastatic malignant tumors of bone and soft tissue can occur in all ages and often require an interdisciplinary approach depending on tumor entity, grading and stage of disease. While tumor resections are the main domain in low-grade tumors, high-grade sarcomas often require combination regimens of chemotherapy, local tumor resection and possibly additional radiation therapy.

Tumor resections are performed as wide resections according to the Enneking classification [1] and aim at limb salvage whenever oncologically feasible. Nowadays, megaendoprostheses are the most common and accepted reconstruction technique applied in osteoarticular defects. Alternatives, such as biological reconstructions or ablative procedures are reserved for special indications.

Key words: Limb salvage, megaendoprostheses, oncological orthopedics, sarcoma

Indications

In the past, megaendoprostheses have mainly been used in the treatment of primary malignant bone tumors. However, with continuously improving treatment regimens and survival periods of patients suffering from metastatic disease, megaendoprosthetic reconstructions have become a viable option in these collectives whenever patients might outlive composite osteosynthetic reconstructions.

In our patient collective, we were able to show in a retrospective analysis of 80 patients treated for bony metastasis in long bones of the upper and lower extremity that the mean patient survival was 2.9 years. Overall survival was 70% at one and 20% at five years. Implant survival was 83% after one and 74% after five years. The overall rate of operative revisions was 18%.

A low rate of complications and rapid functional improvement after operation suggest that usage of megaendoprostheses in appropriately selected patients is feasible [2].
When bones or joints are surrounded or infiltrated by soft tissue sarcomas and wide tumor resection leads to loss of the adjacent bone or joint, megaendoprostheses also come into focus as a means of reconstruction in these cases. Benign, borderline or low-grade malignant lesions sometimes also lead to the implantation of megaendoprostheses in large tumors or in case of local recurrences when wide resections need to be performed. With increasing numbers of joint replacement operations in degenerative disease, complications in these patients may also lead to the use of megaendoprostheses in revision arthroplasty.

Fig. 1: Proximal femur replacement with an ice-cone-shaped pelvic cup (Lumic®) after pelvic resection including an extraarticular proximal femur resection.

Рис. 1: Протезирование проксимального отдела бедренной кости с помощью конусообразной чашечки (Lumic®) после резекции тазовой кости, включающей внесуставную часть проксимального отдела бедренной кости.

Низкий показатель осложнений и быстрое функциональное улучшение после операции дают основание утверждать, что использование мегаэндопротезов целесообразно у тщательно отобранных пациентов [2]. Когда кости или суставы окружены или инфильтрированы саркомой мягких тканей и широкая резекция опухоли приводит к потере прилегающей кости или сустава, мегапротезы являются основным методом реконструкции в этих случаях. Доброкачественные, пограничные или высокодифференцированные злокачественные образования также иногда требуют имплантации мегаэндопротезов при больших размерах опухоли или в случае локальных...
**Megaendoprosthetic Properties**

Modern megaendoprostheses have a modular design. At our department, the “Modular Universal Tumor and Revision System” (MUTARS®, implantcast, Buxtehude) is used, which allows the reconstruction of bone defects of varying lengths in 1 cm intervals. Rotation can be set in 5° intervals [3].

In the upper extremity proximal, diaphyseal, distal and total replacements of the humerus and the proximal ulna are possible. In the lower extremity, diaphyseal and distal and total femur and proximal (Figure 1), diaphyseal, and the proximal ulna are possible. In the lower extremity, distal tibia replacements can be performed. Also, stump-lengthening procedures after proximal humerus resection can be performed. In 5° intervals [3].

Non-articulating components are equipped with a silver coating to prevent infection of the implant in situ when confronted with small quantities of bacteria. In our collective, 51 patients with sarcoma (proximal femur n=22, proximal tibia n=29) were compared with 74 patients who had an uncoated titanium megaprosthesis (proximal femur n=33, proximal tibia n=41) regarding infection rate over a 5-year period. We found that the infection rate was substantially reduced from 17.6% in the titanium to 5.9% in the silver group. While 38.5% of patients in the titanium group ultimately had to undergo amputation for infection, none were performed in the silver group [5].

Polyethylene terephthalate attachment tubes are used to reattach adjacent muscles and tendons to the megaendoprostheses to prevent joint dislocation in the hip joint and after proximal humerus resection. The reattachment of the resection, when necessary, should be performed with an expandable prosthesis to improve the patients’ functional outcome with an exoprosthesis [4].

Prosthesis stems have a hexagonal shape leading to excellent primary rotation stability. They can be implanted cemented or cementless. Cemented implantations need to be considered in elderly patients, osteoporosis, immobilization, following radiation therapy or in metadiaphyseal regions when a press-fit fixation cannot be obtained. Cementless stems have a hydroxylapatite coating to facilitate bone ingrowth. Rotating-hinge and metal-on-metal joint linkage mechanisms are available. Articulating prosthesis components consist of a cobalt-chrome-molybdenum alloy and have a titanium-nitride or titanium-niobium-nitride coating to prevent allergic reaction.

Modern megaendoprostheses to prevent joint dislocation in the hip joint and after proximal humerus resection. The reattachment of the proximal femur n=22, proximal tibia n=29) were compared with 74 patients who had an uncoated titanium megaprosthesis (proximal femur n=33, proximal tibia n=41) regarding infection rate over a 5-year period. We found that the infection rate was substantially reduced from 17.6% in the titanium to 5.9% in the silver group. While 38.5% of patients in the titanium group ultimately had to undergo amputation for infection, none were performed in the silver group [5].

Polyethylene terephthalate attachment tubes are used to reattach adjacent muscles and tendons to the megaendoprostheses to prevent joint dislocation in the hip joint and after proximal humerus resection. The reattachment of the resection, when necessary, should be performed with an expandable prosthesis to improve the patients’ functional outcome with an exoprosthesis [4].

Prosthesis stems have a hexagonal shape leading to excellent primary rotation stability. They can be implanted cemented or cementless. Cemented implantations need to be considered in elderly patients, osteoporosis, immobilization, following radiation therapy or in metadiaphyseal regions when a press-fit fixation cannot be obtained. Cementless stems have a hydroxylapatite coating to facilitate bone ingrowth. Rotating-hinge and metal-on-metal joint linkage mechanisms are available. Articulating prosthesis components consist of a cobalt-chrome-molybdenum alloy and have a titanium-nitride or titanium-niobium-nitride coating to prevent allergic reaction.

Non-articulating components are equipped with a silver coating to prevent infection of the implant in situ when confronted with small quantities of bacteria. In our collective, 51 patients with sarcoma (proximal femur n=22, proximal tibia n=29) were compared with 74 patients who had an uncoated titanium megaprosthesis (proximal femur n=33, proximal tibia n=41) regarding infection rate over a 5-year period. We found that the infection rate was substantially reduced from 17.6% in the titanium to 5.9% in the silver group. While 38.5% of patients in the titanium group ultimately had to undergo amputation for infection, none were performed in the silver group [5].

Polyethylene terephthalate attachment tubes are used to reattach adjacent muscles and tendons to the megaendoprostheses to prevent joint dislocation in the hip joint and after proximal humerus resection. The reattachment of the resection, when necessary, should be performed with an expandable prosthesis to improve the patients’ functional outcome with an exoprosthesis [4].

Prosthesis stems have a hexagonal shape leading to excellent primary rotation stability. They can be implanted cemented or cementless. Cemented implantations need to be considered in elderly patients, osteoporosis, immobilization, following radiation therapy or in metadiaphyseal regions when a press-fit fixation cannot be obtained. Cementless stems have a hydroxylapatite coating to facilitate bone ingrowth. Rotating-hinge and metal-on-metal joint linkage mechanisms are available. Articulating prosthesis components consist of a cobalt-chrome-molybdenum alloy and have a titanium-nitride or titanium-niobium-nitride coating to prevent allergic reaction.

Non-articulating components are equipped with a silver coating to prevent infection of the implant in situ when confronted with small quantities of bacteria. In our collective, 51 patients with sarcoma (proximal femur n=22, proximal tibia n=29) were compared with 74 patients who had an uncoated titanium megaprosthesis (proximal femur n=33, proximal tibia n=41) regarding infection rate over a 5-year period. We found that the infection rate was substantially reduced from 17.6% in the titanium to 5.9% in the silver group. While 38.5% of patients in the titanium group ultimately had to undergo amputation for infection, none were performed in the silver group [5].

Polyethylene terephthalate attachment tubes are used to reattach adjacent muscles and tendons to the megaendoprostheses to prevent joint dislocation in the hip joint and after proximal humerus resection. The reattachment of the resection, when necessary, should be performed with an expandable prosthesis to improve the patients’ functional outcome with an exoprosthesis [4].

Prosthesis stems have a hexagonal shape leading to excellent primary rotation stability. They can be implanted cemented or cementless. Cemented implantations need to be considered in elderly patients, osteoporosis, immobilization, following radiation therapy or in metadiaphyseal regions when a press-fit fixation cannot be obtained. Cementless stems have a hydroxylapatite coating to facilitate bone ingrowth. Rotating-hinge and metal-on-metal joint linkage mechanisms are available. Articulating prosthesis components consist of a cobalt-chrome-molybdenum alloy and have a titanium-nitride or titanium-niobium-nitride coating to prevent allergic reaction.
Surgical Technique

Since local tumor control can be influenced substantially by the extent of tumor resection performed, a wide resection according to Enneking is essential in the therapy of malignant bone and soft tissue tumors [1]. Resection margins cannot generally be defined in centimeters but rely greatly on the experience of the surgeon. In our department, we plan resections with a three-centimeter margin of healthy bone as measured in the initial MRI. The soft tissue margin cannot be measured likewise as tissue barriers such as fascia, perineurium or adventitia – when left on the tumor - are only millimeters thick but can be enough to warrant a wide tumor resection.

The choice of the procedure to be performed depends on tumor size, site, grading and stage of disease. Therefore, preoperative imaging needs to be completed before and after extensor tendon to the tube in proximal tibia replacements improves the functional outcome significantly [6].

For the attachment of adjacent muscles and tendons to the megaprosthesis with the purpose of preventing dislocation in the hip joint and after resection of the proximal component of the femur, polyethylene tubes (‘socks’) are used. The attachment of the extensor tendon to the tube in proximal tibia replacements improves the functional outcome significantly [6].
neoadjuvant chemotherapy including plain radiographs, MRI imaging of the affected bone with adjacent joints with contrast agent to exclude the presence of skip metastases and imaging of the entire body (depending on the underlying disease) to search for distant metastases. Further more, other factors such as patient age, extent of existing soft tissue after tumor resection, functional demands and patient compliance have to be considered. Megaendoprostheses are most commonly used in the reconstruction of large osteoarticular defects in adolescents and adults. A modular prosthesis design allows variable reconstruction lengths and patients have good primary stability as well as good functional and cosmetic results. Children undergoing operation at five years of age or older can often benefit from implantation of growing prostheses to decrease limb length discrepancies developing during the skeletal growth until maturity. However, the use of growing prostheses requires multiple operations and patients are hospitalized and impaired.
Fig. 3a, b: Proximal humerus replacement using an inverse proximal humerus megaendoprosthesis.

Рис. 3а, b: Замена проксимального отдела плечевой кости с использованием инверсеного мегаэндопротеза.
in their functionality during elongation periods. Other causes for revision operations are material wear and bacterial infection. Also, soft tissue coverage of the prosthesis must be sufficient for such a procedure to be performed. Muscle flaps such as a gastrocnemius or biceps femoris flap can improve soft tissue coverage and prevent complications.

Alternatives to Megaendoprosthetic Reconstructions

Osteoarticular or intercalary allografts are an alternate option in reconstructing large bone defects. They have good primary stability but often lead to problems such as bacterial infection or fractures as the bone is not vital and no bony remodeling takes place.

Literature reports high revision rates and leg discrepancies will occur in osteoarticular locations. Also, it is not available in all areas depending on local regulations regarding organ donations and further processing.

Autologous biological reconstructions - such as a vascularized fibula – are vital and show high regenerative and remodeling potential. They are feasible options in reconstructing intercalary defects and especially favorable in the upper extremity for biomechanical reasons. When growth plates can be salvaged in diaphyseal defects leg length discrepancies can be prevented. Therefore, cosmetic results are also very satisfactory. Donor site morbidity (such as peroneal palsy), difficulties with the anastomosis (thrombosis, spasm etc.) and infection or necrosis are among possible complications. Another downside is impaired ingrowth observed when chemotherapy is administered leading to prolonged periods of partial to no weight bearing. Possible additional radiation therapy is a relative contraindication for this procedure.

In pediatric patients who are <5 years of age at the time of operation, rotation plasty and <3 years of age amputation need to be considered among possible options. Functional results using protheses are satisfactory and are often better than those of patients who underwent re-construction with megaendoprostheses and insufficient soft tissue coverage or multiple revision operations.

Phantom pain, neuroma, cosmetic limitations, limited acceptance among patients, psychological problems and loss of bodily integrity are among the deficits of these techniques. Including a gentlemannered approach, MRT пораженной кости со смежными суставами с контрастированием, чтобы избежать присутствие региональных метастазов, а также визуализация других областей тела (в зависимости от основного заболевания), чтобы выявить отдаленные метастазы. Кроме того, учитываются и другие факторы, такие как возраст пациента, объем мягких тканей после резекции опухоли, функциональные требования и способность пациента соблюдать лечебный режим.

Мегаэндопротезы наиболее часто используются при реконструкции больших костно-суставных дефектов у подростков и взрослых. Модульная конструкция позволяет выполнять реконструкцию кости различной длины, пациенты имеют хорошую первичную стабильность, а также хорошие функциональные и косметические результаты.

Дети, подвергающиеся операции в возрасте пяти лет или старше имеют преимущество при имплантации так называемых «растающих» (раздвижных) протезов для уменьшения разницы в длине конечностей, которая развивается во время роста скелета до периода зрелости. Однако использование таких протезов требует нескольких операций, в периоды их удлинения пациентов госпитализируют и их двигательная функция нарушена. Другими показаниями для ревизионных операций являются износ протеза и бактериальная инфекция.

Кроме того, чтобы провести такое протезирование, должно быть выполнено достаточное покрытие протеза мягкими тканями. Мышечные лоскуты, полученные из икроножной или двуглавой мышцы бедра, могут увеличить покрытие протеза мягкими тканями и предотвратить развитие осложнений.

Альтернативные методы реконструкции

Костно-суставные или вставочные альлографты - альтернативный вариант реконструкции больших костных дефектов. Они имеют хорошую первичную стабильность, однако часто приводят к таким проблемам, как бактериальная инфекция или переломы, так как неживые кости не обеспечивают ремоделирования кости. В литературе сообщаются о высоких показателях ревизионных вмешательств и разнице в длине конечностей, которые имеют место при использовании костно - суставных альлографтов. Кроме того, метод доступен не во всех регионах, вследствие особенностей местного законодательства относительно донорства и дальнейшего применения тканей и органов.

Аутологичные биологические реконструкции с использованием васкуляризированной малоберцовой живой кости демонстрируют
Postoperative Management

Due to the large prosthetic surfaces patients receive prophylactic intravenous antibiotic treatment for three to five days depending on soft tissue coverage, followed by an oral regimen until wound healing. Also, patients are recommended to undergo prophylactic antibiotic treatment when bacteremia is to be expected (i.e. dental procedures).

After cementless implantation of a megaendoprosthesis no to partial weight bearing is recommended for a period of six weeks. Afterwards, weight bearing is gradually increased in increments of 10kg per week. After cemented implantation full weight bearing is possible.

After proximal femur replacement, patients are recommended to avoid flexion of >60°, forced rotation and adduction for six weeks after operation to prevent a dislocation of the hip joint. Reconstructions around the knee using a gastrocnemius flap have to keep their joint in a neutral position for 4 weeks before gradually increasing

Fig. 4a, b: Distal femur replacement using a MUTARS® BioXpand distal femur growing megaendoprosthesis
a. during lengthening procedure
b. after consolidation

Рис. 4a, b: Протезирование дистального отдела бедренной кости с использованием растущего мегаэндопротеза MUTARS® BioXpand:
a. во время процедуры удлинения
b. после консолидации
Flexion to ensure ingrowth of muscles and especially the patella tendon into the attachment tube. Otherwise, patients can practice an increasing flexion beginning five days after operation. After proximal humerus replacement, the arm is immobilized in a sling for four to six weeks. The elbow joint and hand can be used freely. When the axillary nerve is intact and an inverse shoulder megaprosthesis was used, passive swinging exercises in the shoulder joint are practiced two weeks after operation, followed by passive movement four and active movement six weeks after operation. After conventional proximal humerus replacement, mobility is severely restricted, therefore stability is more important than flexibility and active and passive motion are practiced more cautiously.

Functional Outcome

The MSTS score is often used in orthopedic oncology to assess the functional outcome and patient satisfaction after operation. The best results are observed after proximal tibia reconstructions (83%), followed by distal femur reconstructions (80%). Flexion of the knee joint is often possible up to 90° and full extension can be free or slightly impaired, depending on how much quadriceps muscle remains. Proximal femur replacements lead to a persistent limping gait because the gluteal muscle is insufficient after resection from the great trochanter and reinsertion to the attachment tube (70%). Reliance on walking aids to cover longer distances might be necessary in elderly patients [7].

Functional aptitude of proximal shoulder replacement is observed to be poorest among reconstructions. However, patients with an inverse meganeprosthetic shoulder replacement (Figure 3) show a significant improvement of active shoulder function compared to anatomically shaped implants. The patients presented a medium MSTS score of 24.6/30. The mean active arm abduction in the shoulder joint was 78 and 88° active arm elevation for patients with intact axillary nerve function [8].

The outcomes of using exoprotheses are often considered acceptable and a good result. For example, the knee joint often allows flexion up to 90° and full extension is possible or slightly impaired, depending on how much quadriceps muscle remains. After proximal humerus replacement, the arm is immobilized in a sling for four to six weeks. The elbow joint and hand can be used freely. When the axillary nerve is intact and an inverse shoulder megaprosthesis was used, passive swinging exercises in the shoulder joint are practiced two weeks after operation, followed by passive movement four and active movement six weeks after operation. After conventional proximal humerus replacement, mobility is severely restricted, therefore stability is more important than flexibility and active and passive motion are practiced more cautiously.

After proximal tibia reconstructions (83%), followed by distal femur reconstructions (80%). Flexion of the knee joint is often possible up to 90° and full extension can be free or slightly impaired, depending on how much quadriceps muscle remains. Proximal femur replacements lead to a persistent limping gait because the gluteal muscle is insufficient after resection from the great trochanter and reinsertion to the attachment tube (70%). Reliance on walking aids to cover longer distances might be necessary in elderly patients [7].

Functional aptitude of proximal shoulder replacement is observed to be poorest among reconstructions. However, patients with an inverse meganeprosthetic shoulder replacement (Figure 3) show a significant improvement of active shoulder function compared to anatomically shaped implants. The patients presented a medium MSTS score of 24.6/30. The mean active arm abduction in the shoulder joint was 78 and 88° active arm elevation for patients with intact axillary nerve function [8].

After proximal tibia reconstructions (83%), followed by distal femur reconstructions (80%). Flexion of the knee joint is often possible up to 90° and full extension can be free or slightly impaired, depending on how much quadriceps muscle remains. Proximal femur replacements lead to a persistent limping gait because the gluteal muscle is insufficient after resection from the great trochanter and reinsertion to the attachment tube (70%). Reliance on walking aids to cover longer distances might be necessary in elderly patients [7].

Functional aptitude of proximal shoulder replacement is observed to be poorest among reconstructions. However, patients with an inverse meganeprosthetic shoulder replacement (Figure 3) show a significant improvement of active shoulder function compared to anatomically shaped implants. The patients presented a medium MSTS score of 24.6/30. The mean active arm abduction in the shoulder joint was 78 and 88° active arm elevation for patients with intact axillary nerve function [8].
Growing Prostheses and Custom-made Reconstructions

Growing megaendoprostheses are limited to special indications in children undergoing tumor resections at approximately five to six years or older at the time of operation and when a leg length discrepancy of >5cm is to be expected. There are currently two types of growing prostheses available: One is equipped with an electric motor and leads to elongation of the prosthetic component, the other works using callotasis of the remaining bone after osteotomy using an intramedullary, extendable nail and therefore generating new bone (Figure 4).

Both techniques are controlled externally and have subcutaneous receivers, which forward the signals to the prosthetic motors. During elongation of the nail no weight bearing is possible. Additional operations are necessary in both cases. In patients < 3 years, when parents refuse ablative procedures, experimental reconstructions using custom-made megaendoprosthetic reconstructions exist. However, no long-term follow-up exists and patients have to undergo multiple operations.

Complications

The most severe complication possible is local recurrence, accompanied by a very poor prognosis. Literature reports recurrence rates ranging from 1-9% [9].

Megaendoprosthetic 5- to 10-year survival is located between 69 and 90% [9]. The most common complications leading to operative revisions are aseptic loosening, bacterial infection and periprosthetic fracture.

Minor operations have to be performed for wear of the ne был поврежден и был использован инверсный мегаэндопротез плеча, через две недели после операции пациент выполняет пассивные упражнения (качания) в плечевом суставе, через 4 недели - пассивные движения, через 6 недель - активные движения. После протезирования проксимального отдела плечевой кости подвижность сильно ограничена, поскольку стабильность важнее гибкости, поэтому пассивные и активные движения практикуются более осторожно.

Функциональный результат

Шкала MSTS часто используется в ортопедической онкологии для оценки функционального результата и удовлетворенности пациентов после операции. Наилучшие результаты наблюдаются после реконструкции проксимального отдела большеберцовой кости (83%), далее следует дистальный отдел бедренной кости (80%). В коленном суставе зачастую возможное сгибание до 90°, полное разгибание может быть свободным или слегка ограниченным, в зависимости от того, какой остался объем четырехглавой мышцы бедра.

Протезирование проксимальной бедренной кости вызывает придерживание вследствие недостаточности ягодичной мышцы после ее резекции с большого вертела и прикрепления к крепежной трубке (70%). Пожилым пациентам, чтобы покрыть большие расстояния, могут потребоваться вспомогательные устройства [7].

Функциональный результат после протезирования проксимального отдела плечевой кости является самым неудовлетворительным. Однако, пациенты с инверсным мегаэндопротезом плеча (Рисунок 3) показывают значительное улучшение активной функции плеча по сравнению с пациентами анатомическими имплантатами. У таких пациентов средний балл по шкале MSTS составляет 24,6 / 30. Среднее активное отведение в плечевом суставе
Наиболее тяжелым осложнением является местный рецидив, который сочетается с очень плохим прогнозом. В литературе сообщается, что показатель рецидива колеблется в пределах от 1-9%, 5-10-летняя выживаемость мегаэндопротезов составляет 69-90% [9].

Наиболее распространенными осложнениями, приводящими к ревизионным вмешательствам, являются асептическое расшатывание, бактериальная инфекция и перипротезный перелом. Малые операции выполняются при износе протезных материалов, таких как полиэтиленовые вкладыши, или при несостоятельности имплантата (например, переломе стержня или металлом-металл шарнира).
Combined Laparoscopic-Endoscopic Colorectal Resections

Background
Flexible endoscopy of the colon was first described in 1968 [1]. While classical transabdominal surgery is performed open since many decades, the first laparoscopically-assisted colectomy was reported by Jacobs et al in 1991 [2]. Meanwhile, large randomized controlled studies have repeatedly proven that laparoscopic colorectal resections are oncological at least equal
doctometry was reported by Jacobs et al in 1991 [2]. Meanwhile, large randomized controlled studies have repeatedly proven that laparoscopic colorectal resections are oncological at least equal
doctometry was reported by Jacobs et al in 1991 [2]. Meanwhile, large randomized controlled studies have repeatedly proven that laparoscopic colorectal resections are oncological at least equal
doctometry was reported by Jacobs et al in 1991 [2]. Meanwhile, large randomized controlled studies have repeatedly proven that laparoscopic colorectal resections are oncological at least equal
Colorectal surgery is estimated unsafe or not possible due to location, size, complexity of the lesion, risk of full-thickness cautery with late perforation, uncontrollable bleeding, or inadequate margins. In these cases, surgical removal has been advocated for many years. Today, laparoscopic resections of such lesions are standard procedures. However, laparoscopic surgery alone does not allow the surgeon to palpate and thus exactly localize the lesion. Therefore, the endoscopic application of metal clips or injection of dye into the wall of the colon prior to surgery can be used for labeling of a lesion. However, still intraoperative uncertainties remain by the chronologic separation of the two procedures, endoscopy and laparoscopy. This problem has been overcome by combined laparoscopic-endoscopic resections, as continuous intra- and extraluminal observation during resection and reconstruction provides a maximum of safety.

Intraoperative endoscopy can further help during surgical resection to choose the best laparoscopic technique, while simultaneously verifying a complete excision of e.g. a polyp, and confirming a leak-proof suture line. The tip of the scope may be used for improved exposure of a polyp for resection, and the endoscopic view offers an additional angle of vision, which might be helpful during excision or placement of a linear-stapling device. Combined laparoscopic-endoscopic resections are no routinely established procedure, thus no clear guidelines exist on when it should be applied. While combined interventions are dispensable in advanced malignant tumors, they represent an ideal modality in the surgical treatment of benign and early results after laparoscopic-chronologic colorectal lesions resection is not worse, and functional - even better results after open operation. However, laparoscopic resections of such lesions are standard procedures. Today, laparoscopic resections have been recommended for many years. However, in these cases, standing in between the transabdominal (laparoscopic or open) and the transanal (endoscopic) approach, combined resections integrate benefits of both methods, while warranting high safety, with the lowest possible trauma to the patient.

Keywords: colorectal, resection, laparoscopy, endoscopy, combination, single incision, robotic, NOTES

Indications
For some colorectal lesions, classical endoscopic removal is estimated unsafe or not possible due to location, size, complexity of the lesion, risk of full-thickness cautery with late perforation, uncontrollable bleeding, or inadequate margins. In these cases, surgical removal has been advocated for many years. Today, laparoscopic resections of such lesions are standard procedures. However, laparoscopic surgery alone does not allow the surgeon to palpate and thus exactly localize the lesion. Therefore, the endoscopic application of metal clips or injection of dye into the wall of the colon prior to surgery can be used for labeling of a lesion. However, still intraoperative uncertainties remain by the chronologic separation of the two procedures, endoscopy and laparoscopy. This problem has been overcome by combined laparoscopic-endoscopic resections, as continuous intra- and extraluminal observation during resection and reconstruction provides a maximum of safety.

Intraoperative endoscopy can further help during surgical resection to choose the best laparoscopic technique, while simultaneously verifying a complete excision of e.g. a polyp, and confirming a leak-proof suture line. The tip of the scope may be used for improved exposure of a polyp for resection, and the endoscopic view offers an additional angle of vision, which might be helpful during excision or placement of a linear-stapling device. Combined laparoscopic-endoscopic resections are no routinely established procedure, thus no clear guidelines exist on when it should be applied. While combined interventions are dispensable in advanced malignant tumors, they represent an ideal modality in the surgical treatment of benign and early results after laparoscopic-chronologic colorectal lesions resection is not worse, and functional - even better results after open operation. However, laparoscopic resections of such lesions are standard procedures. Today, laparoscopic resections have been recommended for many years. However, in these cases, standing in between the transabdominal (laparoscopic or open) and the transanal (endoscopic) approach, combined resections integrate benefits of both methods, while warranting high safety, with the lowest possible trauma to the patient.
(low-risk) malignancies of the colon. If histological examination reveals T1 cancer, the further management depends on specific histological aspects. Completely (R0) resected pT1 “low grade” cancers of the colorectum (defined as G1-2, L0) do not require any further oncological resection, as the risk of local recurrence or metastasis is only 0-5% [7].

Here, endoscopic controls after 6 and 24 months are estimated to warrant sufficient local control [7]. In the case of incomplete endoscopic removal of pT1 colorectal cancers, a further resection is indicated. This can be performed either endoscopically, by combination of laparoscopic and endoscopic resection, or oncological radically (open or laparoscopically) if the exact extension of the tumor cannot be estimated in advance. In the case that the accessibility is limited, e.g. due to the location close to the ileocecal valve, combined laparoscopic-endoscopic resections may spare the patient overtreatment by oncological resection. Finally, albeit not reliable, putative lymph node

Fig. 1: Schematic depiction of laparoscopically assisted endoscopic resection (upper panel), endoscopy-assisted wedge resection (middle panel), and endoscopy-assisted transluminal resection (lower panel).
Lesions that cannot be removed by simple endoscopic forceps or loop may be accessible to endoscopic mucosal resection (EMR), or endoscopic submucosal dissection (ESD). For rectal lesions, transanal endoscopic microsurgery (TEM) offers direct instrumental access for manipulation in the very distal part of the colorectum. Typical polyps and adenomas can usually be removed by forceps or electric snare upon classical endoscopy.

However, if the accessibility is hindered or complete resection appears difficult by endoscopy alone, combined laparoscopic-endoscopic resections should be considered.

Classification of Combined Laparoscopic-Endoscopic Resections [8]

Different methods of combined laparoscopic-endoscopic resections exist. The leading role during the intervention can be executed by both, the abdominal surgeon (laparoscopic, endoscopic assisted) as well as the endoscopist (endoscopic, laparoscopic assisted). During all times of the procedure however, situation dependent adaption according to in situ findings is possible. A recently proposed and generally accepted classification system by the authors is listed below [6, 8].

Laparoscopically Assisted Endoscopic Resection

Pedunculated polyps in locations difficult to reach endoscopically can be exposed intraluminal and thus made accessible for endoscopic snare resection by impressing the corresponding part of the colon with laparoscopic instruments (Figure 1, upper panel). Even in purely endoscopic resections, laparoscopy can help to rule out a putative perforation or violation of the serosa, which could result in secondary perforation. Further, to sew over the resection site in risky situations is easily accomplished.

Endoscopy-Assisted Wedge Resection [6]

Here, after exact endoscopic localization of the lesion, it is resected, such as risk of local recurrence or metatization, which is in general 0-5% [7]. In this case, endoscopic treatment is performed by a team consisting of a surgeon (laparoscopic, endoscopic assisted) as well as the endoscopist (endoscopic, laparoscopic assisted). This approach allows for individual and situation dependent adaption according to in situ findings, and a recent classification system by the authors is listed below [6, 8].

Laparoscopically Assisted Endoscopic Resection

Pedunculated polyps in locations difficult to reach endoscopically can be exposed intraluminal and thus made accessible for endoscopic snare resection by impressing the corresponding part of the colon with laparoscopic instruments (Figure 1, upper panel). Even in purely endoscopic resections, laparoscopy can help to rule out a putative perforation or violation of the serosa, which could result in secondary perforation. Further, to sew over the resection site in risky situations is easily accomplished.

Endoscopy-Assisted Wedge Resection [6]

Here, after exact endoscopic localization of the lesion, it is resected, such as risk of local recurrence or metatization, which is in general 0-5% [7]. In this case, endoscopic treatment is performed by a team consisting of a surgeon (laparoscopic, endoscopic assisted) as well as the endoscopist (endoscopic, laparoscopic assisted). This approach allows for individual and situation dependent adaption according to in situ findings, and a recent classification system by the authors is listed below [6, 8].

Laparoscopically Assisted Endoscopic Resection

Pedunculated polyps in locations difficult to reach endoscopically can be exposed intraluminal and thus made accessible for endoscopic snare resection by impressing the corresponding part of the colon with laparoscopic instruments (Figure 1, upper panel). Even in purely endoscopic resections, laparoscopy can help to rule out a putative perforation or violation of the serosa, which could result in secondary perforation. Further, to sew over the resection site in risky situations is easily accomplished.

Endoscopy-Assisted Wedge Resection [6]

Here, after exact endoscopic localization of the lesion, it is resected, such as risk of local recurrence or metatization, which is in general 0-5% [7]. In this case, endoscopic treatment is performed by a team consisting of a surgeon (laparoscopic, endoscopic assisted) as well as the endoscopist (endoscopic, laparoscopic assisted). This approach allows for individual and situation dependent adaption according to in situ findings, and a recent classification system by the authors is listed below [6, 8].

Laparoscopically Assisted Endoscopic Resection

Pedunculated polyps in locations difficult to reach endoscopically can be exposed intraluminal and thus made accessible for endoscopic snare resection by impressing the corresponding part of the colon with laparoscopic instruments (Figure 1, upper panel). Even in purely endoscopic resections, laparoscopy can help to rule out a putative perforation or violation of the serosa, which could result in secondary perforation. Further, to sew over the resection site in risky situations is easily accomplished.

Endoscopy-Assisted Wedge Resection [6]

Here, after exact endoscopic localization of the lesion, it is resected, such as risk of local recurrence or metatization, which is in general 0-5% [7]. In this case, endoscopic treatment is performed by a team consisting of a surgeon (laparoscopic, endoscopic assisted) as well as the endoscopist (endoscopic, laparoscopic assisted). This approach allows for individual and situation dependent adaption according to in situ findings, and a recent classification system by the authors is listed below [6, 8].

Laparoscopically Assisted Endoscopic Resection

Pedunculated polyps in locations difficult to reach endoscopically can be exposed intraluminal and thus made accessible for endoscopic snare resection by impressing the corresponding part of the colon with laparoscopic instruments (Figure 1, upper panel). Even in purely endoscopic resections, laparoscopy can help to rule out a putative perforation or violation of the serosa, which could result in secondary perforation. Further, to sew over the resection site in risky situations is easily accomplished.
Excised tangentially with a linear stapling device (Figure 1, middle panel). Advancing the endoscope beyond the affected segment protects the respective lumen during resection. For procedures affecting the cecal region, the colonoscope can be passed into the terminal ileum.

**Endoscopy-Assisted Transluminal Resection [6]**

For lesions located near the mesentery, a small colostomy is performed after precise localization of the lesion during colonoscopy. The lesion is elevated and resected by application of a linear-stapling device (Figure 1, lower panel). Closure of the colostomy is achieved by utilizing laparoscopic sutures or a linear stapling device.

**Endoscopy-Assisted Segment Resection [6]**

For lesions inaccessible to the above mentioned procedures, laparoscopic segmental colon resection under endoscopic guidance can be performed. By precise endoscopic localization of the lesion, wide surgical mobilization of the colon usually can be avoided.

**Advantages of Combined Laparoscopic-Endoscopic Resections**

Post polypectomy perforation of the colon secondary to either manipulation or cautery occurs in 0.1% to 3% after classical endoscopic polypectomy [9], with rising rates for difficult polypectomies. By combined laparoscopic-endoscopic resections, the suture can be judged directly during and after performing the anastomosis with regards to bleeding, leakage, or technical defects. As combined laparoscopic-endoscopic resections are usually used for intraluminal detectable lesions, the simultaneous endoscopy warrants an exact identification of the location within the colorectum, so that even if segmental resection becomes necessary, the lowest possible loss of healthy colon is ensured (Figure 2). The extent of resection including safety margins can clearly be identified. By the intraoperative assessment from intraluminal and extraluminal, the specific resection procedure as mentioned above can be chosen instantly without any doubt. In the case of wedge resection, splitting протяжении процедуры ситуация может меняться в зависимости от находок in situ. Недавно предложенная авторами и в целом принятая система классификации приведена ниже [6, 8].

**Эндоскопическая резекция с лапароскопической ассистенцией**

Полипы на ножках, расположенные в местах, которые трудно достичь эндоскопически, могут стать доступными для эндоскопической резекции петлей после вдавления соответствующей части толстой кишки с помощью лапароскопических инструментов (Рис 1, верхний ряд). Даже при чисто эндоскопических резекциях, лапароскопия может помочь исключить предполагаемую перфорацию или повреждение серозной оболочки, что может привести к вторичной перфорации. А также наложить шов в месте резекции в рискованных ситуациях.

**Клиновидная резекция с эндоскопической ассистенцией** [6]

После точной эндоскопической локализации очага поражения, его вырезают по касательной с применением линейного сшивания устройства (Рис 1, средний ряд). Продвижение эндоскопа за пораженный сегмент защищает просвет кишечника во время резекции. При процедуре в области слепой кишки, колоноскоп может быть перемещен в конечную часть подвздошной кишки.

**Транслюминальная резекция с эндоскопической ассистенцией** [6]

При образованиях, расположенных вблизи брыжейки, небольшая колостома формируется после точной локализации образования во время колоноскопии. Опухоль выделяют и резецируют с применением линейного сшивания устройства (Рисунок 1, нижний ряд). Закрытие колостомы выполняется с помощью наложения лапароскопических шовов или использования линейного сшивющего устройства.

**Сегментарная резекция с эндоскопической ассистенцией** [6]

При образованиях, недоступных при вышеописанных процедурах, может быть выполнена лапароскопическая сегментарная резекция толстой кишки под эндоскопическим контролем. При точной эндоскопической локализации образования можно избежать широкой хирургической мобилизации кишки.
the colon with the endoscope protects the respective lumen during tangential stapling [6], thus preventing postoperative stenosis of the resection bearing segment.

Disadvantages of Combined Laparoscopic-Endoscopic Resections

If performed by a trained team consisting of a laparoscopic surgeon and an endoscopist in specialized facilities, no relevant disadvantages result of combined laparoscopic-endoscopic resections when compared to laparoscopy alone. The risk of endoscopic bowel perforation is reduced to a minimum by intraabdominal surveillance. Difficult sections like an elongated sigmoid can even be passed endoscopically with laparoscopic help. Operation times are not elongated relevantly [6], however, larger requirements are made to the physicians’ skills and to the local and instrumental facilities. In a series of the authors’ institution, the intraoperative complication rate after combined resections for colorectal polyps was 1% [6].
However, combined laparoscopic-endoscopic resections are not suitable for resection of advanced malignant tumors because radical lymph node dissection is not part of the technique [6]. If invasive cancer has been proven beforehand or the intraoperative appearance of the lesion is suspicious for malignant disease, laparoscopic or open oncologic resection should be performed [6], with only a few exceptions as mentioned above. If pathological examination of the resection specimen reveals high grade invasive cancer, reoperation with oncological resection is necessary as well [6].

Outlook: Future Developments in Colorectal Resection

Single Incision Laparoscopic Surgery

In single incision laparoscopic surgery (single port technique), only one port is introduced into the abdomen, usually in the umbilicus or at a site where a stoma is planned, in order to reduce trocar related complications, inflammatory response, and to improve cosmetic results, albeit it causes higher costs [10]. In 1992, the first report of appendectomy by single incision laparoscopy was published [11], followed by transumbilical cholecystectomy [12] and colonic resections [13]. Current data including systematic reviews and meta-analysis conclude that single incision laparoscopic surgery is a feasible and safe procedure for selected patients (low BMI, preferably location in the right hemicolon) if applied by trained physicians, however, not superior to conventional laparoscopy regarding postoperative pain, adhesions, and complications [10, 14, 15]. As all other procedures, single incision laparoscopic surgery can be performed together with combined laparoscopic-endoscopic resections as well; however, the experience in this topic is very limited so that no clear conclusions can be drawn today. Due to inherent obstacles and a significant reduction of the degrees of freedom the current impact and estimated future relevance of single incision laparoscopic surgery is low.

Nедостатки комбинированных лапароскопически - эндоскопических резекций

Если вмешательство выполняется обученной командой, включающей лапароскопического хирурга и эндоскописта, в специализированном учреждении, то отсутствуют недостатки, которые могут ухудшить результат комбинированной лапароскопически - эндоскопических резекций по сравнению с лапароскопической операцией. Риск эндоскопической перфорации кишечника сводится к минимуму за счет внутрибрюшного контроля. Сложные участки кишечника, как, например, удлиненная сигмовидная кишка даже могут быть пройдены эндоскопически с лапароскопической ассистенцией. Время операции относительно не увеличилось, однако, такое вмешательство требует соответствующей квалификации хирурга, инструментов и оборудования. В центрах, в которых практикуют авторы статьи, показатель интраоперационных осложнений после комбинированных резекций колоректальных полипов составляет 1% [6].
Robotic Laparoscopic Surgery
In 2002, the first two cases of robotic colectomies were published [16]. Although expensive and time consuming, by three-dimensional imaging, automated reduction of the surgeon’s tremor and a wide range of motion, more advanced laparoscopic interventions are possible by robotic surgery (e.g. da Vinci robotic surgical system, Intuitive Surgical, Inc, Sunnyvale, CA) [10].

Further, lymphadenectomy and intracorporeal anastomosis are easier to conduct by this system [10]. Today, robotic colorectal surgery is estimated safe and feasible, with comparable short-term outcomes compared to conventional laparoscopic surgery [10].

Especially in rectal diseases, the access to the narrow pelvic cavity can be even better than in conventional open procedures, and the excellent view supposedly provides large numbers of harvested lymph nodes, greater distances of the resection margin, and nerve sparing operations [10].
to the sphincter can be better visualized than in a classical transabdominal approach [10].

Conclusion
Endoscopic removal is the treatment of choice for colorectal polyps. The majority of colonic polyps found at endoscopy are suitable for diathermy snare excision via the colonoscope, but large, sessile, or awkwardly located polyps hold the risk of colonic perforation, bleeding, or inadequate excision [9]. Because of location or size, some lesions are deemed unsafe for classical endoscopic resection and therefore have been assigned to extended surgical resection previously. Minimally invasive techniques are still underused today [10], but combined laparoscopic-endoscopic resection is a safe and efficient therapeutic approach for selected patients with large polyps or those that are difficult to access by conventional snare polypectomy [6]. Intraoperative endoscopy provides additional safety for the laparoscopic surgeon by precise localization of the lesion and endoluminal observation of resection and reconstruction [6]. Whenever needed, the completion of treatment by means of laparoscopic colonic resection is possible without problems in the same procedure [9].

ванным лапароскопическим вмешательством с трехмерной визуализацией, автоматическим уменьшением тремора рук хирурга, широким спектром движений (например, хирургическая роботизированная система Да Винчи от Intuitive Surgical, Inc, Саннивэйл, Калифорния) [10]. Кроме того, с помощью этой системы легче выполнить лимфаденэктомию и наложение интеркорпорального анастомоза. В настоящее время роботизированная колоректальная хирургия оценивается как безопасная и целесообразная, а краткосрочные результаты сопоставимы с результатами обычной лапароскопической хирургии. Особенно при заболеваниях прямой кишки, доступ к узкой полости малого таза может быть даже лучше, чем при обычных открытых операциях, а прекрасный обзор позволяет удалить больше лимфатических узлов, обеспечивает большую ширину краев резекции, а также нервосберегающую методику оперирования [10].

Эндоскопическая хирургия через естественные отверстия (NOTES)
При «эндоскопической хирургии через естественные отверстия» доступ в брюшную полость осуществляется через естественные отверстия: рот (трансгастральный доступ), уретру (трансвагинальный доступ), влагалище (трансвагинальный доступ), или анус (трансректальный доступ) [10]. Сообщение о первой трансанальной эндоскопической сигмоидэктомии было опубликовано в 2009 году [17], однако новые методики, как правило, включают применение лапароскопических троакаров, а эксцизия образца тканей выполняется трансвагинально или трансректально [10]. Современная модификация TEM (трансанальной эндоскопической микрохирургии) TAMIS (трансанальная минимально инвазивная хирургия) характеризуется использованием лапароскопическо-
Literature


Выводы
Эндоскопическое удаление является методом выбора при лечении полипов. Большинство полипов толстой кишки, найденные при эндоскопическом исследовании, можно удалить посредством диатермии с помощью петли во время колоноскопии, однако больше, на широком основании, или расположенные в труднодоступных местах полипы несут риск перфорации толстой кишке, кровотечении или недостаточно инсуффекции. Удаление некоторых образований с помощью классической эндоскопической резекции из-за их местораспо-
Introduction
Total elbow arthroplasty (TEA) is indicated for advanced degenerative joint conditions (i.e. rheumatoid arthritis), post-traumatic sequelae and primary fracture treatment [1, 2].

Distal humeral fractures currently represent only 2% of all elbow fractures, and 5% of fractures in individuals older than 60 years [3, 4]. Consequently orthopaedic surgeons in training will encounter relatively few of those during their training years and even when working as a consultant in a specialist upper limb department it is unlikely to be called up to treat these challenging fractures on a regular basis [3]. Due to demographic changes an increasing number of humeral fractures in the elderly can be assumed [5]. Hence, the most appropriate treatment will become the focus.

For old patients with comorbidities and decreased bone quality who suffered a severe intraarticular comminuted fracture of the distal humerus, primary TEA enables an immediately stable joint situation, followed by early functional treatment and rehabilitation with good to excellent clinical results [6, 7].

If surgery is contraindicated in the fracture situation (i.e. due to severe cardiopulmonary diseases) the elbow joint can also be immobilised with a cast (6 to 12 weeks). However, the risk for persistent pain and functional limitations is markedly increased by conservative treatment.

Nevertheless, secondary TEA is still possible [8]. Prasad and Dent [9] observed no significant differences concerning the functional outcome after secondary TEA. The patients included in their study underwent secondary total elbow replacement at a mean of 56 weeks following trauma.

Compared to total knee and hip arthroplasty the overall risk for complications is higher after TEA (24.3% + 5.8%) [10]. There is an increased risk for aseptic loosening of TEA in the post-traumatic sequelae (10.2%) – which includes ankyloses, instability, severe posttraumatic arthrosis – compared to total knee and hip arthroplasty (2.3% + 1.5%) [10].

Consequently, early functional treatment and rehabilitation with good to excellent clinical results can be achieved.

Total Elbow Arthroplasty – Indication and Therapeutic Approach

Тотальное эндопротезирование локтя: показания и терапевтический подход

Введение
Тотальное (полное) эндопротезирование локтя (ТЭЛ) показано при запущенных дегенеративных заболеваниях локтевого сустава (например, ревматоидном артрите), посттравматических осложнениях и лечении первичного перелома [1, 2].

Дистальные переломы плечевой кости в настоящее время составляют лишь 2% от всех переломов локтевого сустава и 5% от переломов у лиц старше 60 лет [3, 4]. Следовательно, хирурги-ортопеды нечасто сталкиваются с такой патологией в период обучения и, даже при работе в качестве консультанта в специализированном отделении верхней конечности, нерегулярно лечат эти сложные переломы [3]. В связи с изменением демографической ситуации, можно предположить увеличение числа переломов плечевой кости у пожилых людей [5]. Следовательно, будет востребовано соответствующее лечение.

У пациентов пожилого возраста с сопутствующими заболеваниями и сниженным качеством костной ткани, с тяжелым внутрисуставным оскольчатым переломом дистального отдела плечевой кости, первичное ТЭЛ обеспечивает немедленную стабилизацию сустава и последующую раннюю реабилитацию с хорошими и отличными клиническими результатами [6, 7]. Если операция при переломе противопоказана, например, из-за серьезных сердечно-легочных заболеваний, локтевой сустав может быть иммобилизован с помощью гипсовой повязки в течение 6-12 недель. Однако после консервативного лечения риск постоянных болей и функциональных ограничений заметно увеличивается.

Тем не менее, после этого все еще возможно проведение вторичного ТЭЛ. Prasad и Dent [9] сообщили, что не наблюдали никакого существенного различия функционального результата после вторичного ТЭЛ. Пациентам, участвующим в их исследовании, полная замена локтка была выполнена, в среднем, через 56 недель после травмы.

Po сравнению с тотальным эндопротезированием коленного и тазобедренного суставов, общий риск осложнений после ТЭЛ выше (24,3% + 5,8%) [10]. В частности, существует повышенный риск асептического расшатывания протеза при посттравматических осложнениях (10,2%), которые включают анкилозы, не-
pared to patients with rheumatoid arthritis (5.3%) or those with an acute distal humeral fracture (3.7%). The survival rate of TEA in patients with rheumatoid arthritis at a 10 to 15 year follow-up is – on average – 92.4% [11]. However, after secondary TEA in post-traumatic sequelae the survival rate decreases to a mean of 65% [12]. Younger patients (< 65 years) with higher daily loads have a three-fold increased risk for “mechanical complications” such as stem fractures or polyethylene wear [12]. Therefore, TEA – especially in younger patients – should be carefully considered. For distal humeral fractures open reduction and internal fixation (ORIF) remains the gold standard – aiming for a reliable and anatomical joint reconstruc-

стабильность, тяжелый посттравматический артроз, у пациентов с ревматоидным артритом (5,3%) или с острым дистальным переломом плечевой кости (3,7%). Выживаемость пациентов через 10-15 лет после ТЭЛ составляет, в среднем, 92,4% [11]. Однако после вторичного ТЭЛ при посттравматических осложнениях такая выживаемость уменьшается, в среднем, до 65% [12]. У более молодых пациентов (<65 лет) с высокими ежедневными нагрузками в три раза увеличен риск «механических» осложнений, таких как переломы ножек или износ полиэтилена [12]. Таким образом, применение ТЭЛ, особенно у молодых пациентов, должно рассматриваться очень тщательно. При дистальном переломе плечевой кости открыта репозиция и внутренняя фиксация (ОРФ) остается золотым стандартом.
Fig. 2: (a) ORIF failure with secondary fragment dislocation and post-traumatic degenerative changes in a 69 year old female who had suffered a severe comminuted distal humeral fracture. (b) At two year follow up after secondary TEA with a cemented, semi-constrained Latitude™ (Fa. Tornier) prosthesis the patient is pain-free and has a good function (E/F 0°-0°-115°, P/S 90°-0°-90°). ©Department of Trauma and Orthopaedic Surgery, University of Cologne, Germany
tion, which allows for an early functional treatment. Although ORIF is generally the treatment of choice, complex fracture patterns of the distal humerus (AO Type B3 and C3) and/or a comminuted dorsal fracture zone (Dubberley Classification Type B [13]) may make it impossible to address the fracture sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

However, the decision must be taken individually. Hence, the option for TEA should be available at the time of surgery for all distal humeral fractures in this patient population [3].

In low-demand patients or in patients with reduced functional expectations, TEA can be performed in patients with even less than 75 years of age. An advantage of primary TEA in old patients with severely comminuted fractures is the potentially shorter time of surgery — compared to ORIF — with a good functional outcome in the short-term [14, 15]. If the elbow joint is already altered preoperatively by degenerative changes or rheumatoid arthritis, primary TEA is an option for simpler fracture patterns as well [14].

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computed tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.

**Diagnostic and Therapeutic Approach**

A detailed patient history should be recorded preoperatively. A thorough physical examination including skin and joint status of the injured elbow and the neurovascular conditions should be performed as well. The course of the ulnar nerve (previous operations?) and a possible tendency to dislocate from the cubital tunnel are of particular interest. Furthermore the condition of triceps and biceps muscle should be analysed.

A radiological examination of the total upper extremity in two standardised views is necessary. In fracture cases we recommend an additional computer tomography (CT) of the elbow with a coronal and a sagittal 3D-reconstruction to facilitate the understanding of the fracture pattern. In complex comminuted distal humeral fractures the decision for ORIF or primary TEA is often made intraoperatively. Primary TEA may be a good alternative therapeutic approach if the joint cannot be sufficiently addressed by an osteosynthesis or if the patient is older than 75 years [Figure 1 a/b].

Non-union, secondary fracture dislocations or advanced post-traumatic osteoarthritis are possible complications after ORIF of comminuted fractures for achieving a reliable anatomic reconstruction of the joint, what allows to perform primary functional reimplantation. However ORIF is a method of choice, complex fracture patterns can be addressed sufficiently by osteosynthesis. Therefore, patients with a severely comminuted fracture of the distal humerus who are older than 75 years should be considered for primary TEA.
of the distal humerus. In young and functionally demanding patients the attempt to save the joint is recommended [12] through the use of different techniques such as Re-ORIF or interposition arthroplasty as a salvage procedure [16]. However, if severe posttraumatic bony changes are obvious and/or a chronic posttraumatic joint instability is detectable, a secondary TEA (cemented and semi-constrained) is an option to reduce pain and improve function [Figure 2 a/b]. Pogliacomi et al [17] recommend TEA for non-unions of the distal humerus as an alternative for ORIF. The satisfactory results in their study lead the authors to consider TEA, preferably with linked implants, indicated in selected patients older than 70 years and low functional-demand.

Regarding postoperative treatment after TEA compliance is crucial. Weight lifting over 5 kg or repetitive movements, with weights of more than 1 kg, should be avoided. Patients’ compliance is mandatory for the success of TEA.

Indications and contraindications for TEA are summarized in tables 1 and 2.

Prosthetic Designs
Elbow arthroplasties have undergone a considerable evolution in the last decades because of better anatomical and biomechanical knowledge, continued development of biomaterials, improvement of operative techniques and better definition of the surgical indications [18]. Total elbow designs include “constrained/linked” and “unconstrained/unlinked” implants. A fully “constrained” prosthesis is no longer commercially produced. To reduce shear forces and stresses on the implant-bone-cement interface modern implants have a “sloppy-hinge” mechanism which enables on average 7° valgus-varus movements. This modification decreased the rate of aseptic loosening and periprosthetic fractures occurring with the fixed-hinged implants [19].

Introduction of the anterior humeral flange – which increases rotatory stability and decreases posteriorly-directed stresses – contributes to the increase in the survival of implants as well [20]. Consequently, modern nой мере восстановлен методом остеосинтеза или если пациент старше 75 лет (Рисунок 1 а/b). Несрастание, вторичное смещение костей или тяжелый посттравматический остеоартрит являются возможными осложнениями после ОРВФ оскольчатых переломов дистального отдела плечевой кости. У молодых и функционально требовательных пациентов рекомендуется попытаться сохранить сустав путем использования различных методов [12], таких как повторная ОРВФ или интерпозиционная артропластика как «процедура отчаяния» [16]. Однако, если тяжелые посттравматические изменения костей очевидны и/или обнаруживается хроническая посттравматическая нестабильность сустава, вторичное ТЭЛ (цементное и полусвязанное) является лечебной опцией с целью уменьшения боли и улучшения функции (Рисунок 2 а/b).

Pogliacomi с соавт. [17] рекомендуют ТЭЛ при несрастании перелома дистального отдела плеча как альтернативу ОРВФ. Удовлетворительные результаты исследования позволяют авторам применять ТЭЛ, предпочтительно со связанными протезами, у отдельных пациентов старше 70 лет и низким функциональными запросами. Критически важным при ТЭЛ является соблюдение послеоперационного режима. В частности, следует избегать подъема грузов более 5 кг или повторяющихся движений с весом более 1 кг. Способность пациентов соблюдать все врачебные предписания является обязательным условием для успешности ТЭЛ.

Показания и противопоказания к ТЭЛ представлены в таблицах 1 и 2.

Дизайн протезов
За последние десятилетия артропластика локтя претерпела значительную эволюцию вследствие улучшения знаний об анатомии и биомеханике сустава, продолжающегося развитие биоматериалов, совершенствования оперативной техники и более четкого определения хирургических показаний [18]. Дизайн протезов локтевого сустава может включать связанные / сочлененные «и несвязанные / несочлененные» имплантаты. Полностью «связанный» протез больше не производится. Для уменьшения сдвигающих сил и нагрузки в зоне взаимодействия имплантат-кость-цемент совре-
“constrained” implants are more appropriately rather termed “semiconstrained”. In younger patients with good bone quality, stable ligaments and a preserved radial column (native radial head or radial head replacement) an unconstrained, cemented TEA can be used. The implantation of an unconstrained prosthesis is generally more sophisticated. Joint stability has to be checked carefully during surgery. If the joint is not stable, the implants must be converted to a constrained prosthesis. Plaschke et al. [21] found in their retrospective analysis of 167 procedures no clinically significant differences after linked or unlinked TEAs. The authors concluded that their results could be due to the implant selected, the level of elbow destruction or the indication for surgery. Axial forces – applied on the hand in extension – are transferred with up to 60% at the radial column [22]. Preservation of radial head or radial head replacement should be contemplated to maintain a physiological load distribution and joint stability. After radial head replacement a sufficient humeral and ulnar articulation over the entire range of motion has to be verified intraoperatively. Otherwise a radial head replacement is not recommended.

If the radial head is not replaced/preserved or the capsule-ligamentous structures are not stable or severe bony lesions are obvious a cemented and “semiconstrained” prosthesis is the treatment of choice. Hemiarthroplasty of the elbow is also an option to treat severely comminuted fractures of the distal humerus. An ideal indication for a hemiarthroplasty is an AO type B3/Dubberley 2B fracture with preserved condyles. Stable joint conditions and integrity of the proximal ulna and radial head must be checked previously. Although reliable medium-term results with functional outcome and complication rates comparable with ORIF and TEA are reported for hemiarthroplasty in comminuted intraarticular distal humeral fractures [23], long-term success of hemiarthroplasty cannot be foreseen at the present time. A progress of degenerative changes – especially of the proximal ulna – and protrusions can be observed due to altered joint kinematics [24-27]. In our therapeutic approach hemiarthroplasty is therefore hardly used.

Surgical Approach
We recommend general anaesthesia combined with a regional anaesthetic procedure (i.e. interscalene catheter) with the patient in supine position.
implants. Two established
the ulna depend on the used
action of the distal humerus and
The bony cut and the prepara-
[10]. For an iatrogenic nerve injury
at the end of surgery. The risk
ous transposition of the nerve
during surgery. We advocate a
to be protected in any case
the medial epicondyle, respec-
the arcade of Osborne – ap-
ulnar nerve must be released
wound healing problems. The
should be dissected to avoid
thickness subcutaneous flaps”
approach is used. “Full
the distal humerus the "triceps
proximally from the arcade
in old patients and the “triceps re-
fracture cases with "loss" of the
distal humerus the "triceps on” approach is used. “Full
thickness subcutaneous flaps” should be dissected to avoid
wound healing problems. The
ulnar nerve must be released proximally from the arcade
of Struthers and distally from
the arcade of Osborne – ap-
proximately 8 cm in relation to the
medial epicondyle, respect-
vatively. The ulnar nerve needs to be protected in any case
during surgery. We advocate a
routine tension free exposure to the elbow joint without an
increased risk for iatrogenic injuries should be used. A
surgical approach other than olecranon osteotomy, which
would preclude TEA is required [3]. In our clinic we use the “tri-
ceps split” of Gschwend [29]
If osteosynthesis is necessary
due to an additional supracon-
dyloid fracture, we would re-
command inserting a trial stem to
preserve a pathway for the
original implant. The humeral
and ulnar bone for both compo-
ents will be prepared by use
of a high speed bone milling
machine, flexible intramedul-
dary drills and implant specific
instruments. This procedure
must be performed carefully to
avoid intraoperative complica-
tions such as bone perfora-
For an optimal retrograde
intramedullary bone cement
application – after thorough
bone cleaning by pulsatile jet-
lavage – we recommend using
a thin nozzle on the cement
injection gun (Cement Nozzle
Small Diameter, Biomet Ger-
many GmbH, Berlin, Germany). Absorbable intramedullary ce-
ment stoppers are obligatory. The humeral and ulnar compo-
ent should be implanted suc-
cessively. Finally, component
systems, which are commonly
used in our clinic, are the
Coonrad-Morrey (Nexel™, Zim-
mer® Company, Warsaw, IN, USA) and the convertible Latiti-
tude™ (Fa. Tornier, Saint-Ismier, France) prosthesis. Detailed
descriptions of implantation
 technique for both systems
have already been published by Müller et al. [15] and Burkhart
et al. [30].

If osteosynthesis is necessary
due to an additional supracon-
dyloid fracture, we would re-
command inserting a trial stem to
preserve a pathway for the
original implant. The humeral
and ulnar bone for both compo-
ents will be prepared by use
of a high speed bone milling
machine, flexible intramedul-
dary drills and implant specific
instruments. This procedure
must be performed carefully to
avoid intraoperative complica-
tions such as bone perfora-
For an optimal retrograde
intramedullary bone cement
application – after thorough
bone cleaning by pulsatile jet-
lavage – we recommend using
a thin nozzle on the cement
injection gun (Cement Nozzle
Small Diameter, Biomet Ger-
many GmbH, Berlin, Germany). Absorbable intramedullary ce-
ment stoppers are obligatory. The humeral and ulnar compo-
ent should be implanted suc-
cessively. Finally, component
functional results and the
complications of the various
implantation techniques, cou-
ounded with a long-term out-
come evaluation. The best
results are obtained with the
Coonrad-Morrey system, with
the lowest complication rates
and the highest patient satis-
faction. The results of the
Gschwend system are also
favorable, but the disad-
bantages of the system are
the difficulty of the surgical
procedure and the higher cost
compared to the Coonrad-
Morrey system.

We believe that the choice
of implantation technique and
the surgical approach should
be based on the specific
requirements of the patient
and the surgical team. Different
approaches may be neces-
sary for different cases, and
the surgeon should be aware
of the advantages and disad-
bantages of each technique.

In conclusion, we recom-
mend using the Coonrad-
Morrey implantation technique
for elbow arthroplasty, espe-
cially in young patients with
varus deformity. The results
are excellent, with a high
level of patient satisfaction and
a low rate of complications. The
Gschwend system is also a good
option, but it requires more ex-
sperience and is more expensive.

In our clinic, we use a vari-
ety of surgical approaches
depending on the patient’s
condition and the surgeon’s
preferences. We believe that
the best results are obtained
with a careful surgical pro-
cedure and a thorough post-
surgical rehabilitation.

References
[5] Zimmer® Company, Warsaw, IN, USA.
[7] cement. The best results are
gained with the Coonrad-
Morrey system, with the lowest
complication rates and the highest
patient satisfaction. The results
of the Gschwend system are also
favorable, but the disadvantages
of the system are the difficulty
of the surgical procedure and
the higher cost compared to the
Coonrad-Morrey system.

We believe that the choice
of implantation technique and
the surgical approach should
be based on the specific
requirements of the patient
and the surgical team. Different
approaches may be neces-
sary for different cases, and
the surgeon should be aware
of the advantages and disad-
bantages of each technique.

In conclusion, we recom-
mend using the Coonrad-
Morrey implantation technique
for elbow arthroplasty, espe-
cially in young patients with
varus deformity. The results
are excellent, with a high
level of patient satisfaction and
a low rate of complications. The
Gschwend system is also a good
option, but it requires more ex-
sperience and is more expensive.

In our clinic, we use a vari-
ety of surgical approaches
depending on the patient’s
condition and the surgeon’s
preferences. We believe that
the best results are obtained
with a careful surgical pro-

Complications
Insufficiency or dehiscence of the triceps muscle is one of the most frequent complications following TEA. A thorough refixation of the extensor mechanism at the end of surgery is therefore mandatory. Due to a relatively thin soft tissue envelope the elbow is at increased risk for infection after TEA which highlights the importance of a secure wound closure. Furthermore, obesity and associated medical comorbidities place patients at increased risk for complications after TEA [31]. Those patients should be appropriately counselled preoperatively about their increased risk for complications [31].

Dissection and protection of the ulnar nerve is important to avoid an iatrogenic injury. We advocate an anterior subcutaneous transposition of the ulnar nerve at the end of surgery to guarantee its tension free course.

Good stability of the capsuloligamentous structures is essential for both “unconstrained” and “semiconstrained” implants. A significant joint instability increases the risk for implant dislocation in “unconstrained” TEA. A significant instability also increases the risk of aseptic loosening in “constrained” TEA due to higher stresses on the implant-bone-cement interface. Despite of the “sloppy-hinge” mechanism higher loads lead to more polyethylene wear debris, which increases the risk for aseptic loosening respectively. The weight limit of 5 kg after TEA is mandatory for the survival of the implants. Most frequent long-term complications are implant failures like stem fractures or dislocation of constrained implants.

Table 2: Contraindications for TEA

<table>
<thead>
<tr>
<th>Contraindications for TEA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absolute</strong>&lt;br&gt;Open fractures&lt;br&gt;Infection&lt;br&gt;Dysfunction of triceps and biceps muscle&lt;br&gt;Severe functional impairment of the hand&lt;br&gt;Tendency to keloid formation (CAVE: soft tissue coverage of implants)&lt;br&gt;Heavy physical work (CAVE: load limit after TEA)</td>
</tr>
<tr>
<td><strong>Relative</strong>&lt;br&gt;Neuropathic arthropathies&lt;br&gt;Poor patient compliance&lt;br&gt;Neuropsychiatric disorders</td>
</tr>
</tbody>
</table>

Table 2: Противопоказания для ТЭЛ

<table>
<thead>
<tr>
<th>Противопоказания для ТЭЛ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Абсолютные</strong>&lt;br&gt;Открытые переломы&lt;br&gt;Инфекция&lt;br&gt;Недостаточность троицы и бицепса&lt;br&gt;Серьезное функциональное нарушение руки&lt;br&gt;Тенденция к абсцессу (CAVE: покрытие протеза тканью)&lt;br&gt;Тяжелая физическая работа (CAVE: нагрузочная норма после ТЭЛ)</td>
</tr>
<tr>
<td><strong>Относительные</strong>&lt;br&gt;Нейропатические артропатии&lt;br&gt;Недостаточность выполнения пациентом процедур&lt;br&gt;Нейropsychические расстройства</td>
</tr>
</tbody>
</table>

Articulation and stability must be examined over the entire range of motion at the end of surgery. A thorough reconstruction of the extensor mechanism is mandatory (i.e. transosseous triceps refixation). Furthermore, a careful wound closure with sufficient soft tissue coverage of the prosthesis is essential to reduce the risk for postoperative complications.
Conclusion
Osteosynthesis remains the gold standard for fractures of the distal humerus. In severely comminuted intraarticular distal humeral fractures – especially in patients older than 75 years – a primary TEA enables a stable joint reconstruction which reduces pain and increases function. If a distal humeral fracture cannot be treated by reliable ORIF the treatment of choice should be a cemented and “semiconstrained” TEA. Postoperative complications can be reduced by careful indication and thorough surgery. A good patient compliance is crucial after TEA. Limitation of weight-bearing (< 5kg) is mandatory and can reduce the risk for “mechanical” complications and early aseptic loosening.


Keywords: ICG (indocyanine green), perfusion, LFA (laser fluorescence angiography), NIR (near infrared) imaging, fluorescence imaging, angiography, colorectal surgery, mesenterial ischaemia, transplantation, parathyroidectomy, metastectomy, sentinel lymph node, esophageal resection

Introduction

Indocyanine green (ICG) evolved during World War II as a dye for photography and was initially applied as a diagnostic modality in liver function tests and later in cardiology. During the last years, a major progress has been made in the field of artificial imaging to support the ICG use in surgery. This technical support has opened new horizons for fluoroscopy and has regenerated the interest of surgeons in the application of ICG [2-4].

ICG is an amphiphilic, water soluble fluorophore with an excellent tissue penetration and a high binding affinity to plasma proteins, globulins and albumin [2, 3]. ICG is administered intravenously in a dosage of 0.1-0.5 mg/kg, has a half-time of 150-180 seconds and is metabolized by the liver [4]. The use of ICG for diagnostic applications is clinically safe as anaphylactic reactions only occur in very rare cases. After intravenous administration, ICG binds rapidly to plasma proteins. The spectral absorption of ICG in blood is at about 780 nm and emission at about 830 nm [2]. The images can be obtained using a charge coupled device near-infrared video camera.

Several imaging systems are commercially available for fluorescence angiography, for example, the SPY Elite (Novadaq) for open surgery, the PINPOINT (Novadaq) for laparoscopic and thoracoscopic surgery, the NIR/ICG system (Karl Storz-Endoskope), the built-in Firefly system (DaVinci) for robotic surgery and the IC-VIEW system (Pulsion). These fluorescence angiography/videography systems are also referred to as “laser fluorescence (LFA) angiography” or “near infrared (NIR) imaging” in the literature.

Spectrum of Practical Application of Indocyanine Green Fluorescence Angiography in General and Thoracic Surgery

A dye for photography and was first introduced in medicine at the Mayo clinic in 1957 [1]. Two years later ICG gained FDA approval and was initially applied as a diagnostic modality in liver function tests and later in cardiology. During the last years, a major progress has been made in the field of artificial imaging to support the ICG use in surgery. These technical support has opened new horizons for fluoroscopy and has regenerated the interest of surgeons in the application of ICG [2-4].

ICG is an amphiphilic, water soluble fluorophore with an excellent tissue penetration and a high binding affinity to plasma proteins, globulins and albumin [2, 3]. ICG is administered intravenously in a dosage of 0.1-0.5 mg/kg, has a half-time of 150-180 seconds and is metabolized by the liver [4]. The use of ICG for diagnostic applications is clinically safe as anaphylactic reactions only occur in very rare cases. After intravenous administration, ICG binds rapidly to plasma proteins. The spectral absorption of ICG in blood is at about 780 nm and emission at about 830 nm [2]. The images can be obtained using a charge coupled device near-infrared video camera.

Several imaging systems are commercially available for fluorescence angiography, for example, the SPY Elite (Novadaq) for open surgery, the PINPOINT (Novadaq) for laparoscopic and thoracoscopic surgery, the NIR/ICG system (Karl Storz-Endoskope), the built-in Firefly system (DaVinci) for robotic surgery and the IC-VIEW system (Pulsion). These fluorescence angiography/videography systems are also referred to as “laser fluorescence (LFA) angiography” or “near infrared (NIR) imaging” in the literature.

Keyophrases: ICG (indocyanine green), perfusion, LFA (laser fluorescence angiography), NIR (near infrared) imaging, fluorescence imaging, angiography, colorectal surgery, mesenterial ischaemia, transplantation, parathyroidectomy, metastectomy, sentinel lymph node, esophageal resection

Introduction

Indocyanine green (ICG) evolved during World War II as a dye for photography and was first introduced in medicine at the Mayo clinic in 1957 [1]. Two years later ICG gained FDA approval and was initially applied as a diagnostic modality in liver function tests and later in cardiology. During the last years, a major progress has been made in the field of artificial imaging to support the ICG use in surgery. These technical support has opened new horizons for fluoroscopy and has regenerated the interest of surgeons in the application of ICG [2-4].

ICG is an amphiphilic, water soluble fluorophore with an excellent tissue penetration and a high binding affinity to plasma proteins, globulins and albumin [2, 3]. ICG is administered intravenously in a dosage of 0.1-0.5 mg/kg, has a half-time of 150-180 seconds and is metabolized by the liver [4]. The use of ICG for diagnostic applications is clinically safe as anaphylactic reactions only occur in very rare cases. After intravenous administration, ICG binds rapidly to plasma proteins. The spectral absorption of ICG in blood is at about 780 nm and emission at about 830 nm [2]. The images can be obtained using a charge coupled device near-infrared video camera.

Several imaging systems are commercially available for fluorescence angiography, for example, the SPY Elite (Novadaq) for open surgery, the PINPOINT (Novadaq) for laparoscopic and thoracoscopic surgery, the NIR/ICG system (Karl Storz-Endoskope), the built-in Firefly system (DaVinci) for robotic surgery and the IC-VIEW system (Pulsion). These fluorescence angiography/videography systems are also referred to as “laser fluorescence (LFA) angiography” or “near infrared (NIR) imaging” in the literature.

Keyophrases: ICG (indocyanine green), perfusion, LFA (laser fluorescence angiography), NIR (near infrared) imaging, fluorescence imaging, angiography, colorectal surgery, mesenterial ischaemia, transplantation, parathyroidectomy, metastectomy, sentinel lymph node, esophageal resection

Introduction

Indocyanine green (ICG) evolved during World War II as a dye for photography and was first introduced in medicine at the Mayo clinic in 1957 [1]. Two years later ICG gained FDA approval and was initially applied as a diagnostic modality in liver function tests and later in cardiology. During the last years, a major progress has been made in the field of artificial imaging to support the ICG use in surgery. These technical support has opened new horizons for fluoroscopy and has regenerated the interest of surgeons in the application of ICG [2-4].

ICG is an amphiphilic, water soluble fluorophore with an excellent tissue penetration and a high binding affinity to plasma proteins, globulins and albumin [2, 3]. ICG is administered intravenously in a dosage of 0.1-0.5 mg/kg, has a half-time of 150-180 seconds and is metabolized by the liver [4]. The use of ICG for diagnostic applications is clinically safe as anaphylactic reactions only occur in very rare cases. After intravenous administration, ICG binds rapidly to plasma proteins. The spectral absorption of ICG in blood is at about 780 nm and emission at about 830 nm [2]. The images can be obtained using a charge coupled device near-infrared video camera.

Several imaging systems are commercially available for fluorescence angiography, for example, the SPY Elite (Novadaq) for open surgery, the PINPOINT (Novadaq) for laparoscopic and thoracoscopic surgery, the NIR/ICG system (Karl Storz-Endoskope), the built-in Firefly system (DaVinci) for robotic surgery and the IC-VIEW system (Pulsion). These fluorescence angiography/videography systems are also referred to as “laser fluorescence (LFA) angiography” or “near infrared (NIR) imaging” in the literature.
ICG tissue angiography can offer a real-time assessment of the tissue blood perfusion, thus providing the surgeon with helpful information when critical decisions concerning the adequacy of the blood perfusion have to be made. Here we report some of the most prevalent fields of interest concerning the use of ICG tissue angiography in surgery.

Fluorescence-guided Parathyreoidectomy
Intraoperative identification of the pathological parathyroid glands is often challenging as they are difficult to detect by palpation and strongly vary in size and consistency. Furthermore, the operation must often be performed in an area, which has already been operated on previously, which makes the intraoperative localization of the glands extremely difficult. Concerning the high rates of hypoparathyroidism after a thyreoidectomy, the identification of the parathyroid glands is of major significance during the thyreoidectomy in order to conserve at minimum one vital parathyroid gland. Our group has evaluated the use of ICG fluorescence angiography for the detection of parathyroid glands in 5 consecutive patients undergoing parathyroidectomy (unpublished data). In all 5 cases we could detect the pathological parathyroid gland (Fig. 1).

Two studies have evaluated the use of intraoperative fluorescence for the detection of pathological parathyroid glands. The first one was performed by Prosst et al in our department between 2004 and 2007 [5]. 25 patients suffering from primary and secondary hyperparathyroidism were photosensitized orally with aminolevulinic acid. In 92% of the cases, blue light illumination successfully supported the intraoperative localization of the pathological glands and therefore facilitated the minimal invasive resection. In a recently published case also named «laserный флуоресцентный ангиографий (LFA)» or «визуализацией в ближнем инфракрасном спектре (NIR)».

ICG - angiography provides the surgeon with helpful information when critical decisions concerning the adequacy of the blood perfusion have to be made. Here we report some of the most prevalent fields of interest concerning the use of ICG tissue angiography in surgery.

ICG tissue angiography can offer a real-time assessment of the tissue blood perfusion, thus providing the surgeon with helpful information when critical decisions concerning the adequacy of the blood perfusion have to be made. Here we report some of the most prevalent fields of interest concerning the use of ICG tissue angiography in surgery.

Fluorescence-guided Parathyreoidectomy
Intraoperative identification of the pathological parathyroid glands is often challenging as they are difficult to detect by palpation and strongly vary in size and consistency. Furthermore, the operation must often be performed in an area, which has already been operated on previously, which makes the intraoperative localization of the glands extremely difficult. Concerning the high rates of hypoparathyroidism after a thyreoidectomy, the identification of the parathyroid glands is of major significance during the thyreoidectomy in order to conserve at minimum one vital parathyroid gland. Our group has evaluated the use of ICG fluorescence angiography for the detection of parathyroid glands in 5 consecutive patients undergoing parathyroidectomy (unpublished data). In all 5 cases we could detect the pathological parathyroid gland (Fig. 1).

Two studies have evaluated the use of intraoperative fluorescence for the detection of pathological parathyroid glands. The first one was performed by Prosst et al in our department between 2004 and 2007 [5]. 25 patients suffering from primary and secondary hyperparathyroidism were photosensitized orally with aminolevulinic acid. In 92% of the cases, blue light illumination successfully supported the intraoperative localization of the pathological parathyroid glands. The first one was performed by Prosst et al in our department between 2004 and 2007 [5]. 25 patients suffering from primary and secondary hyperparathyroidism were photosensitized orally with aminolevulinic acid. In 92% of the cases, blue light illumination successfully supported the intraoperative localization of the pathological glands and therefore facilitated the minimal invasive resection. In a recently published case
of 36 patients who underwent hypocalcaemia. In 30 of the parathyroid glands with ICG in the scenario of postoperative hypocalcaemia. In 30 ICG in the scenario of postoperative hypocalcaemia. In 30 of the parathyroid glands with ICG in the scenario of postoperative hypocalcaemia. In 30 out of 36 patients who underwent thyroid surgery at least one parathyroid gland could be detected by ICG angiography. All patients had normal calcium levels on the first postoperative day and none had to be treated for hypoparathyroidism [7].

Fluorescence-guided Esophageal Resection

Anastomotic leakage after esophagectomy with gastric pull-up is a severe complication which is associated with high morbidity and mortality. Compromised perfusion of the Anastomotic region has been defined as one of the main reasons leading to anastomotic leakage. Various methods have been evaluated for the assessment of the perfusion of the gastric conduit including intraoperative angiography and duplex sonography. However, none of those techniques have been established in clinical practice and surgical experience remained as the only tool of assessment practically available. Zehetner et al. used the SpY imaging system for the intraoperative assessment of the perfusion of the gastric conduit in 144 consecutive patients undergoing esophagectomy [8]. In this trial, the authors observed that in case the anastomosis was performed in an area of good perfusion as defined by the SpY system, the anastomotic leakage rate was significant lower (2% leakage rate) compared to cases in which the anastomosis was constructed in an area of less robust perfusion (45% leakage rate).

The viability of the tip of the gastric conduit is often difficult to evaluate macroscopically but represents the most important part for the anastomotic healing, particularly if the gastric conduit has to be mobilized further. ICG angiography can provide important additional information concerning blood perfusion. Our group used ICG angiography for the assessment of the perfusion of the gastric conduit in 20 patients with esophageal cancer undergoing esophagectomy (Fig. 2). The results were compared with 56 patients from our esophageal database. One case of anastomotic leakage was found in the ICG group compared with 10 cases who were operated without using ICG [9].

Intraoperative detection of parathyroid glands during redo-parathyreoidectomy [6]. A recently published project evaluated the impact of intraoperative angiography for the assessment practically available. Zehetner et al. used the SpY imaging system for the intraoperative assessment of the perfusion of the gastric conduit in 144 consecutive patients undergoing esophagectomy [8]. In this trial, the authors observed that in case the anastomosis was performed in an area of good perfusion as defined by the SpY system, the anastomotic leakage rate was significant lower (2% leakage rate) compared to cases in which the anastomosis was constructed in an area of less robust perfusion (45% leakage rate).

The viability of the tip of the gastric conduit is often difficult to evaluate macroscopically but represents the most important part for the anastomotic healing, particularly if the gastric conduit has to be mobilized further. ICG angiography can provide important additional information concerning blood perfusion. Our group used ICG angiography for the assessment of the perfusion of the gastric conduit in 20 patients with esophageal cancer undergoing esophagectomy (Fig. 2). The results were compared with 56 patients from our esophageal database. One case of anastomotic leakage was found in the ICG group compared with 10 cases who were operated without using ICG [9].

The viability of the tip of the gastric conduit is often difficult to evaluate macroscopically but represents the most important part for the anastomotic healing, particularly if the gastric conduit has to be mobilized further. ICG angiography can provide important additional information concerning blood perfusion. Our group used ICG angiography for the assessment of the perfusion of the gastric conduit in 20 patients with esophageal cancer undergoing esophagectomy (Fig. 2). The results were compared with 56 patients from our esophageal database. One case of anastomotic leakage was found in the ICG group compared with 10 cases who were operated without using ICG [9].

Intraoperative detection of parathyroid glands during redo-parathyreoidectomy [6]. A recently published project evaluated the impact of intraoperative angiography for the assessment practically available. Zehetner et al. used the SpY imaging system for the intraoperative assessment of the perfusion of the gastric conduit in 144 consecutive patients undergoing esophagectomy [8]. In this trial, the authors observed that in case the anastomosis was performed in an area of good perfusion as defined by the SpY system, the anastomotic leakage rate was significant lower (2% leakage rate) compared to cases in which the anastomosis was constructed in an area of less robust perfusion (45% leakage rate).

The viability of the tip of the gastric conduit is often difficult to evaluate macroscopically but represents the most important part for the anastomotic healing, particularly if the gastric conduit has to be mobilized further. ICG angiography can provide important additional information concerning blood perfusion. Our group used ICG angiography for the assessment of the perfusion of the gastric conduit in 20 patients with esophageal cancer undergoing esophagectomy (Fig. 2). The results were compared with 56 patients from our esophageal database. One case of anastomotic leakage was found in the ICG group compared with 10 cases who were operated without using ICG [9].
Fluorescence-guided Liver/ Lung Metastasectomy

The resection of colorectal metastasis in curative intention has been associated with a significant improvement in the 5-year survival rate [10]. However, the sensitivity of CT and MRI significantly decreases for lesions smaller than 5mm, partially explaining the high recurrence rates of hepatic metastatic spread [11, 12]. ICG angiography has been recently introduced for the intraoperative detection of colorectal liver metastases. Van der Vorst et al. used the Mini-FLARE imaging system with ICG angiography for the detection of colorectal liver metastases during hepatic metastasectomy in curative intention. ICG angiography could identify further subcentimeter lesions which were not identified during the intraoperative ultrasound or preoperative computed tomography [12].

Lately, ICG angiography has been introduced in experimental trials for the intraoperative detection of intrapulmonary nodules. Anayama et al. performed an experimental trial during which an artificial lesion was created using ICG and implanted in a resected porcine lung. ICG angiography using an near-infrared thoroscope successfully detected the artificial nodule [14]. Okusanya et al. administered 5 mg/kg ICG, 24 hours prior to thoracotomy to 18 patients. Intraoperative ICG imaging from our database. One case of anastomosis leak occurred in the ICG group compared to 10 cases among patients operated without the use of ICG [9].

Резекция метастазов в печени / легких под флуоресцентным контролем

Резекция колоректальных метастазов с лечебной целью ассоциируется со значительным улучшением показателя 5-летней выживаемости [10]. Однако снижение чувствительности КТ и МРТ при образований меньше 5 мм, частично объясняет высокий показатель рецидивов печеночных метастазов [11, 12]. ICG-ангиография была недавно введена в практику с целью интраоперационного выявления метастазов колоректального рака в печени. Van der Vorst с соавт. используют систему визуализации Mini-FLARE с ICG-ангиографией для выявления колоректальных метастазов в печени во время резекции печеночных метастазов в лечебной цели. ICG-ангиография может обнаружить образование менее одного сантиметра, которое не были выявлены во время интраоперационного ультразвукового исследования или предоперационной компьютерной томографии [12]. Обнаружение и торакоскопическая резекция небольших внутрилегочных образований является еще одним сложным вопросом в области хирургической онкологии. Большие образования часто могут быть обнаружены с помощью торакоскопической пальпации, однако повреждения, которые расположены глубоко в паренхиме легких, часто очень трудно локализовать. Для обнаружения небольших внутрилегочных образований были оценены несколько методов, такие как размещение крючков-проводов или микроспиралей, локализация с использованием техники, меченного радиоактивным изотопом, метиленового синего окрашивания под КТ контролем или ультразвука [13].
fluorescence angiography successfully detected 16 out of 18 intrapulmonary lesions [15].

**Fluorescence during Mesenteric Ischemia**

Acute mesenteric ischemia is a life threatening clinical situation. Many patients are administered with advanced bowel necrosis but the surgeon is often facing the critical problem of the potential viability of the damaged bowel segment in order to determine the resection margins. Diana et al. successfully defined the boundary between ischemic and well perfused bowel by the use of ICG angiography in an experimental porcine model [16]. Our group used ICG angiography in 3 cases of acute mesenteric ischemia and one case of ischemia of the distal stomach due to accidental ligation of the left gastric artery to evaluate the resection margins [17]. In all 3 cases ICG angiography offered significant information without which we may have had to commit a surgical mis-evaluation leading to relevant complications for the patient and his quality of life. Ishizuka et al. used ICG fluorescence angiography to define the bowel resection margins in patients with non occlusive mesenteric ischemia. The authors observed that the length of the bowel which had to be resected differed significantly from the macroscopic estimation [18].

In 15 surgical cases of mesenteric ischemia, the bowel mal-perfusion was retrospectively evaluated by our group using the Pinpoint system. In 7 out of 15 cases, the ICG perfusion assessment influenced the surgical decision for or against a resection/second look operation (unpublished data).

**Fluorescence-guided Sentinel Lymphnode Detection**

Oncologic surgery in case of urological and gynecological malignancies requires lymph node dissections (LND). Radiation with intraligotional lymph node metastases. Apayamu et al. performed experimental investigation, in which the resected lymph nodes with ICG were used successfully for intraoperative lymph node visualization [16]. Okusanya et al. infused ICG 5 mg / kg 24 hours prior to thoracotomy in 18 patients. Intraoperative ICG fluorescence angiography successfully detected 16 out of 18 patients with intrapulmonary lesions [15].

Fig. 3: Evaluation of the perfusion of the ischemic small bowel using PinPoint (Novadaq).
considering the good results in annals of surgical oncology tracers in SNL biopsy for breast cancer [21]. Benson questioned the enrolling a series of 50 patients of 100% for the ICG approach cent study published by Pitsinis the same conclusion [20]. A re-
SLN). Ballardini et al. came to (98% identification rate of method is not inferior to 99mTc negative in breast cancer [19]. The authors stated that the ICG method has successfully been applied for SNL biopsy in bladder cancer [22]. A deposit of a 0.5 ml solution consisting of albumin and 500 µM ICG was injected cystoscopically into the bladder wall for the intraoperative detection of the lymphatic drainage pattern of the bladder. Manny et al. performed a similar study applying 1 mg ICG into each lobe of the prostate percutaneously for Da Vinci radical robotic prostatectomy in 50 patients by use of the Firefly technology (Novadaq) [23]. In a further trial, 135 patients undergoing thoracotomy for early stage non squamous cell lung carcinoma underwent an ICG staining the area around the tumor in order to detect lymphatic invasion. ICG fluorescence angiography was successful in identifying the sentinel nodes in 113 patients during the segmentectomy [24].

Fluorescence-guided Kidney Transplantation In kidney transplantation graft function mainly depends on the quality of organ perfusion [25]. In quite a few cases hypoperfused kidney regions fail to reveal to “surgeon’s eye” intraoperatively but become apparent postoperatively in

Oпределение сторожевого лимфатического узла под флуоресцентным контролем Онкологическая хирургия в случае урологических и гинекологических злокачественных опухолей требует иссечения лимфатических узлов (ИЛУ). Радикальное ИЛУ сопровождается высоким показателем заболеваемости, поэтому такой подход был заменен концепцией биопсии сигнального (сторожевого) лимфатического узла (СЛУ). Эти процедуры являются высоко стандартизованными и включают в себя введение радиоактивных индикаторов, таких как технеций (99mTc), или метиленовый синий краситель. Применение радиоактивных индикаторов (трассеров), которые являются логистическим комплексом, включающим токсиче-

калы и кожи. Тяжелые аллергические реакции на изосульфан в его составе встречаются довольно часто. Поэтому в последних публикациях прослеживался спрос на альтернативный метод. Samorani с соавт. опубликовал результаты проспективного когортного исследования с участием 301 пациентов с целью изучения биопсии СЛУ под ICG контролем при раке мочевой железы [19]. Авторы утверждают, что ICG по своим качествам не уступает 99mTc (показатель идентификации СЛУ составил - 98%). Ballardini с соавт. пришел к такому же выводу [20]. Результаты недавнего исследования, опубликованные Pitsinis и соавт., продемонстрировали 100% обнаружение СЛУ при использовании ICG у 50 пациентов [21]. Benson поставил под сомнение необходимость использования радиоизотопов в качестве со-трассеров при биопсии СЛУ при раке мочевой железы в редакционной статье, опубликованной в анналах хирургической онкологии, учитывая хорошие результаты применения одного ICG [33]. В области урологии, метод ICG уже был успешно применен для биопсии СЛУ при раке мочевого пузыря [22]. Для интраоперационного обнаружения лимфодренажной конфигурации мочевого пузыря с помощью цистоскопа в стенку вводили 0,5 мл раствора,
Fluorescence Imaging

of the transplanted organ or surgical revision of the anastomoses in order to improve blood supply and serve as a helpful resource of intraoperative quality control. In our center, ICG fluorescence videography is routinely employed in kidney transplantation. Figure 4 shows an example of a living kidney donation, in which a lower pole artery had to be inserted separately into the anastomosis. ICG fluorescence videography after reperfusion of the organ administrating 5 mg ICG systemically showed a restricted perfusion of the lower kidney pole, which could not be detected visually.

Intraoperative ICG fluorescence imaging with SPY Elite (Novadaq) enables quantitative measurement of microvascular perfusion after reperfusion of the kidney. Figure 5 shows a homogenously perfused kidney graft with two minor hypoperfused areas. ICG in- and evasion can be displayed in the form of a curve.

routinely performed duplex sonography. Besides visually evaluating the organ surface some other tools exist to assess the quality of anastomoses and graft perfusion objectively during the operation, namely angiography, duplex sonography and measurement of renal tissue oxygenation. However, these techniques are either time consuming, require a relevant examiner’s experience or employ nephrotoxic contrast media and radiation as in the case of angiography. As an alternative ICG fluorescence videography showed to be a safe and feasible technique to assess macro- and microvascular perfusion of the graft intraoperatively [26-27]. Hoffmann et al. employed ICG fluorescence videography in a series of 10 cases of renal transplantations applying 0.3mg ICG/kg bodyweight [27]. The authors could even detect small perfusion deficits which remained undetectable to the surgeon. The results of this assessment allow repositioning of the transplanted organ or surgical revision of the anastomoses in order to improve blood supply and serve as a helpful resource of intraoperative quality control. In our center, ICG fluorescence videography is routinely employed in kidney transplantation. Figure 4 shows an example of a living kidney donation, in which a lower pole artery had to be inserted separately into the anastomosis. ICG fluorescence videography after reperfusion of the organ administrating 5 mg ICG systemically showed a restricted perfusion of the lower kidney pole, which could not be detected visually.

Intraoperative ICG fluorescence imaging with SPY Elite (Novadaq) enables quantitative measurement of microvascular perfusion after reperfusion of the kidney. Figure 5 shows a homogenously perfused kidney graft with two minor hypoperfused areas. ICG in- and evasion can be displayed in the form of a curve.

The authors could even detect small perfusion deficits which remained undetectable to the surgeon. The results of this assessment allow repositioning of the transplanted organ or surgical revision of the anastomoses in order to improve blood supply and serve as a helpful resource of intraoperative quality control. In our center, ICG fluorescence videography is routinely employed in kidney transplantation. Figure 4 shows an example of a living kidney donation, in which a lower pole artery had to be inserted separately into the anastomosis. ICG fluorescence videography after reperfusion of the organ administrating 5 mg ICG systemically showed a restricted perfusion of the lower kidney pole, which could not be detected visually.

Intraoperative ICG fluorescence imaging with SPY Elite (Novadaq) enables quantitative measurement of microvascular perfusion after reperfusion of the kidney. Figure 5 shows a homogenously perfused kidney graft with two minor hypoperfused areas. ICG in- and evasion can be displayed in the form of a curve.

The authors could even detect small perfusion deficits which remained undetectable to the surgeon. The results of this assessment allow repositioning of the transplanted organ or surgical revision of the anastomoses in order to improve blood supply and serve as a helpful resource of intraoperative quality control. In our center, ICG fluorescence videography is routinely employed in kidney transplantation. Figure 4 shows an example of a living kidney donation, in which a lower pole artery had to be inserted separately into the anastomosis. ICG fluorescence videography after reperfusion of the organ administrating 5 mg ICG systemically showed a restricted perfusion of the lower kidney pole, which could not be detected visually.

Intraoperative ICG fluorescence imaging with SPY Elite (Novadaq) enables quantitative measurement of microvascular perfusion after reperfusion of the kidney. Figure 5 shows a homogenously perfused kidney graft with two minor hypoperfused areas. ICG in- and evasion can be displayed in the form of a curve.

The authors could even detect small perfusion deficits which remained undetectable to the surgeon. The results of this assessment allow repositioning of the transplanted organ or surgical revision of the anastomoses in order to improve blood supply and serve as a helpful resource of intraoperative quality control. In our center, ICG fluorescence videography is routinely employed in kidney transplantation. Figure 4 shows an example of a living kidney donation, in which a lower pole artery had to be inserted separately into the anastomosis. ICG fluorescence videography after reperfusion of the organ administrating 5 mg ICG systemically showed a restricted perfusion of the lower kidney pole, which could not be detected visually.

Intraoperative ICG fluorescence imaging with SPY Elite (Novadaq) enables quantitative measurement of microvascular perfusion after reperfusion of the kidney. Figure 5 shows a homogenously perfused kidney graft with two minor hypoperfused areas. ICG in- and evasion can be displayed in the form of a curve.
Fluorescence Imaging
THE JOURNAL OF MEDICINE FOR THE WORLDWIDE MED COMMUNITY

Fluorescence-guided Colorectal Surgery
Adequate healing of the bowel anastomoses in colorectal surgery is an essential condition limiting perioperative morbidity. In particular, coloanal anastomoses after low anterior resections for distal rectal cancer are considered having a high risk for anastomotic leakage up to 40%. Sufficient blood supply is an important factor determining anastomotic healing. The surgeon’s clinical judgement on the perfusion of the anastomosis is usually based on visual (colour) or tactile (pulses) impression and has been proven to have a low predictive value for anastomotic leakage in a prospective trial [28]. The risk of anastomotic leakage is commonly underestimated by the surgeon. ICG fluorescence imaging might be a helpful tool for the intraoperative real-time determination of tissue perfusion.

Jafari et al. were able to show a reduction of the anastomotic leak rate to 1.4% for left-sided and anterior resections in an open prospective multicenter study enrolling 139 patients (PILLAR II) by using ICG angiography [29]. The Pinpoint system (Novadaq) was applied for the intraoperative evaluation of colon perfusion at the planned resection margins before and after creation of the anastomosis using 7.5mg ICG intravenously. The location of the resection margin was changed and the anastomosis was redone according to perfusion assessment. In this trial ICG fluorescence angiography changed surgical plans in 8% of cases. In all these cases there were no anastomotic leakages. Gröne et al. performed 18 laparoscopic anterior and lower anterior colorectal resections in a prospective case series [30]. Perfusion of the planned transection line of the descending colon was evaluated with the Pinpoint System (Novadaq) after ligation of the inferior mesenteric artery and systemic administration of 15mg ICG. Surgical

Checkbox

Рис. 5: Макроскульярная перфузия поверхности почечного трансплантата после реперфузии органа после введения ICG и использования Spy (Novadaq). Стрелки на левом изображении указывают на незначительные участки гипоперфузии. Количественная оценка показана на рисунке справа.

Fig. 5: Microvascular perfusion of the kidney transplant surface following reperfusion of the organ after systemic application of ICG and detection with Spy (Novadaq). The arrows in the left image indicate minor areas of hypoperfusion. Quantitative assessment is shown in the right image.
decision making regarding the line of transection was influenced in 18% of the cases. In these cases, no leakage was detected in the postoperative course. The overall leakage rate could be reduced to 6% employing this method. The maximum added time for this diagnostic procedure was only 6 minutes [30].

Further Applications of ICG Fluorescence Angiography
ICG fluorescence angiography has been additionally applied in several other fields of oncologic and non-oncologic surgery. Kalibori et al performed a randomized clinical trial using ICG fluorescence to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].

Conclusions
ICG fluorescence angiography is an emerging imaging modality in surgery. We presented multiple possible applications of ICG fluorescence angiography as an alternative tool of intraoperative quality control potentially influencing the surgeon’s decisions. This method has been proven to be safe, feasible, time-efficient and easy to learn in several case series and prospective trials. We demonstrated that it is worthwhile considering the enrolment of ICG fluorescence videography for difficult decisions or even as a routine procedure. Further studies are warranted to establish feasible ICG dose schemes and standard operating procedures. Prospective randomized trials should follow confirming the superiority of the application of ICG angiography over alternative methods in short and long term follow-up.

In this study, ICG fluorescence angiography was used to detect bile leakage after hepatic resection [31]. ICG fluorescence cholangiography successfully detected insufficiently closed bile ducts which were not detected by common bile leakage tests. Kimmig could successfully visualize the precise lymphatic networks in patients with uterine cancer using ICG angiography during robotic assisted surgery [32].
Fluorescence Imaging

Literature


Anterior Cruciate Ligament Reconstruction and Cartilage Damage - Current Therapy Concepts

Anatomical Overview
The Anterior cruciate ligament (ACL) originates from anterior and medial aspect of the Tibial plateau and runs posteriorly and superiorly towards its insertion in the medial side of the lateral femoral condyle. The ACL has two bundles anteromedial and posterolateral, these 2 bundles provides approximately 85% of restraining force of anterior translation of the knee, also it prevents the medial and lateral rotation of the tibia as well as varus and valgus stresses. To a little extent ACL checks the extension and hyperextension, together with the posterior cruciate ligament (PCL) they control joint kinematics through guiding the instantaneous center of rotation of the Knee (1).

The Knee joint surface is covered by a special type of cartilage called the Hyaline cartilage that provides a low-friction gliding surface is known to be wear-resistant under normal circumstances. It is avascular and alymphatic structure. The cartilage cells (Chondrocytes) compose only 5% of the hyaline cartilage structure and they receive their nutrition by diffusion and they are responsible for synthesizing and maintain the structure (2).

The Knee joint is reported to be the most injured joint during sports injuries (Majewski et al.), documented approximately 40% of the sports-related injuries to be at the knee joint. Injury to the Knee joint pose a serious obstacle to one’s daily activity, as the knee is 10 times more at risk during sports injury than normal life activities specially the ACL and cartilage, the rupture of the anterior cruciate ligament is one of the most frequently occurring ligament injuries in the human body. The ratio of injuries of the anterior cruciate ligament to the posterior cruciate ligament is about 10:1 (Strobel et al. 2001). These damages will increase the risk of joint degeneration and the risk of Osteoarthritis (OA) due to a low-friction surface and wear-resistant property and to a little extent ACL checks the extension and hyperextension, together with the posterior cruciate ligament (PCL) they control joint kinematics through guiding the instantaneous center of rotation of the Knee (1).
to shifting of the normal weight bearing areas and this can induce cartilage deformation and damage (3). The risk factors for ACL and cartilage injuries include dissimilarities in Knee geometry, sex, size of ACL, limb alignment and type of Sports (4, 5). Females who participate in cutting sports are shown to be at more risk factors for cutting native ACL (5).

The ACL deficient Knee has high risk of instability, future cartilage injuries and meniscus tears (5). Several studies reported the high proportion of lateral Knee compartment cartilage lesions as well lateral meniscus lesions with the ACL lesions, this is due to the fact that the contact in the lateral compartment is higher after ACL injuries (6).

Mechanism of ACL Injury
A basic distinction should be done to address whether the injury is isolated or combined with other structures injuries, partial or complete ACL tear as well as if it’s acute or chronic Knee instability as these are critical factors in determining the best treatment method.

Diagnosis of ACL Injuries
A- History taking
Usually the injury if acute is combination between flexion, valgus and external rotation (Football, Basketball) under weight bearing. In case of chronic ACL insufficiency the Patient usually don’t remember the incident and the knee cartilage and meniscal condition are in a worse condition due to degenerative changes to the menisci and overlying Knee cartilage.

By inspecting the Knee in case of acute injury, the Knee is usually markedly swollen shortly after the injury incident with limitation of movements and pain; special Knee tests are done to clinically diagnose the ACL rupture as Lachman’s test in 30° flexion, anterior drawer test and Pivot shift phenom-
brazevaya связка составляет около 10:1 (Strobel с соавт. 2001). Эти повреждения увеличивают риск дегенерации сустава и остеоартрита (ОА) из-за смещения участков, несущих нагрузку, что может вызвать деформацию и повреждения хряща [3]. Факторы риска развития повреждений ПКС и хряща включают несоответствия в геометрии колена, пол, размер ПКС, выравнивание конечностей и вид спорта [4, 5]. Женщины, которые занимаются конным спортом, подвергаются большему риску разрыва ПКС [5]. Коленный сустав с измененной ПКС имеет высокий риск развития нестабильности, повреждений хряща и мениска [5]. В ряде исследований сообщалось о высокой частоте повреждений хряща латеральных отделов коленного сустава, а также латерального мениска при повреждениях ПКС, что обусловлено более плотным контактом поверхностей сустава после повреждения ПКС [6].

Механизм травмы ПКС
Необходимо различать изолированное повреждение ПКС или сочетанное с травмой других структур, частичный или полный разрыв ПКС, а также острая или хроническую нестабильность коленного сустава, поскольку эти факторы определяют выбор наилучшей методы лечения.

Diagnostica и лечение повреждений ПКС
A- Сбор анамнеза
Обычно острая травма возникает при комбинации сгибания и вальгусного или внешнего вращения (футбол, баскетбол) при нагрузке на колено. В случае хронической нестабильности ПКС пациент обычно не помнит такой инцидент, а хрящ и мениск коленного сустава находятся в худшем состоянии вследствие дегенеративных изменений этих структур.

При осмотре вскоре после острой травмы, как правило, отмечается отечность и болезненность колена с ограничением движений; для клинической диагностики разрыва ПКС проводятся специальные тесты – тест Лахмана (Lachman) с 30° сгибанием, тест «переднего выдвижного ящика», pivot- shift.
enon (the latter isn’t easily performed in acute injuries due to pain and reflex quadriceps muscular spasm).

In case of chronic injuries the patient often complain of instability when walking on uneven ground and experience giving-way phenomenon, the most important test to diagnose chronic injuries is the Pivot shift phenomenon which reveals the dysfunction of the rolling and sliding movement of the knee joint.

B- Radiological Imaging
a. Knee X-ray (AP, Lat., Axial, Long leg axis): are done to exclude fractures, bony ligamentous avulsions, as well as long leg axis X-ray if Knee deformities are inspected or Corrective osteotomies are planned as a part of treatment plan.
b. CT: in case of complex fractures, bony avulsions and in case of revision of ACL reconstruction (to determine the drilling canal width if refilling with bone graft is planned).
c. MRI: Method of choice, it gives excellent idea about ligamentous, meniscal, cartilage and bony injuries.

Methods of ACL treatment:
The goal of performing an ACL reconstruction operation is restoring the Knee instability to decrease subsequent injuries to the Knee.

A lot of progress was done in the last years to improve the isometric and anatomical placement of the graft, to find the optimal method for ACL fixation and to use the best graft for replacement.

C- Methods of Treatment I- ACL
a. Conservative Treatment
Indications: Minor mental and physical trauma elderly inactive patient
1- Lack of compliance.
2- Low risk pivoting sports, e.g. Swimming.
3- Advanced arthritis and Elderly inactive patient with low demand.
Immediate treatment: Cooling, leg elevation, NSAID.
Further treatment: Knee Brace with joint adjustment in Flexion/Extension (F/E): 90°-0°-0° in the first six weeks then free ROM. Concentric Muscular Strengthening exercises.
Functional exercises, cycling test (последний нелегко выполнить при острых травмах из-за боли и рефлекторного спазма четырехглавой мышцы). В случае хронической травмы пациенты часто жалуются на нестабильность колена при ходьбе по неровной поверхности и феномен «провала» коленного сустава; самым значимым тестом при диагностике хронических повреждений является pivot-shift тест, который показывает дисфункцию сустава при качающих и скользящих движениях коленного сустава.

B-Радиологическая визуализация
а. Рентгенография коленного сустава (в прямой, боковой, косой проекциях): проводится для исключения переломов и отрывов костей; при обнаружении деформации колена или планировании корректирующей остеотомии, выполняется снимок длинной оси конечности.
b. КТ: выполняется в случае сложных переломов, отрывов костей, и в случае ревизионной реконструкции ПКС (для определения диаметра канала, если планируется использование костного трансплантата).
c. МРТ: является методом выбора, который прекрасно визуализирует повреждения связок, менисков, хрящей и костей.

C-Методы лечения повреждений ПКС
Целью лечения является восстановление стабильности коленного сустава с уменьшением последующего риска травмы. В последние годы были значительно усовершенствованы методы реконструкции ПКС с помощью изометрического и анатомического размещения индивидуально подобранного трансплантата и его оптимальной фиксации.

a. Консервативное лечение
Показания к применению - незначительная травма у людей пожилого возраста, что может включать следующие факторы:
1- Отсутствие у пациента возможности и желания исполнять все предписания врача после операции
2- Низкий риск спортивной травмы
3- Артрит и низкие запросы у пациента относительно физической активности

Неотложное лечение: холод, приподнятное положение конечности, нестероидные противовоспалительные средства (НПВС).
and swimming are allowed in cases of full mobility with no effusion, contact sports are avoided in the first six months, regular follow up is recommended.

b. Operative Treatment

Timing

Time after the injury consists of two phases: The acute phase, which extends up to 3 days after the injury, the Knee is protected in a Brace in F/E 90-0-0° unless it’s associated with MCL (medial collateral ligament injury) it’s locked in 60-0-0°. The sub acute phase extend after the third day till 3-4 weeks after the initial injury, during this period the surgical intervention preferred to be avoided to decrease the risk of postoperative stiffness (this waiting time can be reduced if there is associated injuries in the knee as complex ligamentous tear).

Technique

In the last few decades many techniques had evolved to treat the ACL injuries which includes the extra articular stabilization, refixation of bony avulsed ligament, also different ligaments supplement had been tried to replace the torn ligament from synthetic materials, to cadaveric or autologous ligament (quadriceps, patellar, iliotibial tract strip, Plantaris tendon and Hamstring tendons either from same or contralateral side). The autologous Hamstrings

Dальнейшее лечение: ношение коленного ортеза с заданной амплитудой сгибания / разгибания (F / E 90-0-0° в течение первых 6 недель, затем разрешаются движения в полном объеме. Выполнение упражнений на увеличение мышечной силы. В случае полной мобильности и отсутствия выпота - функциональные упражнения, езда на велосипеде и плавание. В течение первых шести месяцев следует избегать контактных видов спорта. Пациентам рекомендуется регулярное наблюдение.

b. Хирургическое лечение

Сроки: время после травмы разделяют на две фазы. В острую фазу, которая продолжается до 3-х дней, колено защищают с помощью ортеза с F / E 90-0-0°, если отсутствует повреждение медиальной коллатеральной связки (МКС), при котором допускается амплитуда движений F / E 60-0-0°. В подострой фазе, которая начинается через 3 дня после травмы и длится до 3-4 недель, хирургическое вмешательство рекомендуется избегать, чтобы уменьшить риск послеоперационной скованности в суставе (это время может быть уменьшено в случае разрыва нескольких связок).

Хирургические методы за последние несколько десятилетий многие методы лечения повреждений PK, например, внесуставная стабилизация,
ligaments are more frequently used due to fewer complications and less morbidities. Skin incision 3 cm is done horizontally on the level of the Tibial tuberosity (2 cm medial and inferior), sharp splitting of the Sartorius fascia, dividing of adhesions. Harvesting of the Hamstring tendon (Semitendinosis/Gracilis or both) with a blunt tendon stripper. During this procedure the tendon should always be kept under tension and secured with an additional clamp. The required tendon is harvested and prepared by the assistant on the side table and folded into 3, 4 or 5 folds (Fig 1).

Graft preparation: The tendons are cleared from muscle fiber tissue. Tendon ends are armed with baseball stitch sutures (about 20 mm from each end). Simultaneously a diagnostic arthroscopy is carried out to address concomitant lesions as well as preparation of ACL insertion points. Drilling of the femoral and Tibial tunnels are carried under arthroscopic view and according to the thickness of the harvested tendon (Fig 2).

Many techniques had been implemented regarding drilling the tibial and femoral canals; either double bundle (where 2 canals are drilled to fix 2 AM

---

**Table 1: Imhoff classification**

<table>
<thead>
<tr>
<th>Grade</th>
<th>X-ray</th>
<th>MRI</th>
<th>Arthroscope</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Possible thinning of the bone</td>
<td>Bone bruise, limited change in signal intensity in T1, Edema in T2</td>
<td>Intact cartilage</td>
<td>Bone contusion</td>
</tr>
<tr>
<td>IB</td>
<td>Irrelevant</td>
<td>Thickening of the cartilage</td>
<td>Soft/ un even cartilage</td>
<td>Cartilage softening</td>
</tr>
<tr>
<td>IIA</td>
<td>Thinning of the bone</td>
<td>Low signal intensity T1/T2, after i.v. Contrast increase T1 signal intensity, cartilage changes</td>
<td>Cartilage is demarcated but intact</td>
<td>Demarcation without sclerosis, intact cartilage</td>
</tr>
<tr>
<td>IIB</td>
<td>Thinning of the bone (demarcation by sclerosis)</td>
<td>Same as IIA, but no change in signal intensity after i.v. contrast material injection</td>
<td>Same as IIA</td>
<td>Demarcation with sclerosis, intact cartilage</td>
</tr>
<tr>
<td>IIIA</td>
<td>Partial lose Fragment</td>
<td>Low signal intensity T1/T2, after i.v. Contrast increase T2 signal intensity, cartilage defects</td>
<td>Partial lose Fragment, cartilage is intact</td>
<td>Partial lose, vital fragment, cartilage intact, no sclerosis</td>
</tr>
<tr>
<td>IIIB</td>
<td>Partial lose Fragment, sclerosis zone</td>
<td>Same as IIIA but with no increase in signal intensity</td>
<td>Partial lose Fragment, cartilage isn’t intact</td>
<td>Partial lose, non vital fragment, cartilage isn’t intact, marked sclerosis</td>
</tr>
<tr>
<td>IVA</td>
<td>Complete lose fragment with or without dislocation</td>
<td>High subchondral signal intensity, cartilage lesions, increase signal intensity after i.v. contrast material injection</td>
<td>OCD</td>
<td>Partial lose, vital fragment, no sclerosis</td>
</tr>
<tr>
<td>IVB</td>
<td>Complete lose fragment with or without dislocation</td>
<td>Same as VA but no increase signal intensity after i.v. contrast material injection</td>
<td>OCD</td>
<td>Non vital fragment, marked sclerosis</td>
</tr>
<tr>
<td>VA</td>
<td>Cystic bony changes, no sclerosis</td>
<td>High signal intensity T2</td>
<td>Cartilage intact or chondromalacia</td>
<td>Cyst without sclerosis</td>
</tr>
<tr>
<td>VB</td>
<td>Cystic bony changes, with sclerosis</td>
<td>Low signal intensity T1/T2</td>
<td>Same as VA</td>
<td>Cyst with sclerosis</td>
</tr>
</tbody>
</table>
and PL bundles) or single bundle guided by arthroscope and drilling wires. Many implants had been evolved to fix the re-implanted ligament, recently used either Bio absorbable screws or Tightrope system or combination between them (Fig 3).

The postoperative recovery for ACL Surgery:
Full range of motion and loading of the joint immediately after the surgery should be avoided, during the first 2 weeks the patient can only load partially (20 kg) and after that the load bearing can be increased at a rate of 20 kg per week till full loading (the patient should take anticoagulants until full weight bearing). From the 8th week postoperatively the patient can start swimming (crawl), cycling. From the 3rd Month postoperatively the patient can start running. From 9th to 12th Month postoperatively the patient can start the contact sports.

The postoperative recovery for ACL Surgery with lat. meniscus repair:
Артроскопию с целью устранения сопутствующих повреждений, а также подготовки точек прикрепления трансплантата. Сверление каналов в бедренной и большеберцовой кости осуществляется под артроскопическим контролем, согласно толщине заготовленного сухожилия (Рис 2). Для формирования каналов в большеберцовой и бедренной кости было разработано несколько методов: либо для двухпучковой фиксации сухожилия (сверление двух каналов для переднемедиального и заднелатерального пучков), либо для однопучковой фиксации сухожилия, с помощью артроскопа и направляющей спицы.

Также были усовершенствованы и импланты с целью их надежной фиксации; в последнее время используются биорассасывающиеся винты или Tightrope система, или их комбинация (Рис 3). Послеоперационная реабилитация после хирургии ПКС: Сразу после операции следует избегать полного диапазона движений и нагрузки на коленный сустав, в течение первых 2-х недель пациент может частично нагружать ногу (20 кг), после чего нагрузка увеличивается по 20 кг в неделю до полной нагрузки (до этого момента пациент должен принимать антикоагулянты). С 8-й недели после операции пациент может плавать (кроль)
Fig. 5: MACT: a) suturing of the membrane, b) completed suturing, c) final sealing of suture with fibrin glue. The MACT technique: 2 steps operation, the first is arthroscopic and harvesting the cartilage sample is done in this procedure and sent to the lab. Under sterile measure, the second step is done through open surgery and the membrane with the cultivated cartilage cells are re-implanted and sutured over the cartilage lesion area. (Surgical atlas of Sports orthopedics and sports traumatology Imhoff et.al 2015)

Рис. 5: MACT: а. фиксация мембраны с помощью шва, б. окончательная герметизация шва фибриновым клеем, Метод MACT: 2 этапа операции, первый - артроскопия и забор участка хряща, который отправляют в лабораторию. Второй этап проводится в стерильных условиях с помощью открытой операции: мембрана с выращенными хрящевыми клетками имплантируется и фиксируется в области очага деструкции хряща. (Хирургический атлас по Спортивной ортопедии и спортивной травматологии Imhoff с соавт 2015)

Fig. 6: a) large Osteochondral defect of LFC, b) Filling of the defect with cancellous bone from ipsilateral iliac crest, c) completed cancellous bone graft and impacting, d) final result after MACT. This technique is used in case of subchondral bone deep affection. (Surgical atlas of Sports orthopedics and sports traumatology Imhoff et.al 2015)

Рис. 6: а. большой остеохондральный дефект латерального мыщелка бедра, б. заполнение дефекта губчатой костью из ипсилатерального гребня подвздошной кости, с. размещенный губчатый костный трансплантат и его уплотнение, д. конечный результат после MACT. Этот метод используется в случае глубокого дефекта субхондральной кости. (Хирургический атлас по Спортивной ортопедии и спортивной травматологии Imhoff с соавт 2015)
1st 6 weeks ROM F/E 60-0-0° without loading
7th week 20 kg/ week no loading in more than 90° flexion
12th week postoperatively the patient can start swimming (crawl), cycling.
From the 4th Month postoperatively the patient can start running.
From 9th to 12th Months postoperatively the patient can start contact sports.

The postoperative recovery for ACL Surgery with medial meniscus repair:
First 2 weeks the patient can only load partially (20 kg) active F/E 90-0-0°
No loading is allowed in flexion 3-6th Weeks postoperative:
Full loading is started but only in extension, ROM F/E 90-0-0°
No loading is allowed in flexion 7th week Free ROM
8th week postoperatively the patient can start swimming (crawl), cycling.
From the 3rd Month postoperatively the patient can start running.
From 9th to 12th Month postoperatively the patient can start the contact sports.

Cartilage Injuries
The cartilage injuries can result from high loading, repetitive shearing or torsional injuries that may affect the superficial cartilage layer. Arthroscopic visualization suggested that in about 5% of the knees which undergone arthroscopy procedures there are isolated focal cartilage lesions. (7,8). While there are many techniques for the treatment of cartilage injuries, not enough is known about which lesion needs treatment or about the proper treatment modality for each particular lesion.

Diagnosis of Cartilage Lesions
A-History taking:
Accurate history taking is crucial to determine the type of injury, usually the patients with cartilage lesions complain of recurrent swelling, locking or catching as well as painful movements or painful weight bearing. In case of acute focal cartilage lesion, the patient always report a strong loading injury followed by Knee effusion, in Chronic cartilage lesion the complain is usually recurrent intermittent Knee effusion and dull aching pain during walking, ascending or descending the stairs. By clinical examination there is always tenderness on the injured spot, if the lesion is retropatellar Zohlen sign is positive as well as Patellar facint pain.

B-Imaging
a. X-rays AP and lat., Tunnel views: useful only in detecting и ездить на велосипеде. С 3-го месяца после операции пациент может бегать. В период с 9-го по 12-и месяцы после операции пациент может возобновить занятия контактными видами спорта. В течение первых шести месяцев пациент должен носить защитный коленный ортез без ограничения амплитуды движения.
Послеоперационная реабилитация после хирургии ПКС и латерального мениска:
Первые 2 недели пациент может нагружать колено только частично (20 кг) с амплитудой активных движений F / E 90-0-0°. При сгибании нагрузка не допускается. В течение 3-6 недель после операции допустим полная нагрузка при разгибании, амплитуда движений - F / E 90-0-0°. При сгибании нагрузка не допускается. С 7-ой недели разрешается полный объем движений в коленном суставе.
С 8-ой недели после операции пациент начинает плавать (кроль) и ездить на велосипеде.
С 9-го по 12-ий месяц после операции пациент может бегать.
С 9-го по 12-ий месяц после операции пациент может начать занятия контактными видами спорта.
Повреждения хряща
Повреждения хряща могут возникнуть в результате большой нагрузки на коленный сустав, при повторяющихся поперечных или тorsiонных движениях, которые могут разрушать поверхностный слой хряща. При артроскопической визуализации коленного сустава у 5% пациентов обнаруживаются отдельные очаговые повреждения хряща [7, 8]. Несмотря на то, что существует много методов лечения повреждений хряща, еще полностью не выявлено, какие именно изменения нуждаются в терапии или какой именно вид лечения показан для конкретного повреждения.
Диагностика повреждений хряща
A- Сбор анамнеза
Тщательный сбор анамнеза имеет решающее значение для определения типа повреждения. Как правило, пациенты с повреж-
severe cartilage lesion and has limited rule in diagnosing early or focal cartilage lesions.

b. CT arthrography and 3D CT: to detect any bony involvement and the development of bony cysts.

c. MRI: is best done with 3 Tesla (high magnetic field strength), Delayed gadolinium-enhanced MRI (dGEMRI) for evaluation of glycosaminoglycan content, (T2 mapping) which detects early signs of structural changes of the extracellular matrix and monitors these changes over time. Collagen information Magnetization transfer (MT) to get quantitative and qualitative information on the collagen status of the damaged cartilage and the technique may be applied for the routine monitoring of normal and abnormal articular cartilage.

d. Technetium scintigraphy and SPECT: Scintigraphy examination could be used when patients after trauma do not show any significant injury on normal MRI while they are still in considerable pain. Single photon emission computed tomography (SPECT) could be used to assess the physiology and homeostasis of subchondral bone adjacent to untreated and treated articular cartilage defects.

C- Arthroscopy
Remains the gold standard for evaluation of the cartilage lesions and associated lesions. Descriptive evaluation of the lesion is done by arthroscopy (size, site, shape, depth, grade, single or multiple).

ICRS (International cartilage research society): cartilage classification system, it consists of 5 grades
G 0 Normal
G I a where cartilage has an intact surface but fibration and/or slight softening is present.
Gb superficial lacerations

dением хряща жалуются на рецидивирующий отек, ограничение подвижности или “заклинивание”, а также болезненность при движении и нагрузке на колено. В случае острого повреждения хряща пациент всегда сообщает о травме, связанной с нагрузкой, с последующим выпотом в области сустава. При хроническом поражении хряща, как правило, пациенты жалуются на рецидивирующий выпот в коленном суставе и тупой ноющей боли при ходьбе, поднятии и спускании по лестнице. По осмотру коленного сустава всегда отмечается болезненность в области повреждения, при поражении ретропателлярных отделов - положительный симптом Цолена (Zohlen), а также фасеточная боль в области надколенника.

В- Визуализирующие исследования
а. Рентгенография колена в прямой, боковой и тангенциальной проекции: полезна только для выявления тяжелых повреждений хряща и имеет ограниченное применение при диагностике ранних или очаговых поражений хряща.

b. KT артография и 3D KT: обнаруживает любое изменение костной ткани и развитие костных кист.

c. МРТ: наиболее информативна при высокой напряженности магнитного поля - 3 Тесла, с отсроченным контрастированием гадолинием (dGEMRI) для оценки содержания гликозаминогликанов (T2 картирование); обнаруживает ранние признаки структурных изменений внеклеточного матрикса и позволяет проводить мониторинг этих изменений. Перенос намагниченности (MT) проводится для получения количественной и качественной оценки состояния коллагена поврежденного хряща, метод может быть применен для рутинного мониторинга нормального и измененного суставного хряща.

d. ОФЭКТ: проводится, когда у пациента после травмы отмечается болевой синдром, а при МРТ изменений хряща не выявлено. Однофотонная эмиссионная компьютерная томография (ОФЭКТ)
Lesions that extend deeper but involve <50% of the cartilage thickness

G III Lesions that extend through >50% of the cartilage thickness, subdivided into 4 grades

IIIa lesion doesn’t reach deep the calcified layer

IIIb lesion reach to the calcified layer

IIIc that extend down to but not through the subchondral bone plate

IIId blisters

Osteochondritis dissecans (OCD) are excluded from this grading system and have their own classification system as follows

ICRS OCD I

Stable lesions with a continuous but softened area covered by intact cartilage.

ICRS OCD II

Lesions with partial discontinuity and they are stable when probed.

ICRS OCD III

Lesions with complete discontinuity that is not yet dislocated (“dead in situ”)

ICRS OCD IV

Empty defects as well as defects with a dislocated fragment or a loose fragment within the bed.

Treatment of cartilage defects: Treatment of the cartilage defects depends on the following factors

1. Patient’s age and activity level.
2. The degree of pain and disability that the patients are experiencing.
3. Location of cartilage lesion, size and depth of cartilage lesions.
4. Co-existing joint pathology such as meniscus lesions, ligamentous insufficiency, bone loss and malalignment.
5. Other concomitant diseases

Other factors should be put in consideration before treatment plan implementation, which includes body weight, or body

and fissures are found

> 50% толщины хряща и под-

разделяется на 4 вида

IIIa: повреждение не дохо-

дит до глубокого кальцифи-

цированного слоя

IIIb: повреждение достигают

кальцифицированного слоя

IIIc: повреждение достигает

поверхности субхондраль-

ной костной пластины

IIId: присутствуют участки

потертии кости

ICRS OCD I

очаги размягчения без поврежде-

ния поверхности

ICRS OCD II

очаги деструкции с частичным
разрывом хряща без нарушения
его целостности при исследова-

нии зондом

ICRS OCD III

очаги деструкции с полным раз-

рывом хряща, который еще не

отделились (“мертвые in situ”)
mass index (BMI), an increased BMI (greater than 30) may have an adverse effect on some cartilage repair procedures, Smoking, ability to comply with rehabilitation (9).

Choices of cartilage lesions treatment (10):
1. If the defect size is less than 2 cm² with well-shouldered, protected edges: Debridement or shaving + any of simple Bone Marrow Stimulation techniques, Micro-fracture technique (Fig.4) or Refixation of cartilage by Chondral Dart.
2. If defect size is 2-4 cm² consider Mosaicplasty or MACT (Matrix associated chondrocyte transplantation) with or without Spongioplasty (Fig. 5, 6).
3. If defect size is >4 cm² consider Osteochondral allografts/MACT.
4. If medium size bony defect consider bone grafts, Mega-Oats (Fig. 7).

Patellofemoral Arthroplasty (PFA)
Indication
Isolated patellofemoral arthri-

ICRS OCD IV
пустые очаги деструкции хряща, а также дефекты с вывихнутыми или отделившимися фрагментами на дне.

Лечение повреждений хряща
Лечение поражений хряща зависит от следующих факторов:
1. Возраста и уровня активности пациента.
2. Выраженности болевого синдрома и степени инвалидизации пациента.
3. Расположения очага деструкции хряща, его размера и глубины.
4. Сопутствующей суставной патологии (повреждение мениска, недостаточность связочного аппарата, потеря костной массы, смещение структур). 5. Наличия других сопутствующих заболеваний.

Также при составлении плана лечения должны быть учтены и другие факторы - масса тела или индекс массы тела (ИМТ), поскольку увеличение ИМТ (более 30), может оказать неблагоприятное воздействие на некоторые процедуры по восстановлению хряща, а также курение, возможность и желание пациента соблю-
tis, it’s not used if the medial and lateral compartments are simultaneously affected. PFA has been used for more than 20 years, it’s either inlay or onlay prosthesis (Fig. 8 and 9). The inlay prosthesis are trochlear components which are implanted flush with the surrounding cartilage after creation of a bone bed within the native trochlea, the Onlay design are trochlear components that completely replace the anterior compartment by using the same anterior cut as known from total knee arthroplasty. The use of this type of prosthesis significantly improves functional outcome scores and pain. The theoretical advantages of an inlay design did not result in better clinical outcome scores compared to an onlay design. However, progression of tibiofemoral OA was significantly less common in patients with an inlay trochlear component (11).

Important Note:

Figures 1 to 6 and 9: All images from Surgical atlas of Sports orthopedics and sports traumatology Imhoff et al. 2015, are owned by Springer publishing company. Fig. 7 source: The 5.5-year results of MegaOATS - autologous transfer of the posterior femoral condyle: a case-series study Braun, Imhoff Arthritis and research therapy 2008, Fig. 8 source: Prospective evaluation of anatomic patellofemoral inlay resurfacing: clinical, radiographic, and sports-related results after 24 months, Cotic, Imhoff, Knee Surg Sports Traumatol Arthrosco (2018).

Literature


Pateellofemoral endoprosthesis (PFE)

 показанием к применению является изолированный пателлофеморальный артрит, в случае, если одновременно не повреждены медиальные и латеральные отделы. ПФЭ применяется на практике уже на протяжении более 20 лет с использованием вкладочного или накладного протезов. (Рис. 8 и 9). Протез-вкладка включает компоненты блока, которые планируют на одном уровне с окружающим хрящом после создания костного ложа в головке бедренной кости, дизайн протеза-накладки включает компоненты, которые полностью замещают передние отделы, бедренной кости через передний доступ, как тотальное эндопротезирование коленного сустава. Использование протеза второго типа значительно улучшает функциональные результаты и уменьшает болевой синдром. Теоретические преимущества дизайна вкладки не привело к улучшению клинических результатов по сравнению с накладным вариантм. Однако прогрессирование большеберцово-бедренного OA значительно реже отмечалось у пациентов с вкладочным блоковым компонентом (11).
Quantification of the Prognostic Impact of Lymphovascular Space Involvement (LVSI) in Early Stage Cervical Cancer: a Review of Literature

Key words: Cervical cancer, LVSI, lymphangiosis, prognostic factor

Abstract
Objective
Being the second most common cancer of women, carcinoma of the uterine cervix is a major cause of death in women. Even patients with early stage cervical cancer have a significant risk of mortality which ranges among 15% after 5 years. In order to identify high risk patients despite early stage disease, LVSI (lymphovascular space involvement) has been proposed as additional prognostic factor.

Methods
A systematic review of the available literature concerning LVSI and cervical cancer was performed.

Results and Conclusion
Based on the published data, using LVSI as sole indication for adjuvant therapy seems questionable. However, it should be considered as additional item in cases with an indistinct indication for an adjuvant treatment. In pathological reports, we strongly suggest to report on the exact localisation of LVSI or the presence of satellite-LVSI, respectively.

Introduction
Worldwide, carcinoma of the uterine cervix is the second most common cancer of women. Although decreased incidence of advanced cervical cancer due to early diagnosis by the use of PAP-smear screening (Gustafsson et al., 1997) and improved therapies in case of locoregionally advanced disease by radiation or chemoradiation (Green et al., 2001), cervical cancer remains a major cause of death in women. Patients with early stage disease, even if the majority of them are cured with radical surgery or primary chemoradiation, still have a significant risk of mortality which ranges among 15% after 5 years (Landoni et al., 1997). In addition it has to be pronounced that combined use of radical surgery and adjuvant treatment is associated with an increase of morbidity for the patients. Therefore, exact identification of those patients who really need an adjuvant treatment in cases with not yet defined indications seems questionable.

Тезисы
Цель
Рак шейки матки, являясь вторым наиболее распространенным видом рака у женщин, остается одной из основных причин женской смертности. Даже при ранней стадии рака шейки матки имеются значительный риск смертности, который через 5 лет составляет 15%. С целью выявления пациентов высокого риска, несмотря на ранние стадии заболевания, инвазия лимфоваскулярного пространства (LVSI) была предложена в качестве дополнительного прогностического фактора.

Методы
Проведен систематический обзор и анализ имеющейся литературы по LVSI и раку шейки матки.

Результаты и выводы
На основании опубликованных данных использовать LVSI в качестве единственного показания для адъювантной терапии представляется проблематичным. Тем не менее, LVSI следует рассматривать в качестве дополнительного фактора в случаях с нечеткими показаниями к адъювантной терапии. При проведении гистологических исследований мы настоятельно рекомендуем сообщать о точной локализации LVSI и обнаружении сопутствующей LVSI.

Введение
Во всем мире рак шейки матки является вторым наиболее распространенным видом рака у женщин. Несмотря на то, заболеваемость рака шейки матки снизилась, благодаря ранней диагностике, и сосредоточена в группах с высоким риском, например, в зонах с высокой частотой рака шейки матки. Однако, даже при ранней стадии заболевания, инвазия лимфоваскулярного пространства (LVSI) может быть значительным фактором риска.
treatment after surgery is urgently needed. Ultimately, it is not a very well known field which individual patients with a definitely combination of risk factors benefit from adjuvant treatment modalities. Therefore, efforts have been undertaken in order to identify high-risk patients who could profit by those therapies. Several prognostic factors for identification of those patients have been described, including tumor stage, lymph node metastasis, histological subtype (adenocarcinoma versus squamous cell carcinoma), and LVSIs. However, in the existing literature, there is controversy about the prognostic impact of LVSIs.

This article summarizes and addresses the available literature on the prognostic role of LVSIs in early stage cervical cancer. There is no doubt, that some of the known risk factors are interrelated. Many studies describe a strong association of LVSIs and positive nodal status, which is a major problem concerning investigation of LVSIs as independent prognostic factor. In 12 of 36 studies, LVSIs have been described to be of prognostic value. However, the problem with discussing the results of these studies is, that there are considerable variations of study design, definition and localisation of LVSIs, and statistical analysis. In addition, prognostic factors have to be evaluated in context to the performed surgical procedures which differ considerably.

Methods

We reviewed the available literature investigating LVSIs as prognostic factor for early stage cervical cancer which has been found using the search criteria “early-cervical-cancer-LVSIs-prognostic-factor” in a pubmed-based retrieval. The exclusively retrospective reviewed literature has been published from 1985 to 2008 and most patients were stage IB. LVSIs were evaluated using uni- and multivariate analysis.

Pathological Definition and Localisation of LVSIs

Currently, no generally accepted standards for determination of LVSIs have been described and its prognostic value may be hampered by a high degree of intra- and interobserver variability. The detection rate of LVSIs ranges from 9% to 43% (Creasman and Kohler, 2004). Usually, LVSIs is detected using hematoxylin and eosin staining, since immunohistochemically diagnosed LVSIs is a common event and seems to be of no clinical value (Lim et al., 2008). Only one study differentiated between LVSIs in proximity to the tumor-invasion front (conjoined-LVSIs) and tumor distant LVSIs (satellite-LVSIs) (Herr et al., 2009). The authors of this study considered the localisation of LVSIs and defined satellite-LVSIs as LVSIs occurring distant from the main tumor, in the parametrical tissue or in pelvic lymph nodes with a minimum metrical distance of 1 cm (Herr et al., 2009). From a biological point of view, it seems reasonable to assume an association of satellite-LVSIs and a high risk of recurrence or metastasis. Therefore, it has been hypothesized that the prognosis of patients with satellite-LVSIs differs from patients with conjoined-LVSIs.

Pathological Definition and Localisation of LVSIs

Currently, no generally accepted standards for determination of LVSIs have been described and its prognostic value may be hampered by a high degree of intra- and interobserver variability. The detection rate of LVSIs ranges from 9% to 43% (Creasman and Kohler, 2004). Usually, LVSIs is detected using hematoxylin and eosin staining, since immunohistochemically diagnosed LVSIs is a common event and seems to be of no clinical value (Lim et al., 2008). Only one study differentiated between LVSIs in proximity to the tumor-invasion front (conjoined-LVSIs) and tumor distant LVSIs (satellite-LVSIs) (Herr et al., 2009). The authors of this study considered the localisation of LVSIs and defined satellite-LVSIs as LVSIs occurring distant from the main tumor, in the parametrical tissue or in pelvic lymph nodes with a minimum metrical distance of 1 cm (Herr et al., 2009). From a biological point of view, it seems reasonable to assume an association of satellite-LVSIs and a high risk of recurrence or metastasis. Therefore, it has been hypothesized that the prognosis of patients with satellite-LVSIs differs from patients with conjoined-LVSIs.

Methods

We reviewed the available literature investigating LVSIs as prognostic factor for early stage cervical cancer which has been found using the search criteria “early-cervical-cancer-LVSIs-prognostic-factor” in a pubmed-based retrieval. The exclusively retrospective reviewed literature has been published from 1985 to 2008 and most patients were stage IB. LVSIs was evaluated using uni- and multivariate analysis.

Pathological Definition and Localisation of LVSIs

Currently, no generally accepted standards for determination of LVSIs have been described and its prognostic value may be hampered by a high degree of intra- and interobserver variability. The detection rate of LVSIs ranges from 9% to 43% (Creasman and Kohler, 2004). Usually, LVSIs is detected using hematoxylin and eosin staining, since immunohistochemically diagnosed LVSIs is a common event and seems to be of no clinical value (Lim et al., 2008). Only one study differentiated between LVSIs in proximity to the tumor-invasion front (conjoined-LVSIs) and tumor distant LVSIs (satellite-LVSIs) (Herr et al., 2009). The authors of this study considered the localisation of LVSIs and defined satellite-LVSIs as LVSIs occurring distant from the main tumor, in the parametrical tissue or in pelvic lymph nodes with a minimum metrical distance of 1 cm (Herr et al., 2009). From a biological point of view, it seems reasonable to assume an association of satellite-LVSIs and a high risk of recurrence or metastasis. Therefore, it has been hypothesized that the prognosis of patients with satellite-LVSIs differs from patients with conjoined-LVSIs.
After a median follow-up of 55 months, the authors observed that LVSI is an independent prognostic factor using univariate as well as multivariate analysis. Concerning survival, there are several studies indicating an independent prognostic impact for LVSI by multivariate analysis: Metindir et al. and others showed significantly decreased 5-year disease free survival rates in LVSI-positive patients with stage I-II disease (Metindir and Bilir, 2007, Kenter et al., 1988). In a retrospective study with 187 patients of Takeda et al., LVSI was found to be independently related to poor survival after a median follow up of 83 month (Takeda et al., 2002). For patients who had a tumor histologically confined to a biologically significant area of 1 см (Herr and dr., 2009). С биологической точки зрения предполагается возникновение у пациентов с сопутствующей LVSI и высоким риском рецидива или метастазов. Поэтому, было высказано предположение, что прогноз у пациентов с сопутствующей LVSI отличается от такового у пациентов без LVSI (Herr и соавт., 2009).

**Negative Studies for LVSI as Prognostic Factor**

The available literature with negative results for LVSI as prognostic factor is registered in Table 1. The problem with interpreting this data is, that all studies are retrospective analyses of heterogeneous patient populations with generally small numbers of LVSI-positive cases. In addition, most of the studies with negative results did not have the power to detect significant results due to the high rates of association with nodal positive status. Furthermore, none of the reports distinguished between different localizations of LVSI.

**Positive Studies for LVSI as Prognostic Factor**

The studies reporting positive results for LVSI as prognostic factor are shown in Table 2. Among the studies with stage IIB cervical cancer with negative lymph nodes, LVSI was a significant prognostic factor in the study of Comerci et al. (Comerci et al., 1998). In this study, 275 patients were treated by radical hysterectomy and pelvic node dissection. 75% of these patients had histopathologically confirmed negative pelvic lymph nodes. After a median follow-up of 55 months, the authors observed that LVSI is an independent prognostic factor using univariate as well as multivariate analysis. Concerning survival, there are several studies indicating an independent prognostic impact for LVSI by multivariate analysis: Metindir et al. and others showed significantly decreased 5-year disease free survival rates in LVSI-positive patients with stage I-II disease (Metindir and Bilir, 2007, Kenter et al., 1988). In a retrospective study with 187 patients of Takeda et al., LVSI was found to be independently related to poor survival after a median follow up of 83 month (Takeda et al., 2002). For patients who had a tumor histologically confined to a biologically significant area of 1 см (Herr and dr., 2009). С биологической точки зрения предполагается возникновение у пациентов с сопутствующей LVSI и высоким риском рецидива или метастазов. Поэтому, было высказано предположение, что прогноз у пациентов с сопутствующей LVSI отличается от такового у пациентов без LVSI (Herr и соавт., 2009).

**Таблица 1: Исследования, которые не подтвердили прогностическое значение LVSI**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Number of patients</th>
<th>LVSI as prognostic factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frigerio (Frigerio et al., 1998)</td>
<td>1998</td>
<td>103</td>
<td>no</td>
</tr>
<tr>
<td>Yuan (Yuan et al., 1999)</td>
<td>1999</td>
<td>1006</td>
<td>no</td>
</tr>
<tr>
<td>Hopkins (Hopkins and Morley, 1991)</td>
<td>1991</td>
<td>213</td>
<td>no</td>
</tr>
<tr>
<td>Gentili (Gentili et al., 2000)</td>
<td>2000</td>
<td>16</td>
<td>no</td>
</tr>
<tr>
<td>Kamura (Kamura et al., 1993)</td>
<td>1993</td>
<td>107</td>
<td>no</td>
</tr>
<tr>
<td>Aoki (Aoki et al., 2000)</td>
<td>2000</td>
<td>59</td>
<td>no</td>
</tr>
<tr>
<td>Suprasert (Suprasert et al., 2006)</td>
<td>2006</td>
<td>150</td>
<td>no</td>
</tr>
<tr>
<td>Marchiolé (Marchiole et al., 2005)</td>
<td>2005</td>
<td>292</td>
<td>no</td>
</tr>
<tr>
<td>Snijders (Snijders-Keilholz et al., 1999)</td>
<td>1999</td>
<td>233</td>
<td>no</td>
</tr>
<tr>
<td>Yuan (Yuan et al., 1998)</td>
<td>1998</td>
<td>442</td>
<td>no</td>
</tr>
<tr>
<td>Samal (Samal et al., 1997)</td>
<td>1997</td>
<td>186</td>
<td>no</td>
</tr>
<tr>
<td>Sartori (Sartori et al., 2007)</td>
<td>2007</td>
<td>454</td>
<td>no</td>
</tr>
<tr>
<td>Kainz (Kainz et al., 1994)</td>
<td>1994</td>
<td>142</td>
<td>no</td>
</tr>
<tr>
<td>Gauthier (Gauthier et al., 1985)</td>
<td>1985</td>
<td>100</td>
<td>no</td>
</tr>
<tr>
<td>Kristensen (Kristensen et al., 1999)</td>
<td>1999</td>
<td>125</td>
<td>no</td>
</tr>
<tr>
<td>Finan (Finan et al., 1996)</td>
<td>1996</td>
<td>229</td>
<td>no</td>
</tr>
<tr>
<td>Tsai (Tsai et al., 1999)</td>
<td>1999</td>
<td>222</td>
<td>no</td>
</tr>
<tr>
<td>Trattner (Trattner et al., 2001)</td>
<td>2001</td>
<td>113</td>
<td>no</td>
</tr>
<tr>
<td>Kim (Kim et al., 2000)</td>
<td>2000</td>
<td>368</td>
<td>no</td>
</tr>
<tr>
<td>Hellebrekers (Hellebrekers et al., 1999)</td>
<td>1999</td>
<td>294</td>
<td>no</td>
</tr>
<tr>
<td>Duk (Duk et al., 1996)</td>
<td>1996</td>
<td>282</td>
<td>no</td>
</tr>
<tr>
<td>Obermair (Obermair et al., 1998)</td>
<td>1998</td>
<td>166</td>
<td>no</td>
</tr>
<tr>
<td>Lai (Lai et al., 1999)</td>
<td>1999</td>
<td>134</td>
<td>no</td>
</tr>
<tr>
<td>Grafund (Grafund et al., 2002)</td>
<td>2002</td>
<td>172</td>
<td>no</td>
</tr>
</tbody>
</table>

1. Проблема с интерпретацией этих данных заключается в том, что все исследования являются ретроспективным анализом гетерогенных популяций пациентов с небольшим числом LVSI-положительных случаев. Кроме того, большинство исследований не могут продемонстрировать результаты, связанные с высо- ким показателем ассоциации с поражением лимфатических узлов. Кроме того, сообщения не отличаются различными локализациями LVSI.

**Положительные исследования для LVSI как прогностического фактора**

Исследования, демонстрирующие положительные результаты для LVSI как прогностического фактора, приведены в таблице 2. Среди исследований случаев IIB стадии рака шейки матки без поражения лимфатических узлов в исследовании Comerci с соавт., 1998 LVSI являлась значимым прогностическим фактором. В этом исследовании 275 пациентов лечили с помощью радиальной гистерэктомии и иссечения тазовых лимфатических узлов. 75% этих пациентов имели гистологическое подтверждение отсутствия поражения тазовых лимфоузлов. После наблюдения в течение, в среднем, 55 месяцев, авторы обнаружили, используя однофакторный, а также многофакторный анализ, что LVSI является независимым
to the uterus and had neither parametrial invasion nor lymph node metastasis, LVSI was the most important prognostic factor.
One of the reasons for the different results concerning LVSI in different studies is, that currently there are no standards for the exact description of LVSI. Due to own investigations, particularly the exact localization plays a major role.

However, there is only one study in which this matter was taken into account (Herr et al., 2009): in the above mentioned study of 286 patients with early stage cervical cancer it was differentiated between conjoined-LVSI and satellite-LVSI. While no significant effect of LVSI in general on overall survival (OAS) or disease free survival (DFS) was calculated, the presence of satellite-LVSI was associated with significant decreased rates of both, OAS and DFS. Therefore, satellite-LVSI was proposed as prospect factor being possibly helpful in order to estimate the individual risk for patients with early-stage cervical cancer.

**Association with Positive Nodal Status**
From a biological point of view, it seems indeed plausible to assume positive lymph node metastasis in patients with aggressive tumor present-
Conclusion
The data for using LVSI as indication for adjuvant therapy of the early cervical cancer is contradictory, which can be mostly explained by the different definitions of LVSI. Neither the diagnostic procedure of identifying LVSI nor the exact localisation (satellite-LVSI vs. conjoined-LVSI) is standardized. In addition, prospective studies concerning the value of LVSI in early cervical cancer are lacking.
Based on the data of this review, using LVSI as sole indication for adjuvant therapy seems more than questionable. However, in exceptional cases, it could be considered as additional risk factor in cases where adjuvant treatment is discussed controversial. In pathological reports, we strongly suggest to report on the exact localisation of LVSI or the presence of satellite-LVSI, respectively.
In terms of clinical decision on adjuvant therapy, considering satellite-LVSI as an independent significant prognostic factor based on just one study is questionable. Further data is needed to confirm this finding. Therefore, in nodal-negative patients, the question of a cut-off for considering adjuvant therapy remains unanswered.

Выводы
Данные об использования LVSI в качестве показания к адъювантной терапии на ранних стадиях рака шейки матки являются противоречивыми, что можно, в основном, объяснить различными определениями LVSI.
Диагностическая процедура для обнаружения LVSI и определения ее точной локализации (сопутствующая LVSI vs. соединенной LVSI) в настоящий момент не является стандартизированной. Кроме того, проспективные исследования, касающиеся значимости LVSI на ранних стадиях рака шейки матки, не проводились.
На основании данных этого обзора, использовать LVSI в качестве единственного показания для адъювантной терапии представляется более, чем проблематичным.
Тем не менее, иногда LVSI может рассматриваться как дополнительный фактор риска в тех случаях, когда обсуждается вопрос о целесообразности проведения адъювантной терапии. В гистологических результатах мы настоятельно рекомендуем сообщать о точной локализации LVSI или присутствии сопутствующей LVSI, соответственно.
При принятии клинического решения об адъювантной терапии учитывать сопутствующую LVSI в качестве независимого значения прогнозического фактора, основываясь лишь на результатах одного исследования, не представляется возможным. Необходимы дальнейшие исследования для подтверждения этого факта. Таким образом, у пациентов без поражения лимфатических узлов, вопрос о целесообразности проведения адъювантной терапии остается без ответа.
Cervical Cancer

Literature


A New Device for Long-Term Recording of Wheezing and Cough in Patients with Asthma and Other Respiratory Diseases

Keywords: asthma, wheezing, cough, lung sound recording, auscultation, nocturnal long-term monitoring, respiratory diseases, computerized analysis, LEOSound, symptom detection

Purpose
A mobile device for automated long-term lung sound monitoring and analysis enables assessment of wheezing and cough (8). It is assumed that asthmatic patients, especially asthmatic children with decreased performance and sleepiness during the day have sleep disturbances and a poorer sleep quality because of increased nocturnal asthmatic symptoms (1-6, 9, 10).

Introduction
Asthma is a complex and chronic inflammatory disorder which is associated with reversible airway obstruction and bronchial hyperresponsiveness (7,15). It is one of the most prevalent chronic diseases in children and prevalence further increases worldwide. The majority of asthma patients has mild to moderate asthma, 5 to 10% suffer from severe asthma. Typical symptoms of asthma are breathlessness, cough and wheeze (7). Control of asthma symptoms and a good quality of life are the main goals of therapy. Nocturnal asthma symptoms must be interpreted as an uncontrolled state of asthma, which is associated with increased mortality and decreased quality of life (1,4,9,10).

Nocturnal Asthma
Nocturnal asthma symptoms like wheezing and coughing are a marker of asthma severity (7,12,15). Wheezing is the acoustic manifestation of lower airway obstruction limiting airflow in a collapsible bronchial system and is most frequently diagnosed by auscultation. Wheezes are continuous adventitious lung sounds with a musical quality (12). Their frequency range extends from 100Hz to 2000Hz. Healthy children do not wheeze, so the presence of wheezing during day or night must be interpreted as a manifestation of their disease. The presence of biphasic in- and expiratory wheezing corresponds with more severe bronchoconstric-

Новое устройство для долгосрочной регистрации хрипов и кашля у пациентов с астмой и другими респираторными заболеваниями

Тезисы
Мобильное устройство для автоматизированного продолжительного мониторинга и анализа легочных шумов позволяет регистрировать и анализировать свистящие хрипы и кашель [8]. Пределопагается, что у пациентов с бронхиальной астмой, особенно у детей со сниженной активностью и сонливостью в течение дня, есть нарушения сна и снижение его качества из-за усиления ночных астматических симптомов [1-6, 9, 10].

Ночная астма
Ночные симптомы астмы, такие как свистящие хрипы и кашель являются индикатором степени тяжести астмы (7, 12, 15). Свистящие хрипы являются акустическим проявлением обструкции нижних дыхательных путей и ограничения воздушного потока в деформированной бронхиальной системе, и наиболее часто диагностируются с помощью аускультации. Свистящие хрипы являются легочными шумами с музыкальным оттенком [12]. Их диапазон частот колеблется от 100 до 2000 Гц. У здоровых детей хрипы отсутствуют, поэтому появление хрипов в течение дня или ночи следует интерпретировать как симптом заболевания.
A non-productive cough, which worsens at night, is a typical symptom for asthma. In children, the information about wheezing and coughing during the night is often based on the observation of the parents. The children aren’t able to make sufficient reports about their nocturnal respiratory symptoms and the parents thus often underestimate the situation. Furthermore, parents differ in their understanding and interpretation of wheeze, and reported wheezing often cannot be confirmed by auscultation.

Sleep Quality of Patients with Nocturnal Asthma
Disorders of sleep and daily performance as an effect of nocturnal asthma received comparatively little attention. However, increased daytime sleepiness because of nocturnal awakenings has been documented in a few studies with stable asthmatic adults and children (5,10,14,17). In the study by Chugh et al. in 38 out of 40 clinical stable asthmatic children (95%) nocturnal symptoms of asthma, sleep disturbances and poorer sleep quality were evident (1). Sleep disturbances were reported in 60% of the asthmatics and included daytime sleepiness, difficulty in maintaining sleep, early morning awakenings and struggle against sleep during daytime.

Meijer et al. reported the presence of nocturnal symptoms in almost half of 796, Strunk et al. in a third of 1041 children with asthma (10,14). Most

Fig. 1a/b: Child with the LEOSound-system. Three highly sensitive bioacoustic sensors are attached to the trachea (blue) and on the back of the patient (red, yellow).

C: LEOSound is a special developed new respiratory diagnostic system. The system is able to record and analyze cough, wheezing and other breath and lung sounds over a long period. The device is battery-operated, small and compact and allows a comfortable ambulatory or stationary recording for children and adults.
findings of the studies rely on self-reporting by the children or their parents. Nocturnal asthma symptoms may disrupt the continuity of sleep by awakenings or arousals and can lead to daytime sleepiness, general lack of energy, reduced school performance and increased school absences. Evaluating sleep quality to achieve good control of asthma is important since nocturnal symptoms may disturb sleep. Poor asthma control may increase the risk for sleep problems and a higher rate of exacerbations. Luyster et al. reported that poorer sleep quality is an independent predictor of worse asthma control and quality of life in non-severe and severe asthma patients (9).

A study by Desager et al. described increased daytime sleepiness and tiredness in wheezing school-aged children (2). Even with an optimal antiobstructive and anti-inflammatory therapy, a large number of patients continued to experience nocturnal symptoms of asthma. Janson et al. studied the prevalence of sleep complaints, and sleep disturbances in 98 adult asthmatic patients by means of questionnaires and sleep diaries (5). The most common sleep disorders were early morning awakening (51%), difficulty in falling asleep, and daytime sleeping (9%).

Luyster et al. reported that poorer sleep quality is an independent predictor of worse asthma control and quality of life in non-severe and severe asthma patients (9).

A study by Desager et al. described increased daytime sleepiness and tiredness in wheezing school-aged children (2). Even with an optimal antiobstructive and anti-inflammatory therapy, a large number of patients continued to experience nocturnal symptoms of asthma. Janson et al. studied the prevalence of sleep complaints, and sleep disturbances in 98 adult asthmatic patients by means of questionnaires and sleep diaries (5). The most common sleep disorders were early morning awakening (51%), difficulty in falling asleep, and daytime sleeping (9%).

Luyster et al. reported that poorer sleep quality is an independent predictor of worse asthma control and quality of life in non-severe and severe asthma patients (9).

A study by Desager et al. described increased daytime sleepiness and tiredness in wheezing school-aged children (2). Even with an optimal antiobstructive and anti-inflammatory therapy, a large number of patients continued to experience nocturnal symptoms of asthma. Janson et al. studied the prevalence of sleep complaints, and sleep disturbances in 98 adult asthmatic patients by means of questionnaires and sleep diaries (5). The most common sleep disorders were early morning awakening (51%), difficulty in falling asleep, and daytime sleeping (9%).

Luyster et al. reported that poorer sleep quality is an independent predictor of worse asthma control and quality of life in non-severe and severe asthma patients (9).

A study by Desager et al. described increased daytime sleepiness and tiredness in wheezing school-aged children (2). Even with an optimal antiobstructive and anti-inflammatory therapy, a large number of patients continued to experience nocturnal symptoms of asthma. Janson et al. studied the prevalence of sleep complaints, and sleep disturbances in 98 adult asthmatic patients by means of questionnaires and sleep diaries (5). The most common sleep disorders were early morning awakening (51%), difficulty in falling asleep, and daytime sleeping (9%).

Luyster et al. reported that poorer sleep quality is an independent predictor of worse asthma control and quality of life in non-severe and severe asthma patients (9).
maintaining sleep (44%) and daytime sleepiness (44%). The prevalence of sleep disturbances in the asthmatic group was about twice as high than in the healthy control group. Sleep quality, daytime activity and academic performance improves when children with nocturnal asthma and disturbed daytime psychological function are successfully treated.

Meltzer et al. demonstrated that out of 298 adolescents (age 12-17 years; 48% with asthma) almost 40% of adolescents with severe asthma reported clinically significant insomnia (11). Daytime sleepiness was also found to be greater in adolescents with severe asthma compared to patients with mild or no asthma. Asthma severity and insomnia severity were predictors for daytime sleepiness. Sleep fragmentation and poor sleep quality are likely associated with asthma control and quality of life.

Why Do we Need Objective Long-Term Monitoring of Asthma Symptoms during Sleep?
Many patients do not report nocturnal symptoms to their doctor or the doctor does not ask for these symptoms. Lack of awareness of nocturnal asthma symptoms can lead to a worse asthma control and impaired daytime activity. Up to now, we cannot be sure that clinically stable asthmatic patients during daytime are also stable during sleep. It is obvious that asthmatic children who suffer from tiredness during daytime have no stable asthma during sleeping hours.

Mechanisms of Nocturnal Asthma and Comorbidities
Asthma is influenced by sleep and chronobiological rhythms (15,16). Lung function is usually highest at 4 pm and lowest at 4 am. In the early morning hours, asthma symptoms are more prevalent. A heightened parasympathetic tone and neurogenic inflammation lead to bronchoconstriction, vasodilation and mucus hypersecretion. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. A heightened parasympathetic tone and neurogenic inflammation lead to bronchoconstriction, vasodilation and mucus hypersecretion. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Mechanisms of Nocturnal Asthma and Comorbidities
Asthma is influenced by sleep and chronobiological rhythms (15,16). Lung function is usually highest at 4 pm and lowest at 4 am. In the early morning hours, asthma symptoms are more prevalent. A heightened parasympathetic tone and neurogenic inflammation lead to bronchoconstriction, vasodilation and mucus hypersecretion. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.

Self and Parental Questionnaires to Assess Nocturnal Asthma Symptoms are of Only Small Value!
Asthma is diagnosed and categorized by lung function testing and symptoms during [5]. The association of asthma with nocturnal asthma symptoms is higher than the association with daytime asthma symptoms. The prevalence of nocturnal asthma symptoms was twice as high as the prevalence of daytime asthma symptoms. The association of asthma with a variety of comorbidities like rhinosinusitis, obesity, obstructive sleep apnea and gastroesophageal reflux disease (GERD) are under discussion. Chronic rhinosinusitis and asthma are chronic inflammatory processes in which airway epithelium damage plays a key role. Both can lead to coughing and wheezing. Daytime and nocturnal asthma symptoms improve when sinuses are cleared. The same is evident for patients with GERD, in which the reflux of acid can trigger vagal receptors in the lower oesophagus or can lead to microaspiration. The physiological pathways, which can explain the association between asthma and OSA are not known, epithelium damage by snoring and OSA could play the main role. Obstructive sleep apnea and the intrathoracic pressure swings may also lead to gastroesophageal reflux, aggravated by supine position during sleep.
daytime and sleep. However, data about lung function or respiratory symptoms during sleep are missing. Previous studies evaluated nocturnal respiratory status by waking up the patient in order to obtain data by lung function or peak-flow. However, interrupting the patients sleep seems not a representative respiratory situation for this time. Therefore, further diagnostic tools are necessary to monitor symptoms during sleep objectively. Questionnaire-based studies or diary cards are of only small value, because parents often differ in their understanding of wheeze. Furthermore, the reports of parents or children do not reflect the real occurrence of wheezes and cough episodes throughout the night. Usually wheeze episodes are only detected by auscultation with the stethoscope. If wheezing can be heard without stethoscope, it is only a small, noticeable part of a problem, and does not necessarily reflect the total occurrence of wheezing.

**Computerized Wheeze and Cough Monitoring**

Computerized cough and wheeze monitoring is a practical and non-invasive method for assessing asthma activity in children and adults. Computerized lung sound analysis is expected to be a more objective, reliable and standardizable method (8). To date only a few studies have used computerized methods to detect wheezes and/or cough. Lung function testing during the day represents quite a short moment of respiratory function and is not representative for the 24h time circle. Children up to the age of 6 years are not able to perform a correct lung function testing. Thus nocturnal cough and wheeze monitoring provides a simple tool for assessment of asthma and response to medical treatment.

Computerized lung sound monitoring and analysis, especially detection of wheeze and cough, have been reported to be a much more objective method than diary cards. Lung sound monitoring can be performed continuously over a longer period. The data can also be stored for later assessment. A trend plot of nocturnal cough and wheeze can be helpful for identifying the timing and the distribution of wheeze and cough activity during sleep. Lung sound analysis provides additional information that can help the doctor monitoring children’s asthma and the response to drug therapy. Documentation of nocturnal asthma attacks or symptoms gives objective information on the changes in airway obstruction. Peak flow measurements during the night are only possible when the patient is awake. Furthermore, the accuracy of peak flow meter usage also depends on correct technique and effort.

**The LEOSound System**

LEOSound is a commercial available, automated lung sound monitor, that records lungs sounds continuously by three small bio-acoustical sensors attached to the trachea and to the back of the patient (8) (Figure 1a/1b/1c). Beside this, an ambient microphone is integrated. Thus, it is possible to differentiating lung sounds by the patient in order to obtain data by lung function or peak-flow. However, interrupting the patients sleep seems not a representative respiratory situation for this time. Therefore, further diagnostic tools are necessary to monitor symptoms during sleep objectively. Questionnaire-based studies or diary cards are of only small value, because parents often differ in their understanding of wheeze. Furthermore, the reports of parents or children do not reflect the real occurrence of wheezes and cough episodes throughout the night. Usually wheeze episodes are only detected by auscultation with the stethoscope. If wheezing can be heard without stethoscope, it is only a small, noticeable part of a problem, and does not necessarily reflect the total occurrence of wheezing.

**Computerized Wheeze and Cough Monitoring**

Computerized cough and wheeze monitoring is a practical and non-invasive method for assessing asthma activity in children and adults. Computerized lung sound analysis is expected to be a more objective, reliable and standardizable method (8). To date only a few studies have used computerized methods to detect wheezes and/or cough. Lung function testing during the day represents quite a short moment of respiratory function and is not representative for the 24h time circle. Children up to the age of 6 years are not able to perform a correct lung function testing. Thus nocturnal cough and wheeze monitoring provides a simple tool for assessment of asthma and response to medical treatment.

Computerized lung sound monitoring and analysis, especially detection of wheeze and cough, have been reported to be a much more objective method than diary cards. Lung sound monitoring can be performed continuously over a longer period. The data can also be stored for later assessment. A trend plot of nocturnal cough and wheeze can be helpful for identifying the timing and the distribution of wheeze and cough activity during sleep. Lung sound analysis provides additional information that can help the doctor monitoring children’s asthma and the response to drug therapy. Documentation of nocturnal asthma attacks or symptoms gives objective information on the changes in airway obstruction. Peak flow measurements during the night are only possible when the patient is awake. Furthermore, the accuracy of peak flow meter usage also depends on correct technique and effort.

**The LEOsSound System**

LEOSound is a commercial available, automated lung sound monitor, that records lungs sounds continuously by three small bio-acoustical sensors attached to the trachea and to the back of the patient (8) (Figure 1a/1b/1c). Beside this, an ambient microphone is integrated. Thus, it is possible to differentiating lung sounds by the patient in order to obtain data by lung function or peak-flow. However, interrupting the patients sleep seems not a representative respiratory situation for this time. Therefore, further diagnostic tools are necessary to monitor symptoms during sleep objectively. Questionnaire-based studies or diary cards are of only small value, because parents often differ in their understanding of wheeze. Furthermore, the reports of parents or children do not reflect the real occurrence of wheezes and cough episodes throughout the night. Usually wheeze episodes are only detected by auscultation with the stethoscope. If wheezing can be heard without stethoscope, it is only a small, noticeable part of a problem, and does not necessarily reflect the total occurrence of wheezing.**

**Computerized Wheeze and Cough Monitoring**

Computerized cough and wheeze monitoring is a practical and non-invasive method for assessing asthma activity in children and adults. Computerized lung sound analysis is expected to be a more objective, reliable and standardizable method (8). To date only a few studies have used computerized methods to detect wheezes and/or cough. Lung function testing during the day represents quite a short moment of respiratory function and is not representative for the 24h time circle. Children up to the age of 6 years are not able to perform a correct lung function testing. Thus nocturnal cough and wheeze monitoring provides a simple tool for assessment of asthma and response to medical treatment.

Computerized lung sound monitoring and analysis, especially detection of wheeze and cough, have been reported to be a much more objective method than diary cards. Lung sound monitoring can be performed continuously over a longer period. The data can also be stored for later assessment. A trend plot of nocturnal cough and wheeze can be helpful for identifying the timing and the distribution of wheeze and cough activity during sleep. Lung sound analysis provides additional information that can help the doctor monitoring children’s asthma and the response to drug therapy. Documentation of nocturnal asthma attacks or symptoms gives objective information on the changes in airway obstruction. Peak flow measurements during the night are only possible when the patient is awake. Furthermore, the accuracy of peak flow meter usage also depends on correct technique and effort.

**The LEOsSound System**

LEOSound is a commercial available, automated lung sound monitor, that records lungs sounds continuously by three small bio-acoustical sensors attached to the trachea and to the back of the patient (8) (Figure 1a/1b/1c). Beside this, an ambient microphone is integrated. Thus, it is possible to differentiating lung sounds by the patient in order to obtain data by lung function or peak-flow. However, interrupting the patients sleep seems not a representative respiratory situation for this time. Therefore, further diagnostic tools are necessary to monitor symptoms during sleep objectively. Questionnaire-based studies or diary cards are of only small value, because parents often differ in their understanding of wheeze. Furthermore, the reports of parents or children do not reflect the real occurrence of wheezes and cough episodes throughout the night. Usually wheeze episodes are only detected by auscultation with the stethoscope. If wheezing can be heard without stethoscope, it is only a small, noticeable part of a problem, and does not necessarily reflect the total occurrence of wheezing.

**Computerized Wheeze and Cough Monitoring**

Computerized cough and wheeze monitoring is a practical and non-invasive method for assessing asthma activity in children and adults. Computerized lung sound analysis is expected to be a more objective, reliable and standardizable method (8). To date only a few studies have used computerized methods to detect wheezes and/or cough. Lung function testing during the day represents quite a short moment of respiratory function and is not representative for the 24h time circle. Children up to the age of 6 years are not able to perform a correct lung function testing. Thus nocturnal cough and wheeze monitoring provides a simple tool for assessment of asthma and response to medical treatment.

Computerized lung sound monitoring and analysis, especially detection of wheeze and cough, have been reported to be a much more objective method than diary cards. Lung sound monitoring can be performed continuously over a longer period. The data can also be stored for later assessment. A trend plot of nocturnal cough and wheeze can be helpful for identifying the timing and the distribution of wheeze and cough activity during sleep. Lung sound analysis provides additional information that can help the doctor monitoring children’s asthma and the response to drug therapy. Documentation of nocturnal asthma attacks or symptoms gives objective information on the changes in airway obstruction. Peak flow measurements during the night are only possible when the patient is awake. Furthermore, the accuracy of peak flow meter usage also depends on correct technique and effort.

**The LEOsSound System**

LEOSound is a commercial available, automated lung sound monitor, that records lungs sounds continuously by three small bio-acoustical sensors attached to the trachea and to the back of the patient (8) (Figure 1a/1b/1c). Beside this, an ambient microphone is integrated. Thus, it is possible to differentiating lung sounds by the patient in order to obtain data by lung function or peak-flow. However, interrupting the patients sleep seems not a representative respiratory situation for this time. Therefore, further diagnostic tools are necessary to monitor symptoms during sleep objectively. Questionnaire-based studies or diary cards are of only small value, because parents often differ in their understanding of wheeze. Furthermore, the reports of parents or children do not reflect the real occurrence of wheezes and cough episodes throughout the night. Usually wheeze episodes are only detected by auscultation with the stethoscope. If wheezing can be heard without stethoscope, it is only a small, noticeable part of a problem, and does not necessarily reflect the total occurrence of wheezing.
sounds from speech, and other ambient sounds. The validated system works like a ‘long-term stethoscope’ and allows objective 24 hours lung-sound auscultation at patients home or at the hospital. The 24 hours interval is especially useful to determine the frequency and diurnal variation of coughs in patients with asthma or with persistent cough of unknown cause. The LEOSound analyzer software automatically evaluates the data for the presence of cough and nocturnal wheezing and stores the results and the raw data in a database. The records as well as the automatic ratings are shown on a graphic illustrated user interface (Figure 2). Additionally, the user can listen on all three channels, for verifying the automated analysis. LEOSound is so far the only lung sound monitoring system, which analyses both, wheezing, as well as cough events automatically. The lung sound monitoring system can be very beneficial for asthmatic patients, and has great potential in both clinical and research settings. The relationships between chronic cough and disease entities such as gastroesophageal reflux disease (GERD), obstructive sleep apnea and upper airway cough syndrome are further uses for the LEOSound system.

LEOSound is so far the only lung sound monitoring system, which analyses both, wheezing, as well as cough events automatically. The lung sound monitoring system can be very beneficial for asthmatic patients, and has great potential in both clinical and research settings. The relationships between chronic cough and disease entities such as gastroesophageal reflux disease (GERD), obstructive sleep apnea and upper airway cough syndrome are further uses for the LEOSound system.

LEOSound in the current moment is considered a unique system, which automatically analyzes the detected cough events and stores them in a database. Additionally, the user can listen on all three channels to verify the automated analysis. LEOSound is the only lung sound monitoring system that can analyze both wheezing and cough events simultaneously. The lung sound monitoring system is particularly beneficial for asthmatic patients and has great potential in both clinical and research settings. The relationships between chronic cough and disease entities such as gastroesophageal reflux disease (GERD), obstructive sleep apnea, and upper airway cough syndrome are further uses for the LEOSound system.
In studies it has been demonstrated that cough frequency monitoring is a reliable primary end-point in clinical trials. For the first time, there is the opportunity, to detect and analyze cough events over 24 hours and nocturnal wheezing objectively. As part of a validation study of LEOSound in children, we compared software-based analysis with medical expert’s assessment. The nocturnal results show high sensitivity (93%) and specificity of 99% for the detection of cough. Figure 3a/3b show a typical cough event in epochal view and an enlarged view to single events, exemplarily demonstrating the sensitivity of the algorithms (green lines). Wheezing can be identified by its typical frequency band in the spectrogram, as it is shown in figure 4a/4b. Sensitivity and specificity for wheezing detection is 98% and 96%, respectively (18).

Of further interest, not only in clinical trials, is the quality of cough, namely the computerized discrimination between non-productive and productive cough event in epochal view (3a) and an enlarged view to single events (3b), exemplarily demonstrating the sensitivity of the algorithms (green lines). Wheezing can be identified by its typical frequency band in the spectrogram, as it is shown in figure 4a/4b. Sensitivity and specificity for wheezing detection is 98% and 96%, respectively (18).

Of further interest, not only in clinical trials, is the quality of cough, namely the computerized discrimination between non-productive and productive cough event in epochal view (3a) and an enlarged view to single events (3b), exemplarily demonstrating the sensitivity of the algorithms (green lines). Wheezing can be identified by its typical frequency band in the spectrogram, as it is shown in figure 4a/4b. Sensitivity and specificity for wheezing detection is 98% and 96%, respectively (18).
cough. The software extracts specific patterns from the cough sound signals, to distinguish cough quality in an automated manner. The LEOSound system allows an objective recording and analyzing of occurrence and severity of cough and wheezing events, thus provide a promising addition of the diagnostic repertoire.

Literature
12. Storms WV, Bodmann SF, Nathan RA, Bayer P. Nocturnal asthma symptoms may be more prevalent than we think. J Asthma 1994; 31:313-318
Welcome to German Medical Online - the leading international MED Portal.

German Medical Online is the who’s who of the medical world.

Whatever you are looking for in the medical field – find it in the German Medical Online Portal.

Get connected to the leading hospitals, clinics and medical specialists.

Find the best suppliers of medical equipment, MedTech, instruments and more.
www.german-medical-online.com
Welcome to German Medical Online - the Leading International MED Portal.

Via QR-Code to the direct information on your cell phone. Give it a try.

How it works
Get the free QR Reader for your iPhone from the App Store.
Take a picture from the QR Code and jump to the web page with detailed information.

Heidelberg University Hospital
One of Europe`s leading medical centers. World-renowned experts provide comprehensive care in all medical specialties.

Medical Park
Leading premium provider of medical rehabilitation and preventive care in Germany.

University Medical Center Freiburg
The University Medical Center Freiburg is one of the largest and most reputable in Europe.
Vivantes International Medicine
Vivantes Netzwerk für Gesundheit GmbH is the largest state-owned hospital group in Germany. Located in Europe’s health capital Berlin.

Competence Center for the Diagnostic and Therapy of Chronic Pruritus
Specialists from several Departments of the University offer a complete check-up to identify the origin and best treatment for chronic pruritus.

Department of Obstetrics and Gynecology, University Hospital of Tuebingen
Excellence centre for General Gynecology, Gynecological Oncology, Obstetrics, Urogynecology

Department of Dermatology and Allergy TUM
Department of Dermatology and Allergy Biederstein, Technical University Munich

Department of Ophthalmology, Klinikum rechts der Isar, TUM
diabetic retinopathy, retinal detachment, cataract, corneal transplants, lasik and epilasik and more

Department of Orthopaedic Sports Medicine, Klinikum rechts der Isar
knee shoulder and foot surgery, arthroscopy cartilage cell and bone cartilage transplantation

Department of Pediatric Surgery, University Medical Center Mainz, Germany

Medical Prevention Center Hamburg (MPCH)
Enhance your quality of life - now and in the future.
Neurosurgical Clinic, Ludwig-Maximilians-University Munich-Grosshadern
Treatment of multimodal and brain tumours, vascular malformations, paediatric, spine, neurosurgery.

Specialist Hospital Kloster Grafschaft
Specialist Hospital for Pneumology and Allergology

University Hospital for General, Visceral and Transplantation Surgery
Experienced excellence center for abdominal organ transplantation and surgical oncology.

BG-Trauma Hospital Tuebingen
Traumatology, endoprosthesis, plastic surgery, cranio-maxillo-facial-surgery, paraplegia, reha

Department Obstet. Gynecology, University Hospital LMU Munich
Women Health, Cancer, Prenatal Care, Infertility

Prof. Dr. Werner Knopp
Senior Consultant, Department of Traumatology, Hand- and Reconstructive Surgery
Hospital Planning

Hospital Planning, Building and Managing made in Germany

Dr. Hönle Medizintechnik GmbH

UV therapy systems and iontophoresis devices

proxomed Medizintechnik GmbH

Professional Training Systems for Active Therapy. Future Rehab and health Concepts

German Medical Council

German Medical Council organizes the best medical treatment in Germany for patients from all over the world.

Reuschel & Co. Privatbankiers

Reuschel & Co. Privatbankiers is one of Germany’s leading private banks

ADAC Service GmbH

When it comes to safety, the ADAC-Ambulance Service is the ideal partner for all holiday and business travellers.
Hospital Planning Alliance Ltd.
Germany - U.A.E.

Hospital Planning, Building and Managing
Made in Germany

- Project Development • Consultancy • Design
- Architecture • Engineering • Management Structures
- Quality Management • Hospital Certification
- State-of-the-Art Solutions

www.hospital-planning.com