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WHERE HEALTHCARE CONNECTS WITH TECHNOLOGY
Dear Reader,

Cities are locked down, schools, universities and museums are closed, trade fairs and large events are postponed or cancelled and cruise ships are quarantined. Some companies urge their employees to work from home. The novel coronavirus SARS-CoV-2 has reached global epidemic proportions.

According to experts, the virus is highly contagious. In most people, the disease only causes mild symptoms similar to those of a common cold, which is why infected people usually do not seek medical advice right away. However, during the incubation period, they can already infect others who may develop more severe symptoms. People who have had contact with an infected person or have spent time in a designated high-risk area should stay at home, contact their family doctor by phone and get tested to find out whether they have also been infected with the virus.

Virologists all over the world are racing to explore the new virus and develop an antide, an antiviral agent, as soon as possible. A Swiss high-security laboratory has already successfully created synthetic clones of the virus. This serves to better understand the way the virus works in order to develop therapies and vaccines and identify suitable disinfectants.

In our increasingly globalised world, pathogens can spread rapidly. Until researchers develop a new medicine or active ingredient, the countries and people of this world need to act responsibly and wisely and take measures to prevent transmissions and protect themselves and others against further spread of the disease as effectively as possible.

Stay safe and healthy and enjoy your German Medical Journal.

Nadine Baume
Managing Director

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The new coronavirus SARS-CoV-2

There is growing concern about the coronavirus SARS-CoV-2 on a global scale. More than 500,000 people have already been infected; about 22,000 of them died of the consequences (as of 26 March 2020), especially in China, where the first cases of infection with the novel virus were reported in December 2019. The novel coronavirus has the official name “SARS-CoV-2”, the respiratory disease it causes is referred to as “COVID-19”. SARS stands for “Severe Acute Respiratory Syndrome”.

Apart from China, Italy, USA, Spain, Germany and Iran are strongly affected. The European Union has raised the risk level of coronavirus infection from moderate to high. The virus was first detected in Wuhan, China. It is assumed that the novel coronavirus originated from bats and that the first few people contracted it at a market in Wuhan in the Hubei province of China. According to the information provided by the WHO, 80 percent of the cases are mild. The first symptoms of a coronavirus infection are cough, a runny nose, sore throat and fever. Further symptoms include fatigue, headache and body aches as well as chills. Some people also experience diarrhoea. In some patients, especially older people and people with existing health problems, the disease can have severe, potentially life-threatening consequences, involving respiratory problems and pneumonia. In isolated cases, no symptoms occur at all.

The virus is easily transmitted, because, similar to influenza viruses, it replicates not only in the lungs, but also in the mouth and the throat. According to the WHO, the average incubation period is 5-6 days, but it may also take up to 14 days until first symptoms become apparent. During that period, infected people who have not yet developed symptoms can already transmit the virus and infect others.

Scientists all over the world are racing to develop a vaccine. Various active ingredients are being tested to alleviate the symptoms. A specific therapy for the novel coronavirus is not yet available.

Routes of transmission
The highly infectious coronavirus is transmitted from humans to humans. Its routes of transmission include droplet transmission, direct contact transmission and transmission with the novel virus were already been infected; about 500,000 people have already been infected; about 22,000 of them died of the consequences (as of 26 March 2020), especially in China, where the first cases of infection with the novel virus were reported in December 2019. The novel coronavirus has the official name “SARS-CoV-2”, the respiratory disease it causes is referred to as “COVID-19”. SARS stands for “Severe Acute Respiratory Syndrome”.

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infection, where droplets containing the virus enter the mucous membranes of the airways, the mouth, the nose or the eyes, and smear infection, where the pathogens are transmitted to the mucous membranes by direct or indirect contact.

How can you protect yourself and others from getting infected?
As is the case with influenza and other respiratory diseases, you should observe various hygiene rules and take precautions to protect yourself and others from getting infected with the coronavirus:

- Wash your hands regularly and thoroughly with water and soap for at least 20 seconds, especially after blowing your nose, sneezing or coughing.
- Avoid touching your face as far as possible to prevent any pathogens from entering the mucous membranes of the eyes, nose or mouth. Gloves can also make you more mindful of not touching your face.
- Keep your distance (about 1.5-2 metres) to people who have cough, a runny nose or a fever.
- Avoid shaking hands and hugging when greeting others.
- Use your knuckles instead of your fingertips to press lift buttons or door open buttons.
- Avoid crowded places and events.
- Keep the greatest possible distance and turn away from others when coughing or sneezing. Use the crook of your arm or a paper tissue which you then dispose of right away.

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المحتويات

فيروس كورونا الجديد
SARS-CoV-2

أم الدم بالشريان الأبهري البطني – الصدري التشخيص، الترُصد، المعالجة

المعالجة الإشعاعية المخصصة عالية الدقة للمرضى الذين يعانون من سرطان البروستاتة الأولي

راب مفصل الركبة الكلي والجزئي بمساعدة الروبوت المعالجة متعددة التخصصات للأمراض الوريدية المختلفة ما عدا الدوالي
The New Coronavirus
SARS-CoV-2

Thoraco-Abdominal Aortic Aneurysms

Individualized High Precision Radiation Therapy in Patients with Primary Prostate Cancer

Robotic-Assisted Total and Partial Knee Arthroplasty

Interdisciplinary Management of Diverse Non-Varicose Venous Diseases
Thoraco-Abdominal Aortic Aneurysms
Diagnostic, Surveillance, Treatment
Introduction

Aneurysms and dissections of the thoraco-abdominal aorta (TAAA) remain a central disease for multidisciplinary vascular specialists. During the last decade, both the hospital incidence (1) and treatment of TAAA changed remarkably (2). Besides infrarenal abdominal aortic aneurysms (AAA) and aneurysms limited to the thoracic aorta, TAAA involving the visceral segment are challenging for vascular surgeons. TAAA have been first described in 1955 by Stephen N. Etheredge (3). According to the modified Crawford classification, they can be subdivided into five types (modified by Safi) (Fig. 1).

Keywords: Aneurysm; Endovascular aortic repair (EVAR); Complex aortic repair; Thoraco-abdominal aortic aneurysm; Dissection

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Two distinctly different operative techniques are available to treat patients with TAAA: complex endovascular aortic repair (EVAR) and open-surgical repair (OSR). While fifteen years ago most patients have been treated by OSR, nowadays more than 90% of the patients are treated by EVAR. The global widespread of endovascular approaches was accompanied by various innovative further developments of endografts including fenestrations and branches to connect to target vessels of the thoraco-abdominal aorta using fenestrated or branched stent-grafts (FB-EVAR). Beside surgical and interventional experience with these complex procedures the need for specialized intensive care and surveillance remains in order to minimize perioperative complications.

Epidemiology

Among AAA (60% of all aortic aneurysms)(27), 5% involve one or both renal arteries. In contrast, TAAA account for only 5% to 10% of all aortic aneurysms (6, 7). However, valid population-based data to estimate the prevalence are rare. Various authors report a prevalence of 6 to 15 per 100,000 European inhabitants (8-10). The worldwide increase of hospital incidences and inpatient treatments of TAAA is reflected in the German population (Fig. 2) (11).

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Etiology

80% of TAAA are caused by degenerative atherosclerotic disease. Males are affected more frequently when compared to females (6:1)(28). Common denominator is a marked degeneration of the tunica media, the loss of smooth muscle cells, and the degradation of elastin in the vascular wall.

In addition to that, approximately 20% of the TAAA develops due to chronic dissection. These false lumen aneurysms are characterized by a difference in spinal perfusion when compared to primary degenerative atherosclerotic aneurysms (Fig. 3). Genetic aortic diseases (e.g., Marfan syndrome, Loeys-Dietz syndrome, Ehlers-Danlos syndrome), mycotic aneurysms, and secondary aneurysms due to vascular procedures are much less common.

Diagnosis of TAAA

Clinical symptoms of TAAA are rare and often unspecific. TAAA should be excluded if any of the following symptoms occur: new aortic valve insufficiency, cardiac murmur, pericardial, pericardial tamponade, aneurysms of the abdominal aorta, peripheral aneurysms (12). If the thoracic part of the aneurysm involves the aortic arch, hoarseness can be the initial symptom. The first line

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Fig. 1: Illustration of the Crawford classification (modified by Safi et al. 1998) (4, 5). (ICS: Intercostal space). © Copyright 2017 C.-A. Behrendt
Aortic Aneurysms

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diagnostic tests should include a contrast-enhanced cross-sectional imaging of the aorta, where computed tomography remains the modality of first choice. In addition, transesophageal echocardiography can complement the diagnostic workup (12).

The acute aortic syndrome due to a TAAA can present with searing breast or back pain, abdominal pain, or signs of renal or visceral ischemia. Rarely, an upper or lower gastro intestinal bleeding due to an aorto-enteric fistula can be the first manifestation of TAAA (13).

Invasive Treatment

Few international practice guidelines are available concerning the invasive repair of TAAA (12). Invasive repair of asymptomatic aneurysms is recommended if the diameter reaches 6.0cm (12, 14-16). Symptomatic TAAAs, embolic complications, and rapidly growing (more than 0.5cm in 6 months) TAAAs should be evaluated immediately by a vascular surgeon. The decision for OSR or EVAR should be patient-centered considering the individual aspects in a structured way. A SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) might help the health care professionals and patients pondering the available options. Multidisciplinary aortic confer-

Fig. 2: Number of inpatient treatments (procedure-related) between 2005 and 2015 according to the German Federal Statistical Office (DeStatis). Approximately 7% of the thoraco-abdominal aortic aneurysms have been coded in Hamburg, Germany.

الشكل 2: عدد علاجات المرضى الداخليين (المتعلقة بالإجراءات) بين عامي 2005 و 2015 وفقًا لمكتب الإحصاء الفيدرالي الألماني. تم ترميز حوالي 7% من أم الدم بالشريرى البطني الصندرى - البطنى في هامبورغ، ألمانيا. (DeStatis)

(على سبيل المثال، متلازمة مارفان، متلازمة لويس ديتز، منتلازمة إفامار، دانلوس الوعائية). وَأَمَّ الدَّمِ الفُطْرِيَّة، الظُهْرِيَّة، الشُرْهُل، وأمراض الدم الثانوية الناجمة عن الإجراءات الوعائية.

تشخيص أم الدم بالشريرى الأبهر

TAAA

البطني – الصندرى

الاعراض السيريرية لـ TAAA والغالب ما تكون غير نوعية. يجب استبعاد في حالة حدوث أي TAAA من الأعراض التالي: قصور حديث بالصماد الأبهر، نفخة قلبية، الظلام، أمراض الدم في الأبهر البطني، أمراض الدم في الأبهر الصندرى، أمراض الدم المحيطية (13). يمكن أن تكون بحة العضلات في العرض الأولي إذا كان الجزء الصندرى من أم الدم معتبرًا إلى قوس الأبهر. يجب أن يتضمن الخط

7% in Hamburg (2015)

n=1,532

n=1,532

n=1,804

Thoracic-abdominal aortic aneurysms without rupture (blue) and with rupture (red)


0 500 1,000 1,500 2,000

n=272

Aortic Aneurysms

Fig. 3: 1 to 3: Degenerative atherosclerotic thoraco-abdominal aortic aneurysm (Type III). 3: Postoperative 3D-computed tomography after endovascular implantation of a branched stentgraft. 4-6: Thoraco-abdominal false lumen aneurysm (Type II) due to chronic type b dissection. 6: Postoperative 3D-computed tomography after endovascular implantation of a fenestrated stentgraft for visceral and supra aortic vessels and treatment of the false lumen. 4: Proximal entry of the dissection distal to the left subclavian artery.

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أم الدم بالشريان الأبهري

الشريان الأبهري هو الخط العلجي في الدم بالبطيني (النوع الثاني) في 3 أم الدم بالشريان الأبهري بعد القسطرة الدخولية لزروع الشريان الدموي المقطعي (النوع الثالث) ب elim (النوع الثاني) بسبب الشريان المعده ثلاثي الأبعاد بعد القسطرة الدخولية لزروع الشريان الدموي المقطعي بالأنواع العضوية والفرعين فوق الأبهرية وعلاج المتعة الكاذبة. 4) الدخول القريب للشريان البعيد عن الشريان تحت الترقعة الأيسر.

المتلازمة الباطعة

تشتهر بعض الإشارات حول الممارسة الدولية بخصوص عمليات الإصلاح الباطنية لأم الدم بالشريان الأبهر

النوع (TAAA) (النوع الثاني) يُحدث إصلاح أم الدم الباطنية إذا كان قطرها يصل إلى 60 سم (12).

14-16 سم (النوع الأول من قبل التقييم الفوري لأم الفرات) أو أكثر من 5 سم (النوع الأول من قبل التقييم الفوري)

من قبل محاسبة جراحة الأوعية الدموية. يجب أن يكون قرار الإصلاح الجراحي المفتوح OSR أو إصلاح الأبهر الجراحي المفتوح(EVAR) بالضغط متحيزًا حول حالة المريض مع مراجعة الجوانب الفردية بطريقة منظمة. قد يساعد تحليل نقاط القوة والضعف والمخاطر SWOT

والخليج في التفكير بالميزات بين الخيارات العلاجية المتاحة. يجب أن تستخدم استراتيجيات أمراض الأبهر متعددة التخصصات التوصيات المستددة على
Aortic Aneurysms

Enureses should use evidence-based recommendations from available practice guidelines, which can also serve to reach an informed consent (17). If the aortic anatomy is appropriate for endovascular repair, the patient’s risk profile is unfavorable for open-surgical repair (“unfit patients”), or the patient exhibited prior abdominal surgery (“hostile abdomen”), endovascular repair should be the first line treatment. For patients with genetic aortic diseases, low risk profile, or recent abdominal surgery, stentgraft with fenestrations and branches can be used to connect the celiac trunk (1), the superior mesenteric artery (2), both renal arteries (3, 4), and the inferior mesenteric artery (5) to the stentgraft. EVAR is a minimally invasive surgical procedure that replaces the diseased aorta with an endovascular stentgraft, which is deployed using a catheter inserted through an artery in the leg or chest. The stentgraft is inflated to expand the vessel and secure it in place. This procedure is an alternative to open surgery for treating abdominal aortic aneurysms and can be performed through a small incision or even through a minimally invasive approach, reducing the risk of complications and improving the patient’s recovery time.
Endovascular Aortic Repair

Most commonly, the stent-graft and its connecting bridging covered stents can be deployed through the femoral arteries with help of a steerable sheath. In selected cases, the brachial arteries also serve as access vessels to catheterize the downward-facing reno-visceral branches for connection of the bridging stents. The first description of endovascular repair of a TAAA was published in 2001 (18). Two decades later, the successful revascularization of the visceral or supra aortic vessels remains the main challenge. For this, several stent-grafts with branches, fenestrations and scallops are commercially available (Fig. 4). Depending on the anatomy and urgency of the repair, it can be chosen between patient-specific “custom-made” endo-graft and patient-unspecific “off-the-shelf” endografts with a standardized size and position of side branches.

Recently, a complete transfemoral access has been implemented for branched endografts at our clinic (19). This led to a reduction of stroke risk to 0% in the analysis of the first

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| Complications Following Complex Endovascular Aortic Repair of Thoraco-Abbdominal Aortic Aneurysms |
|----------------------------------|-------------------|------------------|
| Outcome                          | Frequency         | Reference        |
| Stroke                           | 1.4% to 3.3%      | Roselli et al. 2007, Fiorucci et al. 2017 |
| Acute coronary syndrome and other cardiac events | 5.5%            | Roselli et al. 2007 |
| Acute kidney failure with dialysis dependency | 1% to 1.4%       | Roselli et al. 2007 |
| Reintubation and prolonged ventilation | 6.8%            | Roselli et al. 2007 |
| Re-Interventions                 | 21.6% after 3 years | Verhoeven et al. 2015 |

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petitive endovascular attempts, open-surgical repair and hybrid approaches remain an important treatment option. To date, experienced high-volume centers such as the German Aortic Center Hamburg treat more than 90% of the patients with TAAA by endovascular approaches with fenestrated or branched stent-grafts. Due to the particular requirements of these complex procedures, centralization of TAAA to high-volume centers has been recently discussed by the vascular community.

الجدول 1: المضاعفات التالية لإصلاح أم الدم بالشفريان الأوريدي الصدري – البطني المعقدة بواسطة الدخل الوعائي بالقسطرة الفجارية أيضاً أكوعية وصول لقسطرة الفجارية التلقحية الكاذبة نحو الأنصاف من أجل توصيل الدعامات الجسرية. نظر أول وصول للدمعة داخلي الأوريدية الدموية في عام 2001 (18) وبعد مصارع من الزمن، لا يزال التحدي الرئيسي هو في إعادة التدفينة الناجحة للأوعية المستوية أو الأوريدية فوق الأوريدية وهذا، تتوفر العديد من الطعوم الدموية المختلفة أو المتفرعة ومروحة الشكل (شبيه الإسكالوب) في الأسواق (الشعلة). واعتمادًا على تشريع الإصلاح الشفريان ودعامتها، يمكن اختيار بين خعال غطائي مصمم بشكل خاص لمرضيه مدد «طرم خلاقي غير محدّث. نتائج من تعاون وصول الكلم إلى جلبي المفتح الشفري من وضع محدد لإعادة إصلاح الأوريدية (19)». واعتمادًا على تسليم النتائج بعد إصلاح الأوريدية التدفني بالدمعة المثلثية FB-EVAR والمتفرعة.

إصلاح الشفريان الأوريدي المعقد يكون إصلاح الجراح المفتوح من أصل جزء الشفريان الأوريدي الصدري باستخدام الدعامات الوعائية الاصطناعية المتفرعة للمعدة أو المدهنة (على سبيل المثال طعم من الداكرون). يوضع المريض
Aortic Aneurysms

52 patients. The short-term mortality has been reported to be 4% to 10% in early series and is steadily declining in centers of expertise to below 5% (19-24). Besides relevant rates of reinterventions, spinal ischemia remains one of the most feared complications (up to 8% among all procedures). A standardized intensive care unit protocol, including measures such as a patient-blood-management or cerebrospinal fluid drainage, aims to improve the outcomes following FB-EVAR.

Open-Surgical Aortic Repair
Open-surgical repair consists of the replacement of the affected aorta using branched or bifurcated grafts. The surgical approach depends on the location and size of the aneurysm. The common approach is through a retroperitoneal incision in the lower abdomen and flank, allowing exposure of the infrarenal aorta. An alternative approach is through a thoraco-abdominal incision, providing easier access to the thoracic aorta. The repair involves clamping the aorta proximally and distally, entry into the aneurysmal sac, and interposition of a graft. The graft is anastomosed to the aorta beyond the aneurysm, and the limbs are anastomosed to the renal arteries and other branches as needed.

Fig. 5: Open-surgical repair of thoraco-abdominal aortic aneurysms. Upper left figure: Right iliac branch (Arrow 1). Upper right figure: Evoked potentials (Arrow 2). Bottom left: Lung (Arrow 3) beside the Dacron graft with visceral branches (Arrow 4 and 5). Arrow 6 illustrates the incision line. © Copyright 2017 C.-A. Behrendt

The progression of aortic aneurysms can be slow, and some patients may not require intervention for years. However, if the aneurysm grows rapidly or reaches a critical size, surgery becomes necessary. The goals of treatment are to prevent rupture, which is associated with a high mortality rate, and to improve the quality of life. Open-surgical repair offers the highest success rate and long-term durability. However, it is a major procedure with significant risks, including mortality, morbidity, and complications.

The development of endovascular techniques has provided an alternative to open surgery, allowing for less invasive treatment options. Endovascular repair involves the placement of a stent graft into the aneurysmal sac through a small incision in the femoral artery. The stent graft is then expanded to exclude the aneurysmal sac from the bloodstream. This technique is less invasive, offers quicker recovery, and reduces complications. However, it is not suitable for all patients, and long-term outcomes are still being evaluated.

The choice between open surgery and endovascular repair depends on various factors, including the size and location of the aneurysm, patient characteristics, and operator experience. Both approaches have their advantages and disadvantages, and the decision should be made after careful evaluation of the patient's situation.

In summary, aortic aneurysms are a critical condition that requires prompt and careful management. The treatment options have evolved significantly over the years, offering patients a range of choices for effective and minimally invasive care.
modified vascular prostheses (e.g., Dacron graft). The patient is placed in a modified right lateral decubitus position, with the shoulders rotated to 60° and the hips rotated to 30° from horizontal. The patient’s left arm is placed in an elevated position. A left thoracotomy is made, using the fifth or sixth intercostal space (Fig. 5). The proximal clamp is placed -if possible- distal to the left subclavian artery. Although developments in modern vascular surgery improved outcomes significantly, this operation remains a major effort for the multidisciplinary team consisting of vascular surgeons, anesthesiologists, intensive care specialists, neurophysiologists, and nurses. Various measures have been established to improve the perioperative outcomes of TAAA surgery. A mild permissive hypothermia, the partial left heart bypass, selective visceral perfusion, cold renal perfusion, cerebrospinal fluid drainage, and the revascularization of segmental arteries have been reported to be protective (4). A neuromonitoring (e.g., evoked potentials) should be performed during the procedure (25). The in-hospital mortality for elective TAAA repair was reported up to 10% (26) depending on the case volume and specialization of the center (Table 2).

### Innovative Concept – The German Aortic Center Hamburg

A multidisciplinary and interprofessional collaboration is the most important fundament to treat complex thoraco-abdominal aortic diseases. In 2012, the synergistic cooperation of vascular surgery, angiology, cardiology, and cardiac surgery at the University Heart and Vascular Center Hamburg led to the implementation of the German Aortic Center Hamburg. To date, the treatment of all aortic diseases became a main area in Hamburg (Fig. 7). As international reference

| Complications Following Complex Open-Surgical Aortic Repair of Thoraco-Abdominal Aortic Aneurysms |
|------------------|-----------------|-----------------|
| Outcome                        | Frequency | Reference        |
| In-hospital mortality         | 7.8% to 10%   | Bensley et al. 2013, Kouchoukos et al. 2013 |
| Stroke                        | 3.7%         | Kouchoukos et al. 2013 |
| Acute coronary syndrome and other cardiac events |             |                  |
| Acute kidney failure with dialysis dependency | 2.7% to 10.7% | Bensley et al. 2013, Coselli et al. 2007 |
| Pneumonia                     | 23.1%        | Bensley et al. 2013 |
| Reintubation and prolonged ventilation | 13.8%      | Bensley et al. 2013 |
| Spinal ischemia               | 5.3% to 6.3%  | Kouchoukos et al. 2013, Coselli et al. 2007 |

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By surgery - Am. Aortic repair the thoracic visceral arteries have been reported to improve the perioperative outcomes of TAAA surgery. A mild permissive hypothermia, the partial left heart bypass, selective visceral perfusion, cold renal perfusion, cerebrospinal fluid drainage, and the revascularization of segmental arteries have been reported to be protective (4). A neuromonitoring (e.g., evoked potentials) should be performed during the procedure (25). The in-hospital mortality for elective TAAA repair was reported up to 10% (26) depending on the case volume and specialization of the center (Table 2).

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Aortic Aneurysms

Conclusions
- Thoraco-abdominal aortic aneurysms count for 5% to 10% of all aortic aneurysms with increasing prevalence. Approximately 5% to 7% of all German-wide treatments were performed in Hamburg.
- Contrast-enhanced computed tomography remains the first line diagnostic procedure. It may be complemented by a transesophageal echocardiography.
- For invasive repair, endovascular and open-surgical and hybrid approaches are available. More than 90% of the patients with thoraco-abdominal aortic aneurysms can be treated less invasively with complex stent-grafts. Genetic aortic diseases and low risk profile can be reasons to choose open-surgical approaches.
- The main predictors of a favorable outcomes are the case volume and expertise of the vascular center. A good collaborative multidisciplinary teamwork and excellent infrastructure are needed to assure patient safety.
- Major complications such as spinal ischemia remain a challenge for multidisciplinary teams. Innovative treatment and surveillance protocols can help to lower the complications rates.

center for aortic and complex rare diseases, patients are transferred to Hamburg from various countries.

Fig. 6: Development of endovascular (blue) and open-surgical (red) aortic repair at the German Aortic Center Hamburg between 2005 and 2015.
Aortic Aneurysms

References


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Individualized High Precision Radiation Therapy in Patients with Primary Prostate Cancer

Implementation of advanced imaging techniques like multiparametric magnetic resonance imaging (mpMRI) or Positron Emission Tomography (PET) in planning of high precision radiotherapy (RT) for patients with primary prostate cancer (PCa) demands several preconditions: accurate staging of the extraprostatic and intraprostatic tumor burden, robust delineation of the intraprostatic gross tumor volume (GTV) and a reproducible characterization of the PCa’s biological properties.

In this article we summarize the currently available imaging techniques for primary PCa patients and how their implementation helps in improving high precision RT approaches in terms of focal RT.

I. MpMR and PSMA PET Imaging

In the last decade advanced medical imaging techniques have improved and mpMRI as well as PET have been implemented in diagnostics of primary PCa and RT planning. Current guidelines recommend a risk-adapted imaging, taking into account the patient’s wishes and comorbidities (1).

MpMRI consists of T1w, T2w and additionally diffusion weighted (DWI) MRI or dynamic contrast enhanced (DCE) sequences. Two meta-analysis investigated sensitivity and specify scores of mpMRI to identify intraprostatic lesions based on histopathologic studies. Reported scores ranged from 74% to 89% and from 73% to 88% for a combination of T2w-, DCE- and DWI-imaging (2, 3). MpMRI’s shows limitations in detecting small PCa lesions (4), poor sensitivity in case of T-zone involvement, as well as false positive rates in benign prostatic hyperplasia (5). Furthermore, a notable inter-reader variability to identify intraprostatic tumor volumes has been reported (6).

The recent update of the Prostate Imaging Reporting System (PI-RADSv2) (7) standardizes the evaluation and reporting of mpMRI and thus increases robustness in detecting PCas (8-10). Three studies examined whether local recurrences of PCa after primary RT occur at the primary tumor side using mpMRI or PET (11).

II. Equipment

PET Imaging

PET consists of T2w, DCE- and DWI-sequence. Two meta-analysis investigated sensitivity and specify scores of mpMRI to identify intraprostatic lesions and specify scores of mpMRI analysis investigated sensitivity (DCE) sequences. Two meta-analysis investigated sensitivity and specify scores of mpMRI to identify intraprostatic lesions based on histopathologic studies. Reported scores ranged from 74% to 89% and from 73% to 88% for a combination of T2w-, DCE- and DWI-imaging (2, 3).

III. Clinical Application

In current guidelines recommend accurate staging of the extraprostatic and intraprostatic tumor burden, robust delineation of the intraprostatic gross tumor volume (GTV) and a reproducible characterization of the PCa’s biological properties (1).

IV. Conclusion

In conclusion, implementation of advanced imaging techniques like mpMRI or PET in planning of high precision radiotherapy (RT) for patients with primary prostate cancer (PCa) demands several preconditions: accurate staging of the extraprostatic and intraprostatic tumor burden, robust delineation of the intraprostatic gross tumor volume (GTV) and a reproducible characterization of the PCa’s biological properties.
Pre and post treatment MRI. All of them observed that local recurrences after RT mostly occurred at the side of the primary MR-visible tumour (11-13). Our group delineated retrospectively the intraprostatic GTV based on mpMRI in patients with primary EBRT for PCa. We could prove that the dose distribution within the imaging-defined GTV correlates better with the biochemical recurrent free survival than the RT dose delivered to the rest of the prostatic gland (14). Lymph-node staging normally involves T1w and T2w imaging. A meta-analysis reported a pooled sensitivity of 39% and a pooled specificity of 82% for mpMRI in lymph-node staging (15), which can be improved by usage of DWI sequences (16).

In the recent years PET-CT has emerged as a promising technique to identify prostate cancer lesions. In diagnostic of PCa, the role of PET tracers usually used for oncologic imaging like 2-deoxy-2(18F)-fluoro-D-glucose (FDG) or 11C-labeled tracers are insufficient in detection of PCa metastases (20-23). Development of new radioactive tracers like 68Ga- or 18F-PSMA, binding to the prostate-specific-membrane antigen, which is being overexpressed in PCa cells (24), has gained interest in the last decade. PSMA-PET/CT is already on the verge of being established as the gold standard for restaging in recurrent PCa after surgery (25, 26). However, its potential to guide therapies in a first line diagnostic setting needs to be investigated more thoroughly. Previously our group evaluated PCa localization in primary PCa patients using mpMRI, PSMA-PET/CT and biopsy cores and we observed highly discrepant results between the three modalities (27). To further address which imaging modality performs better, correlation studies with histology information after surgery have been warranted.

Several studies investigated correlations between PSMA-PET/CT and histopathology after radical prostatectomy. Sensitivity and specificity score for detection of intraprostatic lesions range from 49% to 92% and from 85% to 97%, respectively.

In the study of our group in Freiburg could demonstrate, that choline PET/CT fails to distinguish between PCa and non-PCa tissue (18, 19). FDG- and 11C- and 18F-PET/CT are also insufficient in detection of PCa metastases (20-23).

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respectively (28-35). A slice by slice comparison between PSMA PET and histology performed by the Freiburg group reported a sensitivity score of 75% and specificity of 87% (34). A voxel-level PET/histology correlation performed also by our group could further reconfirm the excellent performance of PSMA PET in intraprostatic GTV detection (35).

Several groups supposed that a combination of mpMRI and PSMA-PET/CT imaging to overcome each technique’s limitations might lead to complementary information in PCa detection (34). Using hybrid PET/MR imaging Eiber et al. postulated, that mpMRI and 68Ga-PSMA PET may offer complementary information in PCa detection. The sensitivity increased up to 0.76 when both imaging methods were combined. The authors divided each prostate into sextants and observed that in 19% of the sextants, PET imaging detected PCas with a negative result in mpMRI. Conversely, mpMRI was positive with negative PSMA PET findings in 13% of the sextants (36). The Freiburg group reported an increase in sensitivity up to 0.82 when GTV-union (addition between GTV-PET and GTV-MRI) was considered (34).

Rhee et al. showed that not all lesions in histopathology were positive by both, PSMA PET and mpMRI. If GTV-intersection (intersection volume between GTV-MRI and GTV-PET) was used, the specificity even increased up to 99 % (37). The value of PSMA-PET/CT in detection of lymph nodes metastases in patients with primary PCas was analyzed in recent studies (38, 39). Sensitivity and specificity scores investigated for 68Ga-PSMA-11 PET/CT for lymph node detection using histopathologic reference range between 0.64 – 0.66 and 0.96 – 0.99 respectively and thus performed better than conventional cross sectional imaging (40, 41). Furthermore Maurer et al. could demonstrate that PSMA-PET/CT can detect lesions with 2mm size (40). In a recent work from our group, we could demonstrate that radiomic features derived from the primary intraprostatic tumor lesion may even enhance the sensitivity of PSMA-based lymph node detection to 85% (42).

Additionally, PSMA-PET/CT has higher sensitivity and specificity scores (0.99 and 0.88) for detection of bone metastases than standard bone scintigraphy (0.87 and 0.61) (43) and detects on average double the number of lesions (44).

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II. Focal Radiation Therapy: Rationale and First Experiences from Other Groups

The five-year rates for biochemical relapse for localized intermediate and high-risk PCa after RT is approximately 35% (45, 46) and local relapses after primary RT mostly occur in areas of dominant intraprostatic lesions (47, 48). Randomized trials have demonstrated an approximately 35% biochemical relapse within five years in patients with localized intermediate-risk PCa after primary RT (45, 46). The corresponding dose volume histogram (bottom) shows dose distribution for bladder (yellow), rectum (brown), whole prostate (pink) and the boost volume (purple). Please notice the prosthesis in the right femur which affects the RT planning process.

Fig. 1 exemplarily shows the dose distribution using focal dose escalation applied via external beam radiotherapy in axial, coronal and sagittal planes (top). GTV-PET (using 30% SUV-max) and GTV-MRI were co-registered and the union of both GTVs + a margin of 4mms was used as boost volume. Organs at risk shown are bladder (yellow) and rectum (brown). The corresponding dose volume histogram (bottom) shows dose distribution for bladder (yellow), rectum (brown), whole prostate (pink) and the boost volume (purple). Please notice the prosthesis in the right femur which affects the RT planning process.
improved biochemical disease-free survival with RT dose escalation on the entire prostatic gland using external beam radiotherapy (49-53). However, further increase of RT dose to the whole gland is not favorable, as increased toxicity rates have been reported with this approach (54-56). To overcome these issues the concept of focal RT arose.

Focal RT is defined as ultra-focal RT (treatment of the GTV only) and localized RT (treatment to the entire prostatic gland and RT dose escalation to the GTV). Dose escalation can be delivered via external beam radiotherapy and high-dose-rate (HDR) brachytherapy.

A prospective phase II study reported promising results regarding tolerance, toxicity profiles, as well as biochemical and functional response, applying a focal boost using HDR brachytherapy with MRI-transrectal ultrasound fusion for image guidance (57).

There are three randomized controlled trials currently investigating the focal dose escalation via external beam radiation. The FLAME study, performed in centers in the Netherlands and Belgium, is currently investigating the delivery of an integrated boost in external beam radiation to 95 Gy. Besides the primary endpoint, the 5 years rate of progression free survival (PFS), secondary endpoints such as toxicity are collected (58). Two years outcomes of toxicity rates were published in 2018 and showed no significant difference in grade 2-4 genitourinary and gastrointestinal toxicity rates between the standard treatment and dose-escalated treatment arm (59).

Furthermore the delivery of a boost up to 95 Gy is feasible and the dose constraints for rectum and bladder did not differ between treatment group arms (59).

The HEIGHT study performed at the University of Miami is investigating hypofractionated targeted radiotherapy boost to the dominant tumor lesion (60). The PIVOTALBoost study, performed in the UK, is analyzing four different treatment arms with radiotherapy of prostate and pelvis versus prostate alone with or without boost (61).

The results are encouraging that an integrated boost will increase the PFS rates without an increment of toxicity rates. Moreover, the implementation of advanced imaging techniques, especially with regard to the promising results of PSA-MET/CT, have the capabilities to improve treatment even further.

The results are encouraging that an integrated boost will increase the PFS rates without an increment of toxicity rates. Moreover, the implementation of advanced imaging techniques, especially with regard to the promising results of PSA-MET/CT, have the capabilities to improve treatment even further.
III. Focal Radiation Therapy Based on Multimodal Imaging: the Freiburg Experience

Since 2017, PSMA PET/CT and 3 tesla mpMR imaging are offered routinely to patients suffering from primary PCA for RT planning at our institution to ensure the highest performance in intra- and extraprostatic tumor definition. Using modern RT techniques like intensity modulated RT (IMRT), image guided RT (based on cone-beam CT scans and implanted fiducials) and adaptive RT we established a workflow for localized RT on a daily practice. Being part of the Comprehensive Cancer Center Freiburg (CCCf) therapies are based on collaborations with the departments of urology, radiology and nuclear medicine as well as recommendations given by the interdisciplinary tumorboard.

Localised focal RT was applied by using external beam radiotherapy (EBRT) or high-dose rate (HDR) brachytherapy for dose escalation. In the following we would like to report our initial results. The EBRT group consisted of 31 patients with histologically ascertained PCa. All underwent insertion of intraprostatic fiducial markers followed by MRI imaging and a PSMA PET/CT planning scan. According to NCCN guidelines 18.

Fig. 2 exemplarily shows the dose distribution using focal dose escalations applied by HDR-brachytherapy (top left). Please notice the dose reduction in the central area to spare the urethra. The corresponding Ga68-PSMA-PET/CT (right) shows the multilocular tumor lesions. The corresponding dose volume histogram (bottom left) shows the dose distribution for rectum (green), urethra (yellow) as well as the whole prostate (red) and the boosted GTV-union volume (purple).

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Fig. 2 exemplarily shows the dose distribution using focal dose escalations applied by HDR-brachytherapy (top left). Please notice the dose reduction in the central area to spare the urethra. The corresponding Ga68-PSMA-PET/CT (right) shows the multilocular tumor lesions. The corresponding dose volume histogram (bottom left) shows the dose distribution for rectum (green), urethra (yellow) as well as the whole prostate (red) and the boosted GTV-union volume (purple).
respectively 13 patients have been classified as intermediate and high risk. After image fusion, target volumes were contoured based on MRI (GTV-MRI) and PET images. MRI and PET GTVs were merged (GTV-union) and the planning target volume for dose escalation (PTV-boost) was created by isotropic expansion with 2-4 mm. The clinical target volume (CTV) for the entire prostate gland and the seminal vesicles was created according to the ESTRO guidelines and expanded isotropically with 6 mm to create the respective PTV. RT was performed using rapid-Arc (IMRT) and image guided RT (IGRT) (Fig. 1).

During RT the doses applied to the target volumes and organs at risk were adapted considering cone beam CT scans. 8 patients received androgen deprivation therapy. A focal dose escalation could be realised in 21 patients (68%). Impeding reasons were multifocal tumour lesions (>3), prolonged rectum contact and extensive tumour volume. One patient had pelvic lymph nodes in PET but not in MRI. Median volumes of GTV-MRI, GTV-PET and GTV-union were 2.1 ml (0-16.7 ml), 3.9 ml (0-11.13 ml) and 5.5 ml (1-20.5 ml), respectively. Thereby GTV-union showed to be significantly larger than GTV-MRI (p<0.05). Patients undergoing dose escalation received a mean dose of 74 Gy on the whole prostate PTV and 80 Gy on the boost volume, both in 40 fractions. Acute grade 2 GTV-union showed to be significant, respectively 11.13 ml) and 5.5 ml (1-20.5 ml), 3.9 ml (0-16.7 ml), 2.1 ml (0-11.13 ml) and 5.5 ml (1-20.5 ml), respectively. Thereby GTV-union showed to be significantly larger than GTV-MRI (p<0.05). Patients undergoing dose escalation received a mean dose of 74 Gy on the whole prostate PTV and 80 Gy on the boost volume, both in 40 fractions. Acute grade 2 GTV-toxicity occurred in 3 patients and acute grade 2 GU-toxicity in 4 patients, following CTC AE 5.0. One patient developed an acute grade 3 GU-toxicity most probably due to fiducial insertion, which was resolved completely. After a median follow-up of 2 years no patient had biochemical recurrent disease and most patients had PSA levels <1 ng/ml. Since there is growing evidence that RT dose escalation with brachytherapy may increase tumor control and may lead to improved outcome (62, 63). Compared to EBRT alone, we also treated 5 other patients with combined HDR-brachytherapy and EBRT. The patients received EBRT (50 Gy in 2 Gy) to the entire prostate gland and a HDR boost in 2 fraction with 10 Gy to the entire prostate. A simultaneous HDR brachytherapy boost was applied to GTV-union of these patients with 11-12 Gy, respectively (Figure 2). After a median follow-up of 2 years, again this treatment was very well tolerated and no grade 3 toxicity (CTCAEv5) as well as no PSA relapse occurred.

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These promising results are the backbone for a multicentre, prospective study which will be shortly initiated by the Freiburg group: the HypoFocal study.

The aim of this prospective, non-randomized, multicenter phase II study is the individualization of RT for patients with primary PCa based on modern imaging techniques. The intraprostatic GTV will be defined by combined mpMRI and PSMA PET/CT information. The entire prostatic gland will receive a RT dose according to the current guidelines and a simultaneous dose escalation to the GTV-union will be performed either by moderate hypofractionated external beam RT (EBRT, Arm 1) or by high-dose rate brachytherapy (HDR-BT, Arm 2) under strict adherence to the organs at risk’s dose constraints.

Toxicities, patient reported quality of life as well as biochemical response will be assessed. Based on the findings of this study a prospective phase III will be initiated in order to compare the dose escalation regimen with standard RT schemes.

Literature


44. Thomas L, Balmus C, Ahmadzadehfar H, Essler M, Shuvaev I, Bendschuh RA. Assessment of Bone Metastases in Patients with Prostate Cancer: A Comparison between [(99m)Tc]-Bone-Sцинтigraphy and [(68)Ga]-Ga-PSMA PET/CT. Positron tomography (Basel, Switzerland). 2017;10(3).


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The goal of this Hypofocal Prospective phase II trial is to investigate the benefit of focal lesion ablative microboost in prostate cancer (FLAME-trial): study protocol for a randomized controlled trial. Trials. 2011;12:295.


Robotic-Assisted Total and Partial Knee Arthroplasty

**Keywords:** MAKO, Robotic arm assisted surgery, knee arthroplasty, partial knee replacement, Robot-assisted total knee replacement, Robot-assisted unicompartmental knee arthroplasty

**Introduction**

Although knee arthroplasty is a very successful surgery, which significantly improves the quality of life of the patient and the functionality of the joint, up to 20% of patients are dissatisfied with the postoperative outcome [1, 2]. Even with experienced surgeons, the results with conventional techniques are not always sufficient. Various mechanical causes can contribute to this: Incorrect implant positioning and leg alignment, insufficient soft tissue balancing, approach-related complications, but also intraoperative deviations due to femoral curvature, individual angulation or the deviation of the oscillating saw blade in sclerotic bone [3-6]. In addition, the surgery by itself may cause complications, such as dislocation or failure of the implant, or the need for revision surgery.

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Advantages of the robot-assisted knee arthroplasty over the conventional method are (1) the preoperative individual 3D planning and the possibility of implanting the endoprosthesis in kinematic alignment, which demonstrably can improve the clinical outcome [1-5], (2) to implement this preoperative planning perfectly due to precisely performed bone cuts and (3) to provide the surgeon an objective, intraoperative feedback that enables optimization of the knee kinematics and soft tissue balancing while protecting important structures [1].

Kinematic Alignment
The optimal positioning of the components and the restoration of kinematics seems to be one of the most important factors for good postoperative outcome in knee arthroplasty [9]. Especially in the last years a paradigm shift occurred regarding the biomechanics and surgical technique. For a long time the conviction was to restore a neutral, straight leg with a perpendicular joint line (mechanical alignment) and that a deviation of more than three degrees from the mechanical alignment is not tolerable. This is based on the assumption that a neutral leg posture and a mechanical axis that is perpendicular to the joint line is the ideal alignment. However, recent studies have shown that a mechanical alignment in the coronal plane leads to an increased risk of postoperative complications such as knee pain, instability, and failure. Therefore, it is recommended to achieve a kinematic alignment, which means that the implants are aligned with the natural anatomy of the knee joint. This can be achieved by using computer-assisted navigation systems during the surgical procedure, which provide real-time feedback to the surgeon and allow for precise bone cuts and implantation. In this way, the alignment of the knee joint can be optimized, leading to improved clinical outcomes and reduced complications. The optimal alignment of the knee joint should be individualized for each patient based on preoperative imaging and intraoperative feedback. 

Regarding the role of the robot-assisted navigation system (MAKO), this technology has been developed by Stryker Orthopedics and consists of a camera system, a workstation, and a robotic arm [1a © Stryker Orthopedics]. The system is designed to provide accurate and reproducible bone cuts and implantation, reducing the risk of errors and complications. The surgeon can visualize the planned and actual alignment of the implants in real-time, allowing for adjustments and optimization of the alignment during the surgery. This can lead to improved clinical outcomes and reduced complications. In conclusion, the use of robot-assisted navigation systems for knee arthroplasty can provide significant advantages over traditional surgical techniques, including improved alignment, reduced errors, and better clinical outcomes. Therefore, it is recommended to use this technology whenever possible to achieve the best possible results for the patient.
mechanical axis induces increased wear and leads to an early loosening and shorter survival rate of the implants [10]. Any type of axis deviation was therefore corrected during surgery and the implant position was mechanically idealized. Recently it is becoming more and more clear that only about 15% of all patients demonstrate a neutral, straight leg axis before surgery [11]. So, the orientation at the mechanical axis is only a compromise and this is assumed to be one reason for the limited results.

In recent times, the concept of the kinematic alignment was developed, which aims to restore the individual knee anatomy and ligament tension, to restore native knee kinematics. For example patients with bowed legs seems to benefit from a slight varus alignment of the prosthesis [12]. Using this concept, the same amount of cartilage and bone is resected which is reconstructed by the implant (true measured resection technique). In several prospective studies improved clinical results based on “Patient Reported Outcome Measures” (PROMs) and a higher satisfaction of the patients has been demonstrated compared to mechanical alignment [13-16]. Using a robotic arm assisted surgery, based on the 3D model of the patient’s knee, the implant can be adapted to the individual kinematics. Furthermore, the accuracy of the bone cuts can improve the position of the implants and achieve optimal mechanical leg axes. The implant positioning with robot-assisted implantation allows therefore for an individual alignment and more precise and reproducible results and seems to offer better functional results [17].

This way, the former problems of clinical alignment are avoided: using a mechanical axis leads to increased wear, earlier loosening and decreased survival rate of the implant [10]. Any type of axis deviation was therefore corrected during surgery and the implant position was mechanically idealized. Recently it has become clear that only about 15% of all patients demonstrate a neutral, straight leg axis before surgery [11]. So, the orientation at the mechanical axis is only a compromise and this is assumed to be one reason for the limited results.

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MAKO Robotic Arm Technology

Mako or The Robotic Arm Interactive Orthopedic System, originally developed by MAKO Surgical Corporation, which was acquired by Stryker Orthopedics (Mahwah, NJ) in 2013, was approved in 2008 by the FDA (Food and Drug Administration) [18]. Mako technology can be used for total knee replacement (bicondylar) with the Triathlon knee system (Stryker Orthopedics) or for partial replacement (patella-femoral and unicondylar) with Mako Restoris implants (Stryker Orthopedics) [19]. It consists of a camera system, a workstation and a robotic arm that supports the implantation through a haptic interface with a feedback system [20] (Figure 1). This semi-active robot system only allows the operator to perform the bone resection within the limits specified in the preoperative plan. This improves the surgeon’s ability to reproduce the knee alignment and protect essential soft tissue structures like the medial collateral ligament, the posterior cruciate ligament and the popliteal artery [4, 22-25]. Internationally, this technique was used in more than 50,000 knee surgeries until 2016 [21]. Because the Mako system is currently the most used robot worldwide for arthroplasty surgery, the study situation is comparatively broad: The previous literature for the robot-assisted Mako operation show improvements in terms of accuracy, soft tissue balancing and outcome. In unicondylar knee replacement the robot-assisted technique is able to reconstruct the posterior or tibial slope and the coronary alignment much more accurately [26-28]. The pain and functionality improved postoperatively [29]. In addition, the Mako robotic arm can be used to perform additional tasks around the knee. This is called the "three-arm" technique (Figure 2). The surgeon uses the robotic arm to perform the bone resection and protect the surrounding soft tissue structures. The Mako robotic arm can then be used to perform additional tasks around the knee. This is called the "three-arm" technique (Figure 2). The surgeon uses the robotic arm to perform the bone resection and protect the surrounding soft tissue structures. The Mako robotic arm can then be used to perform additional tasks around the knee. This is called the "three-arm" technique (Figure 2). The surgeon uses the robotic arm to perform the bone resection and protect the surrounding soft tissue structures.
Fig. 4: Bone Registration and validation: the position of the knee joint is registered (a). The rotation center of the hip and the ankle are determined with defined movements (b). A total of 80 points are registered on the articular surfaces of the femur (c) and tibia to match the 3D model. The points are critically important in setting the AP, ML, proximal/distal directions and the axial rotation (internal/external) alignment of each bone.

الشكل ٤: تسجيل العظام والتحقق منها. تم تسجيل موقع مفصل الركبة (ا)، تحديد مركز دوران مفصل الورك والكاحل بحركات محددة (ب). تسجيل ما مجموعه ٨٠ نقطة على الأسطح المفصلية لعظم الفخذ (ج) والتفاهم مع النموذج الثلاثي الأبعاد. هذه النقاط مهمة للغاية في تحديد الاتجاهات الأمامية/خلفية، الإنسية/الوحشية، والاتجاهات القريبة/ البعيدة والارتباطات الدورانية المحورية (الداخلي/الخارجي) لكل عظم.
Fig. 5: After the trial prosthesis is inserted, the correct fit and ligament stability are dynamically checked and objectively evaluated again on the computer.
hospitalization and the revision rate [30] could be reduced and patient satisfaction [21] increased compared to conventional procedures. For total knee replacement, Mako provides more precisely bone cuts, which leads to predictable and reproducible implant positioning with significantly less deviations from the preoperative planning [2]. In a prospective cohort study, postoperative pain was reduced, the postoperative rehabilitation was improved and an earlier discharge from the hospital was achieved in patients with robotic-assisted total knee arthroplasty [5].

MAKO Operation Technique
In order to prepare for surgery a CT Scan of the affected joint and leg (with hip and ankle) is first carried out in order to create a virtual, patient-specific 3D model of the patient’s knee anatomy including anatomical landmarks such as the trans-epicondylar axis, the posterior condylary axis and the mechanical axis [2, 4, 24]. This allows for a precise planning of bone resection, implant size and implant positioning (Figure 2). This usually happens about 1-2 weeks before surgery. After the usual preparation for surgery and the common approach to the knee joint, optical markers are attached to the femur and tibia for the duration of the surgery (Figure 3). The navigation system with infrared camera uses these markers to identify the position of the bones and knee joint during the operation. The rotation center of the hip and the ankle are defined and a total of 80 points on the articular surfaces of the femur and tibia are recorded with a probe (Figure 4). This entire process takes less than 5 minutes and produces a very precise picture of the bone anatomy by matching the 3D model. The ligament tension is determined in different joint positions. The software virtually calculates continuously the distance between the planned components. Ligament balancing can now be included in the planning process and the implant position adapted to the individual balancing situation and anatomy of the knee joint. Each individual parameter can be changed three-dimensionally in 0.5 mm or 0.5° steps. This allows for an optimal joint stability over the entire range of motion. When this virtual planning has been optimized and finalized the robotic arm is moved to the operating table and the calibration is checked again with an error tolerance of less than 0.5 mm. In case of total knee replacement the saw cuts are made with the help of the robotic arm or in case of partial knee arthroplasty the prosthetic bed is milled. The surgeon always guides the instrument. The robot specifies the correct and planned saw plane and prevents the saw from being set incorrectly. It also prevents resection outside the defined resection area by automatically stopping the device. After all saw cuts have been made, the trial prosthesis is inserted. The correct fit and the correct ligament stability are dynamically checked and objectively evaluated again (Figure 5). Should deviations occur, the system can correct them at any time. Finally, the original prosthesis could be exchanged.

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Araf: مفصل الركبة

استخدمت هذه التقنية في أكثر من 5000 عملية جراحية على المفصل replacer عام 2016 [21] يتوقع أن نظام ماكو حاليا هو الروبوت الأكثر استخدمًا في العالم لجراحة المفاصل، فإن وضع الدراسة واسع النطاق الذاتي للتحقيق الدقيق لقسط العظام والرخوة والمفصلات المنحنية والمسار لفصل الفخذ والمسار الحسابي (الشكل 3). يمكن استخدام النظام لتحديد موضع العظام ووضع المفصل الروبوت خلال الجراحة. وتحديد مركز دورة المفصل الركبي والكاحلي، ويسجل ما يجمعه 80 نقطة على المطبوعة الفصلية (الشكل 4). تستغرق هذه العملية بمرتين أقل من 5 دقائق وتحت صورة نافذة الاتجاه من تشريح العظام بواسطة مطابقة المفصل الثلاثي الأبعاد. يتم تحديد توفر الرابط في موضع مختلف للفصل، يصعب البرمجة في الفصل، بفضل البرمجة في الفصل العامة بين المكونات المخططة مثل المحور عبر الفخذ ومسار النافذة والمسار الطبيعي [4, 24]. ويسمح ذلك بالتخطيط الدقيق لقسط العظام والرخوة وموضع المفصل الركبي، يمكن تغيير كل معلمة ثالثية الأبعاد للفصل بالتوافق مع المفصل الروبوت، مما يؤدي إلى تحسينات التخطيط فحص المفصل الروبوت في وقت مبكر من المستشفى [5].

تقنية العملية باستخدام ماكو MAKO

من أجل التشخيص للعملية الجراحية نجري أولًا نسبًا للفصل المصطبة والمفصل لا يوجد كمية معًا للفصل المصطبة والمفصل

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Arab: مفصل الركبة

العظام والكاحلي) من أجل إنشاء نموذج افتراضي ثلاثي الأبعاد لتشخيص المفصل replacer عام 2016 [21] يتوقع أن نظام ماكو حاليا هو الروبوت الأكثر استخدمًا في العالم لجراحة المفاصل، فإن وضع الدراسة واسع النطاق الذاتي للتحقيق الدقيق لقسط العظام والرخوة والمفصلات المنحنية والمسار لفصل الفخذ والمسار الحسابي (الشكل 3). يمكن استخدام النظام لتحديد موضع العظام ووضع المفصل الروبوت خلال الجراحة. وتحديد مركز دورة المفصل الركبي والكاحلي، ويسجل ما يجمعه 80 نقطة على المطبوعة الفصلية (الشكل 4). تستغرق هذه العملية بمرتين أقل من 5 دقائق وتحت صورة نافذة الاتجاه من تشريح العظام بواسطة مطابقة المفصل الثلاثي الأبعاد. يتم تحديد توفر الرابط في موضع مختلف للفصل، يصعب البرمجة في الفصل، بفضل البرمجة في الفصل العامة بين المكونات المخططة مثل المحور عبر الفخذ ومسار النافذة والمسار الطبيعي [4, 24]. ويسمح ذلك بالتخطيط الدقيق لقسط العظام والرخوة وموضع المفصل الروبوت، يمكن تغيير كل معلمة ثالثية الأبعاد للفصل بالتوافق مع المفصل الروبوت، مما يؤدي إلى تحسينات التخطيط فحص المفصل الروبوت في وقت مبكر من المستشفى [5].

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implanted (Figure 6). If a partial replacement (uni-condylar or patello-femoral) is performed the transition zone between healthy cartilage and implant can be precisely aligned for a smooth surface (Figure 7). Therefore, the surface of the healthy cartilage is determined and the implant is positioned flush to the surface to create a smooth transition from the femoral component to the anterior edge of the femoral condyle [32].

Own Experiences and Conclusion
In our hospital, robot-assisted surgery with the MAKO has become firmly established in primary knee arthroplasty. The short- and midterm results are very promising. We observe faster pain relief and rapid recovery in these patients and an excellent function. So, in our opinion, robot-assisted total and partial knee replacement with the MAKO system seems to be a major improvement. Further studies are needed to investigate the long term outcome and implant survival rate.

Fig. 6: Postoperative x-rays in a moderate varus knee
Knee Arthroplasty

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Literature
11. Hernigou, P. and G. Deschamps, Posterior slope of the tibial implant and the outcome of unicompartmental knee

شريعة تخفيف الأثناء السينية بعد العملية الجراحية بعد الاستبدال الجزئي: أحادي الحجرة الإنسانية (أ)، أحادي الحجرة الوحشية (ب) والاستبدال الجزئي الداعشي الفخذي (ج).

Fig. 7: Postoperative x-rays after partial replacement: unicondylar medial (a), unicondylar lateral (b) and patellofemoral (c) partial replacement.
Interdisciplinary Management of Diverse Non-Varicose Venous Diseases

Management of diverse non-varicose venous diseases and the need of an interdisciplinary vascular medical (comprising open vascular-surgical and image-guided) approach - a representative selection of cases including their challenging management

Keywords: Non-varicose venous diseases, vascular medical management, vascular surgical intervention, image-guided approach

Abstract
The aim of this representative and extraordinary case series is the practice-relevant demonstration of case-specific characteristics, in particular, the patho-anatomical, degenerative, inflammatory and/or malignant profile of non-varicose venous diseases with need of a therapeutic approach using interdisciplinary vascular medical (comprising open vascular-surgical and image-guided) approach - a representative selection of cases including their challenging management

Results (specific case descriptions): 1) A 54-year old woman experienced a mid-term, relatively tumor-stable outcome (5 1/2 years) of a leiomyosarcoma of the inferior vena cava (IVC) with hepatic infiltration and pulmonary metastases after multimodal approach comprising former successful surgical intervention (segmental resection of the IVC, liver resection, tumor thrombectomy within the hepatic veins), re-operation, local tumor ablation as well as chemotherapy. 2) A 61-year old woman with invasive
adrenal carcinoma invading the IVC underwent successful resection of the tumour mass and reconstruction of IVC with tumour-free long-term outcome of more than 7 years. 3) A 65-year old patient underwent a palliative 2-side hybrid approach (endovascular image-guided and vascular surgical intervention) because of paraneoplastic thrombosis of the superior vena cava caused (SVC) by bronchogenic carcinoma-induced compression, with open-surgery guided vascular reconstruction of IVC with Dacron - PTFE-graft to reconstruct left renal vein.

Fig. 1 Relevant images related to Patient 1: a: Preoperative coronary CT scan of the abdomen showing tumor lesion obstructing lumen of the IVC; b: Intraoperative situs: Hepatic metastasis; c: Intraoperative situs: Leiomyosarcoma of IVC; d: Intraoperative situs: Vascular reconstruction of IVC with Dacron - PTFE-graft to reconstruct left renal vein.
access to the left jugular vein for thrombectomy and transfemoral placement of a stent within the stenotic segment of the (SVC) and left brachiocephalic vein. 4) A 50-years old female was diagnosed with a rare aneurysm of the popliteal vein causing recurrent episodes of pulmonary embolism, which should be included into differential diagnosis. Its management may warrant a hybrid vascular and endovascular approach. 5) A 66-year old man showed venous aneurysmatic malformation of the thoracic wall as rare cause of pulmonary embolism (native manifestation of an aneurysmatic venous bundle at the proximal segments of the right brachial, axillary and subclavian veins), which was approach by i) transfemoral image-guided embolization and ii) ligation of the aneurysmatic neck. 6) A 64-years old male patient had rare horseshoe kidney and doubled right kidney who underwent initially an R2 resection of renal cell carcinoma (regional hospital) with tumor thrombus within IVC followed by a multimodal protocol including organ-extending R0 resection at the former R2 resection site, extirpation of the tumor thrombus and reconstruction of IVC using xenogeneic patch plasty.

Conclusion: The complex cases demonstrate impressively the challenge, which need competent interdisciplinary management in diagnostics, decision-making and therapeutic splitting not rarely planned as hybrid procedure and mostly performed within a center of vascular medicine recommendable for a favorable outcome.

Introduction
Non-varicose venous diseases with need for vascular surgical therapy is – though rarely occurring – a fascinating group of specific diagnoses, for which there is a lack of extensive management experiences with regard to diagnostic work-up and therapeutic approaches due to its low incidence.

However, these findings can occur and be diagnosed in daily clinical/vascular medical practice sooner or later and may, thus, become of great importance, in particular, if they have to be appropriately managed in an emergency setting. The objective of this article is to review representative but rare profile of pathological non-varicose venous conditions based on selected references from the literature and the experiences obtained in the partially complex diagnostic and therapeutic management of the mostly challenging diseases.

The confluence of (a) aneurysmatic thrombosis and (b) aneurysmatic embolism (IVS) in an emergency setting. The objective of this article is to review representative but rare profile of pathological non-varicose venous conditions based on selected references from the literature and the experiences obtained in the partially complex diagnostic and therapeutic management of the mostly challenging diseases.

The case: A 46-years old male patient had rare horseshoe kidney and double right kidney who underwent initially an R2 resection of renal cell carcinoma (regional hospital) with tumor thrombus within IVC followed by a multimodal protocol including organ-extending R0 resection at the former R2 resection site, extirpation of the tumor thrombus and reconstruction of IVC using xenogeneic patch plasty.

Conclusion: The complex cases demonstrate impressively the challenge, which need competent interdisciplinary management in diagnostics, decision-making and therapeutic splitting not rarely planned as hybrid procedure and mostly performed within a center of vascular medicine recommendable for a favorable outcome.
Patients and Methods

In the Division of Vascular Surgery (Department of General, Abdominal, Vascular and Transplant Surgery), selected patients with specific non-varicose venous disorders and their patient- and finding-specific characteristics were registered, data and parameters of the diagnostic and therapeutic management were documented, and both the short- (i.e., postoperative) and long-term outcomes were assessed in this prospective patient cohort study (design).

Statement

Study was performed according to the guidelines of the Declaration of Helsinki for Biomedical Research from 1964 and its further amendments as well as the polycyic and further regulations of the Institutional Review Board. Patients’ care was subject of Good Research Practice – their data were evaluated and presented according to the requirements of Good Research Practice.

All patients signed consent form after adequate talk on the

treatment and the risks involved.

Fig. 2: Images relevant for case 2: a: CT scan: Tumor infiltration of the VCI up to the right atrium (blue arrow); b: Exirpated tumor thrombus from IVC as ex-situ specimen; c: Intraoperative situs: Lateral venorrhaphy of IVC after cavotomy for removal of tumor thrombus

تشهد هذه المقالة مشاهدة الممارسة الطبية السريرية اليومية في مراكز جراحة الأوعية الدموية، وهي تظهير الحالة المرضية والطريقة. الدكتور الخبير في جراحة الأوعية الدموية ونurse أختير مرضى مسجّلين في عيادة جراحة الأوعية الدموية (قسم الجراحة العامة و提供更多 البطن والأوعية الدموية وزيادة الأعضاء) يعانيون من اضطرابات وردية غير دوالية نوعية. وجرى تسجيل الصفات الموجودة النوعية بالمرضى وبعد إجراء التحاليل التشخيصية، وتوفير بيانات ومعايير التشخيص في الحالات الطوارئ.

الهدف من هذه المقالة هو مراجعة النماذج التمهيلية، ولكنها نادر الحدوث للحالات المرضية الوريدية غير الدوالية بناءً على مراجع، مختارة من الأدب الطبي والتجارب التي تم الحصول عليها من التدابير.
The histopathological diagnosis confirmed the diagnosis of leiomyosarcoma metastatic to the liver with R0 resection status at the hepatic tumor resection site.

Postoperatively, the patient developed chylous ascites and lymphocele, which was managed conservatively by an initial attempt of middle-chain triglyceride (MCT) diet. After 3 years, the patient suffered from increasing ascites-related symptoms. Abdominal CT scan revealed recurrence of metastatic tumor growth within the liver as well as pulmonary metastasis (resembling military infiltration of the liver) and lymphocele, which was confirmed the diagnosis of leiomyosarcoma.

Case 1: An asymptomatic female who was admitted to Magdeburg's University Hospital and had been complaining on vague epigastric discomfort of four-weeks duration, nausea, and deterioration of the general condition. Medication history was not significant for previous surgery or major illness. Routine blood and urine examinations were normal. Contrast-enhanced computed tomography of abdomen and thorax revealed surprisingly a huge hepatic lesion adherent to IVC (Figure 1a) with multiple lesions in the liver in segments 1, 4 and 7 measuring about 2 cm, 4 cm and 6 cm in diameter, respectively. The patient underwent percutaneous biopsy of the mass, which revealed a smooth-muscle tumor. In addition, a retroperitoneal tumor mass was found, and surgical exploration was advised by the interdisciplinary tumor board.

Tumor lesion was completely resected en-bloc including the hepatic metastases (Figure 1b and c). The defect in the IVC was reconstructed using PTFE graft (Figure 1d).

Conclusion: The histopathological diagnosis confirmed the diagnosis of leiomyosarcoma metastatic to the liver with R0 resection status at the hepatic tumor resection site. Postoperatively, the patient developed chylous ascites and lymphocele, which was managed conservatively by an initial attempt of middle-chain triglyceride (MCT) diet. After 3 years, the patient suffered from increasing ascites-related symptoms. Abdominal CT scan revealed recurrence of metastatic tumor growth within the liver as well as pulmonary metastasis (resembling military infiltration of the liver) and lymphocele, which was confirmed the diagnosis of leiomyosarcoma.

Case 2: A 54-year-old slim woman who was admitted to Magdeburg's University Hospital and had been complaining on vague epigastric discomfort of four-weeks duration, nausea, and deterioration of the general condition. Medication history was not significant for previous surgery or major illness. Routine blood and urine examinations were normal. Contrast-enhanced computed tomography of abdomen and thorax revealed surprisingly a huge hepatic lesion adherent to IVC (Figure 1a) with multiple lesions in the liver in segments 1, 4 and 6 cm in diameter, respectively. The patient underwent percutaneous biopsy of the mass, which revealed a metastatic growth within the liver as well as pulmonary metastasis (resembling military infiltration of the liver) and lymphocele, which was confirmed the diagnosis of leiomyosarcoma.

Case 3: A 54-year-old slim woman who was admitted to Magdeburg's University Hospital and had been complaining on vague epigastric discomfort of four-weeks duration, nausea, and deterioration of the general condition. Medication history was not significant for previous surgery or major illness. Routine blood and urine examinations were normal. Contrast-enhanced computed tomography of abdomen and thorax revealed surprisingly a huge hepatic lesion adherent to IVC (Figure 1a) with multiple lesions in the liver in segments 1, 4 and 6 cm in diameter, respectively. The patient underwent percutaneous biopsy of the mass, which revealed a metastatic growth within the liver as well as pulmonary metastasis (resembling military infiltration of the liver) and lymphocele, which was confirmed the diagnosis of leiomyosarcoma.

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and various metastatic sites after a survival time of approximately 5 1/2 years.

Case 2:
A 61-year-old female patient was admitted for a recent onset of effort-associated dyspnea, exhaustion and abdominal discomfort in the upper right quadrant. The clinical examination revealed ascites and abdominal tenderness. CT scan displayed a right adrenal mass with a thrombus extending into the IVC (Figure 2a). Laboratory values for plasma-free metanephrines, aldosterone, potassium, and testosterone were all within normal range. The histological examination of a biopsy confirmed the diagnosis of a non-functioning adrenal carcinoma of stage III with tumor thrombosis of IVC. The patient received adjuvant mitotane therapy post-operatively. (4,5) Furthermore, the patient received anticoagulation therapy with Vitamin-K antagonist for 6 months and additionally hormonal replacement therapy with cortisone and Thyroxin. Over a follow-up time period of 7 years using CT and MRI, the patient remained free of local/systemic recurrence.

Case 3:
Here, a case study of a 65-years-old male patient is presented who had originally adenosquamous adenocarcinoma in the upper lobe of the right lung and who developed a symptomatic superior vena cava syndrome (SVCS). The patient complained of increasing fatigue with dizziness and headache. Review of systems is positive for:
- neck swelling noted in the morning,
- hoarseness of voice during the past period,
- purplish discoloration across his chest,
- increased dyspnea on exertion,
- difficulty of swallowing, and
dry cough.

Pertinent physical findings showed:
- diffuse edema in the neck,

At admission the patient was discharged without any morbidity or complaints. Histopathology confirmed the diagnosis of a non-functioning adrenal carcinoma of stage III with tumor thrombosis of IVC. The patient received adjuvant mitotane therapy post-operatively. The postoperative course was uneventful, and the patient was discharged without complications. The postoperative anticoagulation therapy with Vitamin-K antagonist for 6 months and additionally hormonal replacement therapy with cortisone and Thyroxin. Over a follow-up time period of 7 years using CT and MRI, the patient remained free of local/systemic recurrence.

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Fig. 3: Radiological imaging in case 3:
Figure 3.1: Pre-interventional DSA: Thrombotic obstruction of left brachiocephalic vein: (upper left: a) After transjugular open thrombectomy with balloon inserted in the venous confluence; (upper right: b) Post-interventional control images with placement of a Gianturco stent in the brachiocephalic vein; (lower left: c) and SVC; (lower right: d);
Figure 3.2: Correct positioning of the stent within left brachiocephalic (red arrow) and SVC (blue arrow).
- dilated engorged blood vessels on the upper right chest wall and under the tongue, as well as
- edema in the left arm and hand.

Because these symptoms are suggestive of SVCS, he was immediately admitted to the hospital. A Duplex-ultrasonography and digital subtraction angiography identified the source of the SVCS to be the formerly diagnosed malignancy. The diagnostic measures showed an almost complete obstruction of SVC with simultaneous thrombosis of brachiocephalic veins bilaterally and of the left subclavian vein (Figure 3.1a and b).

According to the consensus of the vascular medical board decision, the patient was scheduled for image-guided radiological intervention, a transjugular aspiration thrombectomy to recanalize the SVC. Unfortunately, it was not successful.

Therefore, the patient underwent hybrid procedure comprising of

- open vascular surgical thrombectomy of left brachiocephalic vein via access to the left internal jugular vein followed by endovascular placement of a Gianturco stent (Ø: 20 mm; Cook, Inc., Bloomington, IN/USA) into the left brachiocephalic vein and a Gianturco stent (Ø: 30 mm) into the SVC (Figure 3), and
- control by precordially placed balloon to prevent thromboembolism with transcutaneous access via common femoral vein. The patient tolerated the intervention well, post-interventional clinical course was not significant for any complication.

Case 4:
A female patient, 50 years old, explained of non-specific intermittent discomfort in the right chest wall and under the tongue, as well as
- dilated engorged blood vessels on the upper right chest

According to the diagnosis of popliteal venous aneurysm with marginal thrombosis (Øaneurysm: 2 cm). Phlebography confirmed the diagnosis of popliteal venous aneurysm just proximally to the confluence of popliteal vein in the popliteal fossa. The deep venous system and arterial system were normal (Figure 4 (1-6)).

Surgical exploration was performed through a posterior approach to the right popliteal fossa. A tangential aneurysmatic resection with lateral

- Mitral failure with transient hypertension
- Phase 1 (a) and b).

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Case 4:
A female patient, 50 years old, explained of non-specific intermittent discomfort in the right chest wall and under the tongue, as well as
Venorrhaphy of the popliteal vein was performed (Figure 4a-c). First, antithrombotic therapy with low molecular weight (LMW) heparin, then Vitamin-K antagonist (cumarine derivative) was initiated and continued for 6 months in combination with compression therapy using elastic bandages (compression class II according to the German standard). There were no complications after 6 months of follow-up.

Case 5:
A 66-year-old man was admitted for investigation of recurrent acute dyspnea with hypotension but without tachycardia. The patient had severe antrum gastritis and tubulo-villous adenomas of the colon with low-grade dysplasia. Previously, he had undergone open vascular surgery such as desobliteration of iliac and femoral arteries because of peripheral arterial occlusion disease stage IV (according to Fontaine’s classification) of the right foot. The patient received anticoagulation medication with Vitamin-K antagonist because of thrombophilia (in particular, antiphospholipid syndrome). Blood analysis, including a white blood cell differential count, creatinine kinase, D-dimer, troponin-T and myoglobin were slightly abnormal. An electrocardiogram yielded normal results without signs of cardiac overload or right-sided hypertrophy. CO₂ diffusion capacity was normal. Bronchial (methacholine) challenge test did not show bronchial hyper-reactivity. Chest X-ray revealed calcified structures on the right-sided thoracic wall (Figure 5a). Computed tomographic (CT) scanning confirmed the presence of multiple calcified structures adjacent to the right-sided thoracic wall (Figure 5b). To plan an appropriate therapy, diagnostic phlebography was performed, which revealed a huge venous aneurysm of the right-sided thoracic wall (Figure 5c). The patient was scheduled for hybrid procedure comprising of i) image-guided radiological intervention and ii) an open vascular surgical approach. The venous malformation was initially embolized with 40 mL of ethanol (concentration, 95 %) using selective catheterization of aneurysmatic sac through the right femoral vein with simultaneous blocking of the aneurysmatic neck using an inflated intravascular balloon to prevent systemic spread of the used thrombogenic material.

After successful partial thrombosis of the giant aneurysm, the patient underwent open vascular-surgical treatment during the same interventional session. The aneurysmatic wall of the aneurysm was removed (Figure 5d). A 4a-c). First, antithrombotic therapy with low molecular weight (LMW) heparin, then Vitamin-K antagonist (cumarine derivative) was initiated and continued for 6 months in combination with compression therapy using elastic bandages (compression class II according to the German standard). There were no complications after 6 months of follow-up.

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After successful partial thrombosis of the giant aneurysm, the patient underwent open vascular-surgical treatment during the same interventional session. The aneurysmatic wall of the aneurysm was removed (Figure 5d).
The neck was easily dissected free from the surrounding tissue, securing the aneurysmal neck with a balloon to prevent extension of the intralesional thrombosis and distant pulmonary embolization, and subsequently the aneurysmatic neck was ligated. The patient had an uneventful postoperative course and was discharged a few days after the operation.

He was followed up at the outpatient clinic of the vascular surgery division for 16 post-operative months, continuing the oral anticoagulation a with Vitamin-K antagonist, with no signs of recurrence.

**Fig. 4:** Comparison of preoperative imaging and intraoperative findings in case 4: Preoperative phlebography in various projections (1-6) and intraoperative situs (a-c) of popliteal vein aneurysm (yellow arrow in b) with lateral venorrhaphy of popliteal vein (“direct venous suture” - yellow arrow in c).

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Case 6:
A 64-years-old man was transferred after right transabdominal renal nephrectomy in a regional hospital 15 days ago. Patient’s medical history was unremarkable except arterial hypertension for years and bilateral inguinal hernia after former herniotomy on the right side. Diagnostic work-up had revealed a rare horseshoe kidney with simultaneous doubled right organ and ureter duplication (Figure 6.1) and also a renal cell carcinoma (RCC) of the right kidney. In particular, initial CT scan revealed the tumor lesion of the right kidney (diameter, 11 cm) suspicious for infiltration of the right psoas muscle. It also showed enlarged lymph nodes at the para-aortic site (also increased para-aortic lymph nodes as well as its lymph nodes). An abdominal angiographic multi-slice CT scan was performed. It showed:
- A necrosis at the renal parenchyma resection area,
- retroperitoneal and inter-aortocaval lymphadenopathy,
- precise tumor site of the IVC thrombus—namely, proximal to the former confluence of the right renal vein up to the pancreas,
- no tumor detection at the confluence of the hepatic veins (as well as)
- no hepatic or pulmonary metastases (Figure 6.2).

The patient underwent an interdisciplinary approach planning of a surgical re-intervention and to:
- achieve an appropriate re-staging of the current tumor manifestations,
- assess the vascular involvement (and)
- estimate short-term follow-up with regard to residual left kidney and residual tumor lesions as well as its lymph nodes,
- an abdominal angiographic multi-slice CT scan was performed. It showed:
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When the margin is 0.5 cm, a transplant is not feasible. For infiltration of the right psoas muscle. It also showed enlarged lymph nodes at the para-aortic site (also increased number). On admission, clinical examination revealed a patient in good physical condition with no abdominal wound complication after former surgical intervention. Histopathological investigation had revealed a clear cell carcinoma up to 11 cm in diameter (tumor stage, pT3a pNx pMx L0 V1 G2).

In addition, there was an incomplete RCC resection status indicated by R1 at the parenchymal transection site and R2 at the stump of the left renal vein, with remaining tumor manifestation (endovascular thrombus) extending to and within the IVC as well as lymph node metastases within the former resection area, in particular, assessed by a post-operative control CT scan of the abdomen provided by the transferring regional hospital. Prostate was enlarged with no further pathological finding. For planning of a surgical re-intervention and to:
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The patient underwent an interdisciplinary approach:

- to achieve an appropriate re-staging of the current tumor manifestations,
- to assess the vascular involvement (and)
- to estimate short-term follow-up with regard to residual left kidney and residual tumor lesions as well as its lymph nodes,
comprising:
- a complete urological resection of residual RCC tumor lesion at the former transection site, with right adrenalectomy and extended radical lymphadenectomy, including:
- vascular-surgical cavotomy at the renal pedicle IVC segment under total clamping below the hepatic confluence, removal of tumor thrombus plus tangential resection of IVC wall and xenogenic patch plasty (Vascu-Guard, Vascutek, Hamburg, Germany; length, 6 cm) using successfully the interdisciplinary cooperation of urologists and vascular surgeons (Figure 6.3).
Histopathological examination revealed vital and necrotic parts of clear cell RCC at the former renal isthmus with infiltration of the adherent surrounding connective-tissue but tumor-free lateral resection margins. In addition, a thrombosis of the right renal vein stump with initia-
lated fibrotic transformation and small infiltrations of the RCC in the wall of the vein were found (panel b of Figure 6.4). The IVC thrombus was classified as tumor thrombus of the clear cell RCC (Figure 6.4.c/d). Resection margins of IVC and interaortocaval as well as sub-hepatic lymph nodes were tumor-free (Figure 6.4). Final tumor stage was assessed as follows: pT3b pN0 cM0 L0 V1 R0 G2. Postoperative hospital stay was uneventful. By 6 months postoperatively, control CT scan did not reveal any suspicion for tumor recurrence. Currently, after a postoperative follow-up time period of 8 months, there are no further health problems.

**Discussion**

There are several venous non-varicose diseases the spectrum of which is highlighted by the presented top six diagnoses (beside trauma lesions, arterio-venous fistula, postoperative/interventional alterations etc.) such as vein-associated malignancies, endovascular tumor thrombus associated with RCC, aneurysm of the popliteal vein, venous malformations, and venous alteration from outside. These include unusually accompanying diseases, diagnostic / therapeutic approaches (favoring inter-disciplinary [vascular-medical] decision-making, surgical interventions and/or hybrid procedures) and clinical and/or post-interventional-operative courses, as well as outcome aspects as reported in the well selected and representative case presentations.

Two basic questions arise regarding the treatment of patients with non-varicose venous diseases. Is there a role of endovascular therapy to treat these disorders appropriately and to provide minimal invasiveness as possible in these specific patients and, in addition, which is the most suitable treatment in these particular cases to achieve the lowest peri-procedural and perioperative risk?

In recent years, improvements made in endovascular interventions allow in the majority of cases a safe approach, which can be combined with open therapy and vascular reconstruction. The hybrid vascular therapy seems to reduce perioperative mortality when compared to open surgery alone since it uses consequently the advantages of various procedures at the same time by a reasonable combination of the procedures with regard to type and sequence of each single measure. Even after reviewing the literature, the evidence situation for the IVC thrombus was classified as tumor thrombus of the clear cell RCC (Figure 6.4). By 6 months postoperatively, control CT scan did not reveal any suspicion for tumor recurrence. Currently, after a postoperative follow-up time period of 8 months, there are no further health problems.

**Resection margins of IVC**

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establishing the indication for a hybrid procedure and selecting the suitable treatment modality for rare non-varicose venous disorders remains modest due to the presence of selection bias and rarity of those indications and cannot be improved by the results reported here. The aim of this study was to present an overview of the results of modern interdisciplinary treatment in a small but representative patient sample with the very specific and rare diagnosis, non-varicose venous diseases with therapeutic need at a specialized vascular-surgical medical center, in which the two treatment modalities as open vascular and endovascular approaches are available on the basis of an interdisciplinary consensus (“Vascular-medical Board”) and used in a complementary manner.

Case 1:

Leiomyosarcoma originating in IVC is a rare, malignant, slowly growing tumor lesion with poor prognosis (2). Here, we report on a case of successful excision of an advanced leiomyosarcoma arising from the suprarenal part of the IVC with more the 3 years of partial remission period with acceptable quality of life despite a persisting lymphatic complication and repeated need for numerous multimodal measures such as open tumor ablation, chemotherapy, crianoity and tumor-extrapolation to approach tumor re-manifestations at the liver, lung and brain. Today’s technical and surgical capabili-ties allow for the successful resection of such tumor manifestations. However, the interventions require experienced abdominal, vascular and cardiac surgeons, as well as sufficient perioperative management.

In case of an IVC-associated leiomyosarcoma, the surgeon should be prepared to perform and achieve a complete surgical resection and follow up carefully since a radical surgical resection of the tumor is the only curative option associated with improved survival (survival rate, 49.4 % and 29.5 %)(3).

Case 2:

Complete surgical resection with negative margin ‘R0 Resection’ remains the most effective treatment in adreno-cortical carcinoma (ACC) and, along with an early staging, is among the strongest predictors of overall survival (4).

Despite direct invasion or extension of tumor thrombus into the IVC (or both), complete (R0) resection can be achieved. Thus, this scenario should not preclude attempted curative resection in patients with adrenal cancer.
Case 3:  
Another clinical picture, which usually demands the cooperation between interdisciplinary specialties is the SVCS. The goal of management is palliation of symptoms of venous obstruction. In this specific case, a hybrid approach through transjugular open thrombectomy and endovascular placement of stents into central veins was used. An adequate follow-up using duplex-ultrasonography and an appropriate anticoagulation are advised.

Case 4:  
Primary venous aneurysms are uncommon and in most cases of little clinical significance, can be treated conservatively. However, in some cases, especially when there is a risk of rupture or compression of surrounding structures, endovascular treatment is indicated. The goal is to achieve hemostasis and prevent further complications. It is important to monitor the patient for recurrence and complications.

Fig. 6: Various illustrative images in case 6: 1. Preoperative ureteropyelography with doubled right renal pelvis and ureter duplication in a horseshoe kidney; 2. CT coronal (2a left panel) and transversal scan (2b right panel): Residual horseshoe kidney after right nephrectomy with a necrotic area at the isthmus region and inferior vena cava; 3. Intraoperative situs after cavotomy showing endovascular tumor lesion (a) and removal of the tumor thrombus, partial wall resection and xenogenic patch plasty (b) (Vascu-Guard®, Vascutek, Hamburg, Germany);
whereas popliteal venous aneurysms are a form of potentially life-threatening disease because they have been recognized to be a source of recurrent pulmonary emboli. In patients with popliteal venous aneurysms, tangential aneurysmectomy with lateral venorrhaphy is the procedure most commonly performed at present. (6) Besides tangential aneurysmectomy, graft interposition or venous patch plasty has also often been performed in popliteal venous aneurysm (7). The long-term patency of reconstructed popliteal veins has so far been poorly documented in previous reports, and the need and effects of postopera-

Fig. 6: Various illustrative images in case 6: 4. Photo documentation of tumor specimen’s pathological investigation: Macroscopic appearance of the resected inferior vena cava wall (*) with tumor thrombus (a). Histology of the tumor thrombus of the right renal vein stump (b) (H&E stain; magnification). Histology of the tumor thrombus of the IVC showing tumor cells of the renal cell carcinoma embedded in fibrin (c) (H&E stain; magnification) and partial fibrous organization of the thrombus (d) (Elastica van Gieson stain; magnification).

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The available limited experience suggests that a venous aneurysm of the lateral thoracic wall can be excised easily without a great risk of complication or recurrence.

Thus, the authors think that if the venous aneurysm is asymptomatic, associated with any complication, enlargement, or ambiguous etiology, it should be excluded, e.g., by ligation of the aneurysmatic neck as performed, and all feeder veins ligated or as a hybrid approach using intraoperative endovascular embolization, which alone may be sufficient if the whole aneurysmal sac could be embolized as done almost in this manner.

**Case 5:**
Venous aneurysms are generally asymptomatic and easily misdiagnosed as soft tissue tumors (8-12). Here, a case with a venous aneurysm arising from lateral thoracic wall causing recurrent pulmonary emboli is reported. The venous malformation was excised successfully via a hybrid endovascular and surgical approach. Vascular Doppler-ultrasoundography studies can differentiate venous aneurysms from artery aneurysms or arterial venous malformations. Imaging studies such as CT scanning or magnetic resonance imaging can also provide clues to the diagnosis, which is best confirmed by venography study. The available limited experience suggests that a venous aneurysm of the lateral thoracic wall can be excised easily without a great risk of complication or recurrence.

**Case 6:**
A case of RCC combined with IVC tumor thrombus in a horseshoe kidney and doubled right kidney experienced successful interdisciplinary cooperation of urologist and vascular surgeons in a complex and advanced tumor disease. In spite of advances in systemic treatment of RCC, primary complete tumor resection with tumor-free resection margins is the only curative treatment in the T1/T2 stage. IVC tumor thrombus of the advanced T3 RCC, requiring partial wall resection of IVC and patch-plasty, was classified as stage II by STAEHLER confirmed by venography study. This case demonstrates the importance of venous aneurysms from lateral thoracic wall being from lateral thoracic wall and on the diagnosis, which is best conformed by venography study. Studies such as CT scanning or Vascular Doppler-ultrasoundography can also provide clues to the diagnosis, which is best confirmed by venography study. The available limited experience suggests that a venous aneurysm of the lateral thoracic wall can be excised easily without a great risk of complication or recurrence.

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A secondary adjuvant or alternative medication with tyrosine kinase inhibitors can be considered a further therapeutic option according to novel and recent reports.

In summary, a diagnostically complete and conclusive preoperative imaging is essential for the assessment of tumor extension, surgical options and planning the specific approach as well as prognosis. Preferably in advanced, complex and complicated tumor manifestations, diagnostic and primary treatment should be performed in a center of excellence to achieve an optimal outcome by interdisciplinary cooperation of operative disciplines and an adequate perioperative intensive care.

Conclusion
The interdisciplinary team approach to diverse rare venous disorders is beneficial for patients and required for achieving optimal management and prevention of complications. We emphasize on the role of interdisciplinary management across a variety of diagnostic modalities. Interdisciplinary team work is a complex process, which means that different types of staff work together to share expertise, knowledge, and skills to influence patient care.

Take Home Message
- This is the first report in literature to discuss the complexity of non-varicose vein disorders including malignancies and how to manage them substantially based on the interdisciplinary team work of vascular surgeon and other specialties including interventional radiologists.
- Collaboration amongst specialists should be focused onto further systematic collection of experiences in diagnostic, peri-interventional/operative and therapeutic management including a competent follow-up to finally be able to create and further optimize consensus documents and structured educational programs that emphasize the interdisciplinary care of these selected patients with complex non-varicose venous diseases.


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<td>International Exhibition and Scientific Conference, For more information please visit: <a href="http://www.turkmenhealth.com">www.turkmenhealth.com</a></td>
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<tr>
<td><strong>The Saudi International Medlab Expo</strong></td>
<td>02.11. - 04.11.2020</td>
<td>Riyadh, Saudi Arabia</td>
<td>Riyadh International Convention and Exhibition Center, For more information please visit: <a href="http://www.saudimedlabexpo.com">www.saudimedlabexpo.com</a></td>
</tr>
<tr>
<td><strong>Saudi International Pharma Expo</strong></td>
<td>02.11. - 04.11.2020</td>
<td>Riyadh, Saudi Arabia</td>
<td>Riyadh International Convention and Exhibition Center, For more information please visit: <a href="http://www.saudipharmaexpo.com">www.saudipharmaexpo.com</a></td>
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