Original Article

Priorities and strategy for the implementation of enhanced recovery after surgery (ERAS) in thoracic surgery

Tomas Piler, Martin Schauer, Christopher Larisch, Julia Riedel, Reiner Neu, Hans-Stefan Hofmann, Michael Ried

Department of Thoracic Surgery, University Hospital Regensburg, Regensburg, Germany

Contributions: (I) Conception and design: T Piler, M Ried; (II) Administrative support: T Piler, M Ried; (III) Provision of study materials or patients: T Piler, J Riedel, M Schauer, R Neu; (IV) Collection and assembly of data: T Piler, J Riedel, M Schauer; (V) Data analysis and interpretation: T Piler, M Ried; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Tomas Piler, MD. Department of Thoracic Surgery, University Hospital Regensburg, Franz-Josef-Strauss-Allee 11, 93053 Regensburg, Germany. Email: tomas.piler@ukr.de.

Background: Enhanced recovery after surgery (ERAS) is a perioperative care protocol, which was introduced several years ago and has gained increasing importance in thoracic surgery. The aim of this study was to provide guidance through clinical implementation and to identify factors for better compliance.

Methods: This prospective cohort study collected data between July 2021 and June 2022 at the Department of Thoracic Surgery (University Hospital Regensburg, Germany). A modified enhanced recovery after thoracic surgery (ERATS) protocol with recommendations covering the pre-, intra- and postoperative phases was established and followed. The primary objective was to evaluate the implementation of the ERATS protocol. Secondary, specific and clinically relevant recommendations were analyzed regarding their compliance.

Results: The study included 139 patients undergoing elective lung resections. Many ERATS recommendations were already part of standard perioperative care, including perioperative antibiotics, venous thromboembolism prophylaxis and intraoperative warming. Other measures such as anemia management, carbohydrate loading or chest drain management were updated or newly established and standardized according to our ERATS protocol. The recommendations emphasizing early postoperative mobilization were found to be crucial. We identified three groups with significantly different compliance rates: (I) patient-dependent measures which require active participation (49.3%); (II) treatment measures requiring interdisciplinary consensus (85.8%); and (III) surgical measures (88%).

Conclusions: The implementation and continuous evaluation of our perioperative ERATS protocol led to a new categorization of targeted measures into three groups with actors of different competencies. The new grouping enables gradual implementation and a step-by-step targeted approach in order to achieve a higher compliance of ERATS in the future as well as long-term sustainability.

Keywords: Enhanced recovery after surgery (ERAS®); thoracic surgery; perioperative care; fast-track surgery

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Introduction

Over the last few decades, minimally invasive surgical techniques have become the standard procedure for lung cancer surgical management (1,2). Nevertheless, lung resections are still associated with perioperative morbidity and mortality regardless of the approach (3). Parallel to technical progress, it has therefore become necessary to pay increasing attention to perioperative complications and their management, initially to reduce length of stay (LOS) and complication rates and nowadays also to enable patients to participate in multimodal therapy concepts (4). Every operation is associated with certain level of stress reaction

to the human body, which can potentially be reduced (5). Enhanced recovery after surgery (ERAS®) offers such perioperative care elements, which aim to identify general and individual stress factors, counteract them in a targeted manner and maintain physiological functions (6).

The ERAS® protocol has been introduced worldwide in various modifications since the publication of the European Society of Thoracic Surgery (ESTS)/ERAS guidelines in 2019. The increasing number of publications dealing with ERAS® confirmed the importance of this topic (7). The 45 recommendations cover the preoperative, intraoperative and postoperative care (8). The recommendations are evidence-based and the strength of each recommendation takes into account the desired outcome. However, the exact pathophysiological way in which the 45 recommendations and their synergisms contribute to improving recovery and reducing complications is not yet fully understood (9).

ERAS® is not a task for surgeons alone, but rather a multimodal clinical concept carried out by a multidisciplinary team of physicians, nursing staff and organizational personnel (10). In this way, ERAS® has the opportunity to fulfil the so-called "Quadruple Aim" in healthcare, which is firstly to achieve better outcomes for patients, secondly to reduce costs, thirdly to improve the experience of patients, doctors and nursing staff and fourthly to increase the satisfaction of healthcare providers (11).

The success of ERAS® essentially depends on the implementation level and compliance with the protocol (12,13). The implementation process was not sufficiently studied yet and that there is a lot of potential that should be exploited. The focus of the discussion should be on the best possible overall recovery from surgery rather than on surgical details (14).

Primary objective of the study was to evaluate the implementation of ERAS®-based recommendations, but slightly modified enhanced recovery after thoracic surgery (ERATS) protocol for elective lung resections and to identify the compliance of specific, clinically relevant variables of our protocol. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1866/rc).

Highlight box

Key findings

- Compliance rates vary widely between the different recommendations of the enhanced recovery after surgery (ERAS) protocol in thoracic surgery.
- Patient-dependent measures that require active participation achieve the lowest compliance rate.

What is known and what is new?

- Compliance to ERAS recommendations remains a highly relevant success factor.
- ERAS recommendations should be divided into three groups, depending on the actors and their competencies.

What is the implication, and what should change now?

- This grouping enables a step-by-step gradual implementation and strengthening the long-time sustainability of ERAS in thoracic surgery.
- The process of implementation and sustainability needs to be further investigated.

Methods

Study design

In this prospective, observational study a total of 152 patients with an indication for lung resection at the Department of Thoracic Surgery (University Hospital Regensburg, Germany) were screened between July 2021 and June 2022. Inclusion criteria were age >18 years and an elective admission. Patients with severe preoperative immobility or language barrier were excluded. Finally, 139 patients were identified and entered into an electronic database. Data collection included patient demographics, general and surgical factors as well as compliance with each element of the ERATS protocol guidelines. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the University of Regensburg (No. 23-3216-104). Individual patient consent was waived because of routine patient care and the retrospective analysis's nature.

ERATS protocol

In the initial analysis, center-specific, protocol-compliant ERATS elements were identified. Individual recommendations from all three phases (preoperative, intraoperative and postoperative) were already established. Furthermore, new measures were initiated to establish a workflow according to the ERATS protocol guidelines (*Table 1*). A broad interdisciplinary consensus was reached in a multidisciplinary team (surgery, anesthesiology, nursing staff, physiotherapy, etc.) involved in the treatment. ERATS-specific information for patients was newly introduced.

Table 1 Modified ERATS protocol guidelines at our institution (8)

Phase	Recommendation
Preoperative	Education/counselling ERATS conform
	Pulmonary prehabilitation
	Smoking cessation
	Oral carbohydrate loading
	Anemia management
Intraoperative	Perioperative anesthesiology related items
	Perioperative antibiotics
	Intraoperative warming
	Regional/multimodal anesthesia
	Minimally invasive surgery
	Antero-lateral thoracotomy
Postoperative	Postoperative admission to standard surgical ward
	Chest drain management
	Catheter management
	Early mobilization

ERATS, enhanced recovery after thoracic surgery.

Table 2 Internal standard for perioperative anesthesiology-related items

No routine preoperative administration of sedatives
Lung-protective strategies during one-lung ventilation
Short acting analgesics
Normovolemic fluid regime and use of vasopressors
PONV control

PONV, postoperative nausea and vomiting.

Table 3 Internal standard for chest drain management

Use of single chest tube
Chest tube diameter 20–24 Charrière
No aspiration therapy by wedge-resection or standard lobar resection without air leakage
Chest X-ray on 1st POD
Chest drain removal if no air leakage and drain flow <450 mL/24 h
Chest drain removal by absence of hemorrhagic/chyle secretion
Chest drain removal by absence of clinically relevant pneumothorax
Use of digital drain system if chest tube cannot be removed on 1st POD

POD, postoperative day.

An internal audit of the current therapy standards was initially carried out, which confirmed, that several recommendations of the ERAS®-guideline were already addressed as part of the department's internal therapy standards (8). These included anesthesiology-related items (*Table 2*), the chest drain management (*Table 3*) and some general perioperative procedures such as perioperative antibiotics, surgical field preparation and anemia management.

As part of the modified ERATS protocol, patients received informal preoperative ERAS® education/counselling through medical staff at least a day before operation. Pulmonary exercise with breathing trainer (Volumetric Exerciser VS 5000, Medtronic, Germany) and inhaled mucolytic was initiated preoperatively. Instructions were given by both medical and nursing staff one to three days before surgery. Preoperative carbohydrate loading was newly introduced (200 mL Fresubin® 2kCal, Fresenius Medical Care, Germany). Smoking cessation was not addressed in a particular matter as there are publicly accessible subliminal offers for smoking cessation in our hospital. Nutritional assessment is one of the standard procedures regularly carried out by nursing staff and was therefore not included as a specific point in our protocol. Venous thromboembolism (VTE) prophylaxis was excluded from the analysis as it was addressed in the national guidelines similar to ERAS® recommendations.

Particular attention was paid to multimodal pain therapy with a focus on regional analgesia. Thoracic epidural analgesia (TEA) was not used routinely, but only in planned thoracotomies, while erector spine plane block (ESPB) and local analgesia were mainly used for VATS. Strong oral opioid medication was subsequently reduced after removing the chest tube and was slowly phased out under daily pain monitoring and outpatient conditions. Central venous catheter was not placed routinely. Urinary catheter would be inserted if the operative time was expected to be more than 3 hours.

Nursing staff were made aware of the need for early mobilization of patients. Physiotherapy was carried out daily to encourage the mobilization. Initial mobilization in a sitting position took place on the day of surgery and out of bed, going to toilette and walking along the corridor on 1st

Table 4 Patient characteristics

Variable	Values (n=139)
Age, years	64±11
Gender, female	57 [41]
Physical status	
ASA I	2 [1]
ASA II	40 [29]
ASA III	94 [68]
ASA IV	3 [2]
ICU postoperative	54 [39]
Hospital stay, days	8.5±6.3

Data are presented as mean ± standard deviation or n [%]. SD, standard deviation; ASA, American Society of Anesthesiologists; ICU, intensive care unit.

Table 5 Surgical procedures and applied regional analgesia of the study sample

Variable	Values (n=139)
Surgical approach, n [%]	
Minimal-invasive surgery (VATS)	100 [72]
Antero-lateral, muscle-sparing thoracotomy	37 [27]
NI-VATS	2 [1]
Type of surgical lung resection, n [%]	
Sublobar resection, including segmentectomy	86 [62]
Lobectomy	49 [35]
Pneumonectomy	4 [3]
Regional anesthesia (multiple counts possible), n [%]	
ESPB	96 [69]
TEA	31 [22]
Intercostal pain catheter (PainBuster®)	31 [22]
Local infiltration analgesia	27 [19]

VATS, video-assisted thoracic surgery; NI-VATS, non-intubated video-assisted thoracic surgery; ESPB, erector spinae plane block; TEA, thoracic epidural analgesia.

POD. All patients were reviewed daily, including weekends, by an attending thoracic surgeon.

Study endpoints

The primary endpoint concerned the implementation and compliance with the modified ERATS protocol. Secondary endpoints concerned specific and clinically relevant recommendations regarding their clinical application and impact on compliance.

Statistical analysis

A retrospective analysis of prospectively collected data was performed. Descriptive methods were used to analyze the data. Total numbers, frequencies and mean values were described. Parameters were specified in absolute or relative frequency if applicable with standard deviation. The statistical analysis with graphical representation of the results was carried out with Microsoft Excel (version 2108).

Results

Patient demographics

Table 4 shows an overview of the study sample with most relevant treatment data. A total of 112 patients (81%) received complete preoperative workup as outpatients, while the remaining patients were hospitalized for missing diagnostic examinations, which led to consecutive extension of the LOS. In addition to the lack of diagnostics, capacity restrictions during coronavirus disease 2019 (COVID-19) pandemic were also among the reasons for postponements. Our standard of care included a planned stay in the intensive care unit (ICU) for patients undergoing sleeve-resection (4%) or pneumonectomy (3%). Furthermore, the ICU was reserved for patients with relevant concomitant comorbidities such as renal insufficiency requiring dialysis. Among the most common unscheduled reasons for postoperative admission to the ICU was failed weaning from catecholaminergic medication (9%) followed by temporary respiratory insufficiency (7%). The median length of postoperative hospital stay was 7 days (range, 1–57 days). The overall perioperative complication rate was 19%. No patient died within the first 30 days postoperatively.

Treatment data

Table 5 shows an overview of surgical and regional anesthetic procedures. Simultaneous lymphadenectomy was performed in 93 patients (67%). Regional analgesia was also used in combination as part of the multimodal therapy concept. There were no complications in association with regional analgesia at all.

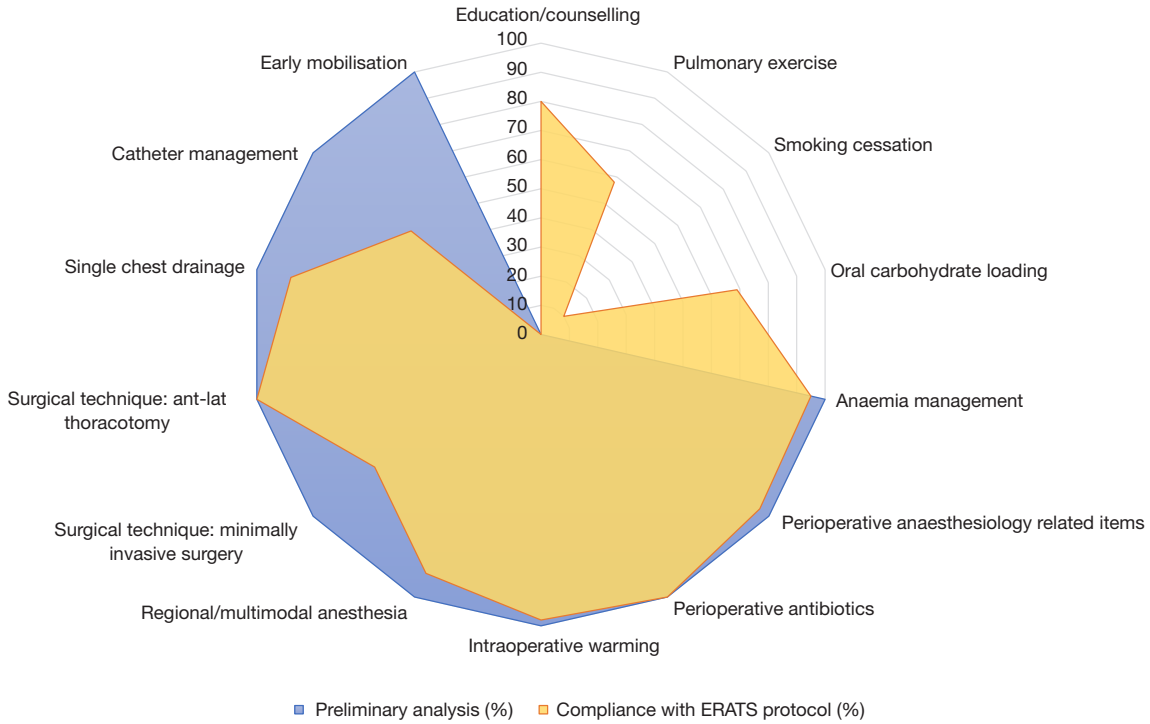

Figure 1 Compliance with ERATS protocol. Baseline score was defined 100%, whereas newly introduced measures in accordance with the ERATS protocol were assigned 0% in the preliminary analysis (highlighted in blue). The measured compliance was highly variable across individual parameters (yellow field). ERATS, enhanced recovery after thoracic surgery.

Compliance to ERATS

The center-specific ERATS-compliant recommendations which were already established prior to the beginning of the study were given a baseline score of 100%, whereas the measures newly introduced in accordance with the ERATS protocol were assigned 0% in the preliminary analysis (*Figure 1*). The measured compliance was highly variable across individual parameters.

The recommendations that were already part of standard therapy achieved the best compliance rates. These included perioperative antibiotics (compliance 100%), intraoperative warming (98%) and in case of open surgical techniques antero-lateral thoracotomy (100%). Some of the recommendations were expected to achieve high compliance rate as they were individual measures, such as preoperative education/counseling (80%), carbohydrate loading (69%) and anemia management (95%). The recommendations for one-lung ventilation and other anesthesiologic aspects such as normovolemia were also successfully implemented (compliance 96%). We have noticed that there were considerable deficits in the handling of chest drains (*Table 6*) and catheter management (central venous catheter 55%; urinary catheter 60%). Most difficulties were encountered in the management of patient-dependent measures such as smoking cessation (10%), pulmonary exercise (58%) and early mobilization. We identified different rates of compliance with the ERATS protocol depending on three groups (*Figure 2*): (I) patient-depending measures which require active participation (49.3%); (II) treatment measures requiring interdisciplinary consensus (85.8%); (III) surgical measures (88%).

Discussion

The implementation of ERAS® recommendations in thoracic surgery still represents a challenge, as not only clinical procedures, but often also administrative issues need to be addressed, which requires a multidisciplinary team approach (15). In addition, it can be assumed that the increasing demand for ERAS® will come from the patients themselves in the near future. Patients will change from a passive recipient of (health-) care to an active player. In this context, we are observing a shift towards greater patient

involvement in shared-decision making process regarding treatment plans as known from lung cancer screening programs (16,17). Our clinical practice had already shown that adherence to different ERATS measures varied greatly. Adherence to the measures that require active patient participation requires a great deal of effort. Therefore, the benefits of active participation in the treatment process must be explained to patients in a simple and understandable way. This can increase patient motivation and thus also compliance to protocol guidelines (18).

Our data proved, that the compliance with the ERATS protocol varied significantly in all three phases of the perioperative process. Taking into account the clinical implementation, we recommend categorization into the following three newly defined groups:

(I) Patient-depending measures which require active participation;
(II) Treatment measures requiring interdisciplinary consensus;
(III) Surgical measures.

In addition to traditional classification into preoperative, intraoperative and postoperative elements, new grouping seems to facilitate the implementation of an ERATS program. It could help in cases where, for example, no consensus has yet been reached between all healthcare providers.

- Group 1—patient-depending measures that require active participation—had the lowest overall compliance of only 49% with our ERATS protocol. Smoking cessation and pulmonary exercise require active patient participation and strong motivation. They also require a change in patient lifestyle and habits. This must be addressed on an individual basis and additional easily accessible advice centers should be created. Since the overall compliance rate in this group was insufficient, special attention should be paid to this group. It can be argued that a high level of compliance in this group has a positive effect on quality of life, which could become by far the most important parameter in the future (19-21).

Table 6 Results regarding chest drain management

Variable	Values (n=139)
Single chest drain used	123 [88]
Size of chest tube	
20 Charrière	18 [13]
24 Charrière	120 [86]
26 Charrière	1 [1]
Duration of chest tube drainage, days	3.0±2.5
Digital drainage system used	75 [54]

Data are presented as mean ± standard deviation or n [%].

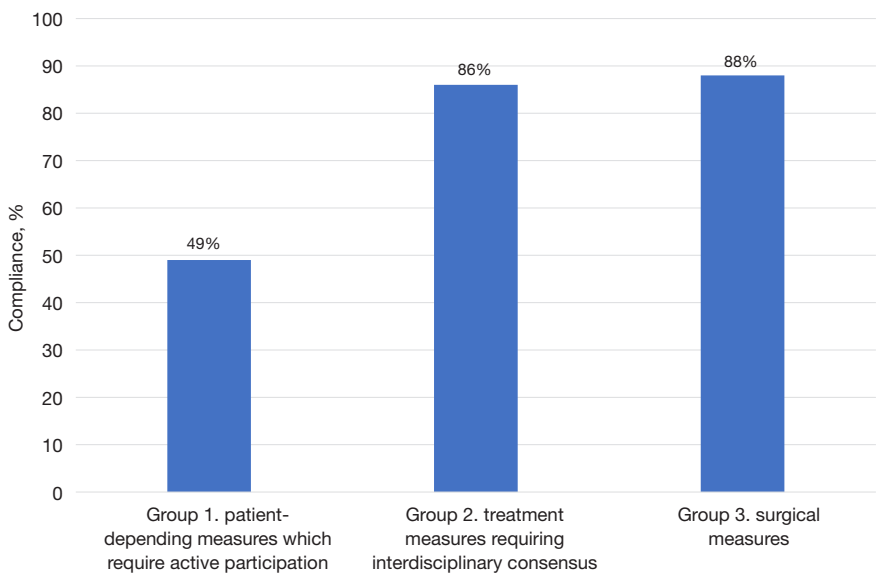

Figure 2 Average compliance rate (%) in three newly defined groups.

- Group 2—treatment measures requiring interdisciplinary consensus—contains recommendations that can be implemented with satisfactory compliance of 86% once a consensus has been reached within the entire treatment team because they are usually single item recommendations with a relatively easy accomplishment. These include general perioperative elements independent of surgical subspecialty (e.g., anemia management, prophylactic antibiotics, intraoperative warming) as well as anesthesia-related recommendations which are of general applicability (e.g., short acting anesthetics, normovolemic fluid regime and use of vasopressors, PONV control) and lung-protective strategies during one-lung ventilation used specifically in thoracic surgery (22). Same day surgery for example, could have a significant impact on LOS, which has become a frequently assessed parameter concerning ERAS® although its relevance might be marginal regarding to patient outcome (23). Urinary catheters and invasive monitoring instruments severely restrict patient mobility. Particular attention should be paid to the early removal of these measures in order to increase compliance with regard to mobilization.
- Group 3—surgical measures—are characterized by the fact that the entire management is in the hands of the surgical team and showed an excellent compliance rate of 88%. On the other hand, problems may arise as to which compromises are accepted, e.g., with chest drain management. This is certainly based on regional practices. While in some regions discharge with the chest drain attached to a one-way valve is accepted in case of persistent air leakage, in other regions this would probably lead to postponement of discharge (24,25). In addition, the willingness of the surgical staff to replace traditional procedures with evidence-based approach could vary greatly. In particular, a quality review meeting showed a significantly improved compliance to elements of the thoracic ERAS® protocol and should therefore be considered for implementing surgical protocols (26).

Most of the ERAS® recommendations are not new, suggesting improved recovery by strengthening the synergistic effects of all measures (13). The premise under which complications after surgical interventions were considered have changed. Therefore, perioperative management must also be reconsidered. Without appropriate measures, there is a risk that some patients will not participate in multimodal therapy.

Limitations and perspectives

We are aware of the limitations of this study in terms of sample size and single center implementation. In addition, a rather heterogeneous sample of surgical procedures was studied, including both cancer and benign diagnoses, which could potentially play an important role with regard to psychosomatic aspects. The next problem we see is the lack of possibility to compare the ERATS group with a control group. There is a considerable contamination between the two hypothetical groups because some recommendations were usually already implemented in the control group. Another critical aspect regarding compliance is the relative shortage of personnel due to high workload for already existing staff. This point becomes particularly important when new procedures are introduced. This became particularly clear during the Covid pandemic, which led to a shortage of medical staff and operating room capacity. The outcome of early mobilization could not be evaluated in our study due to lack of standardization and institutional changes, nevertheless the same issue discussed above applies to this element. On the other hand, increasing standardization and greater familiarity with the protocol leads to better convalescence and earlier discharge of patients, which should relieve nursing staff in the future. Digital-based applications are also conceivable here.

Conclusions

In conclusion, the ERAS® guideline for lung resections are very wide-reaching. Compliance to these perioperative care recommendations remains a highly relevant success factor. The implementation and continuous evaluation of our perioperative ERATS protocol led to a new categorization into three groups. This additional categorization might help to quickly identify the weak points in the implementation process and can hopefully contribute to a higher compliance of ERATS through a focused approach.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1866/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1866/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1866/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the University of Regensburg (No. 23-3216-104). Individual patient consent was waived because of routine patient care and the retrospective analysis's nature.

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