Deutsches Register Klinischer Studien
German Clinical Trials Register

Trial Description

Title

Influence of Positive End-expiratory Pressure (PEEP) on Ventilation, Compliance and Oxygenation in Trendelenburg Positioning during Robotic-assisted Surgery

Trial Acronym

[---]*

URL of the trial

[---]*

Brief Summary in Lay Language

General anesthesia for robot-assisted prostatectomy requires artificial ventilation, i.e. during the operation, patients are ventilated with the help of an anesthetic machine. The steep head-down positioning required by the surgeon in addition with expanding the abdominal cavity with carbon dioxide for the robot-assisted intervention poses a challenge for ventilation due to the resulting lung compression. In this setting we want to measure the pressure variables in the ventilation system and examine the regional ventilation of the lungs.
During artificial respiration, a positive pressure that can be imagined as a slight “headwind” during expiration is set as a standard to prevent alveolar collapse. Because of this feature it is also called "positive end-expiratory pressure". In our study, we would like to test the assumption that during head-down positioning combined with laparoscopic surgery a higher positive-end expiratory pressure is beneficial for a more consistent ventilation of the lungs and for keeping the alveoli open.
Therefore, as far as the clinical circumstances allow, we plan to vary the positive-end expiratory pressure during exhalation in order to measure the effects on the characteristic variables of the respiratory system.
The aim of the study is therefore to investigate whether an increase of this positive end-expiratory pressure can reduce positioning-related restrictions in pulmonary function during artificial ventilation.
In the case of participation in the study, a belt with electrodes will be placed around the chest and adhesive electrodes placed on the forehead before induction of anesthesia. These measurements will enable us to measure the ventilation of the lungs and the oxygenation of the brain. During anesthesia, gas pressure and gas flow in the airways are also recorded.
For this purpose, measuring devices will be connected to the artificial airways. In addition, a soft tube, similar to a gastric tube, will be inserted into the esophagus after induction of anaesthesia as a pressure measurement device. The duration of the anesthetic will not be prolonged by these measurements.

Brief Summary in Scientific Language

1. Summary
Mechanical ventilation, which is necessary during intubation anaesthesia, leads to number of pulmonary changes and bears the risk of causing secondary damage. Thus, optimal ventilation strategy is required. Part of the ventilation strategy is to

avoid collapse of the terminal airways by applying a positive end-expiratory pressure (PEEP). In addition to previous pulmonary disease, nutritional status and surgery-related features, patient positioning is a decisive factor in the choice of the level of PEEP. Among the growing number of laparoscopic, robot-assisted interventions, Trendelenburg head-down positioning represents an extreme. So far, however, research on the respiratory physiological effects of this extreme, has been insufficient.

The aim of this monocentric, prospective and controlled intervention study is therefore the investigation of the respiratory mechanics depending on the PEEP in Trendelenburg positioning during laparoscopic robot-assisted radical prostatectomy (RARP). The regional ventilation is measured non-invasively using electroimpedance tomography. After measuring the target parameters as a baseline in Trendelenburg storage (approx. 30-40 °) during application of a PEEP of 7 mbar (clinic standard), the PEEP will be increased in steps of 3 mbar until a horizontal compliance profile is reached (indicated by intratidal compliance analysis in real-time using the graphical user interface (GUI)) or a maximum of 24 mbar and then gradually reduced to the initial value. In addition to the ventilation data, cerebral oxygenation is recorded using near-infrared spectroscopy (NIRS).

The hypothesis of the present study is that increasing positive end-expiratory pressure (PEEP) in Trendelenburg positioning improves ventilation, compliance and oxygenation and thus provides a protective effect on lung function.

2 Background
Laparoscopic robot-assisted radical prostatectomy (RARP) is increasingly replacing open radical prostatectomy. Current reviews not only show the non-inferiority of RARP, but that it is also associated with a shorter hospital stay and less need for blood transfusions [1]. The number of RARPs should therefore continue to grow in the future. Intraoperatively, the abdominal pressure and consequently the ventilation pressure increase due to the application of a capnoperitoneum and the Trendelenburg head-down positioning which is required for the procedure.
To minimize (post-)operative pulmonary complications such as atelectasis due to lung compression, optimal intraoperative anesthesiological management is required. At the same time, the current scientific situation in this regard is insufficient. A study by a Turkish working group published in 2017 shows, that patients in Trendelenburg positioning ventilated without positive-end expiratory pressure (PEEP) had a worse post-operative pulmonary function compared to ventilation with a PEEP of 8 cm H_2O [2]. However, a PEEP of 7 mbar is already standard in our clinic and it could be shown by our working group that a further adaptation of the PEEP to the intra-operative positioning (here abdominal positioning) should be considered and could prevent possible lung damage through artificial ventilation [3]. For the Trendelenburg head-down positioning, an increase of the PEEP also seems worth considering, but, so far, has not been satisfactory scientifically evaluated.
Therefore, the present study examines the changes in ventilation, compliance and oxygenation at different PEEP levels in Trendelenburg positioning.
Starting with a PEEP of 7 mbar, the PEEP will be increased in steps of 3 mbar if the lungs are under-distended (meaning continuous recruitment and derecruitment) until a horizontal intratidal compliance profile is reached or up to a maximum of 24 mbar. This titration is carried out individually during real-time intratidal compliance analysis, which prevents over distension of the lungs and allows finding a PEEP value that is optimal for each patient [4]. For this purpose, a program with graphical indication of intratidal compliance [5] and the gliding slice model [6,7] is used. The analysis of regional ventilation is carried out using

electroimpedance tomography (EIT, Pulmovista, Dräger medical, Lübeck). Arterial blood gas measurements are only included as a part of routine clinical monitoring. If the respiratory mechanics analysis shows that an increase in PEEP has a positive effect on lung function, the goal is to optimize not only intra-operative ventilation, compliance and oxygenation, but also to avoid secondary damage in a patient group that is expected to continuously grow with with the increasing number of robot-assisted surgeries.

[1] Ilic D., Evans S.M., Allan C.A., Jung J.H., Murphy D., Frydenberg M. (2018): Laparoscopic and robot-assisted vs open radical prostatectomy for the treatment of localized prostate cancer: a Cochrane systematic review. BJU Int 121(6): 845-853.
[2] Haliloglu M., Bilgili B., Ozdemir M., Umuroglu T., Bakan N. (2017): Low Tidal Volume Positive End-Expiratory Pressure versus High Tidal Volume Zero-Positive End-Expiratory Pressure and Postoperative Pulmonary Functions in Robot-Assisted Laparoscopic Radical Prostatectomy. Med Princ Pract 26(6): 573-578.
[3] Spaeth J., Daume K., Goebel U., Wirth S., Schumann S. (2016): Increasing positive end-expiratory pressure (re-) improves intraoperative respiratory mechanics and lung ventilation after prone positioning. Br J Anaesth 116(6): 838-846.
[4] Wirth et al. Intraoperative positive end-expiratory pressure evaluation using the intratidal compliance-volume profile. Br J Anaesth. 2015 Mar;114(3):483-90
[5] Bühler et al. Monitoring of intratidal lung mechanics: a Graphical User Interface for a model-based decision support system for PEEP- titration in mechanical ventilation J Clin Monit Comput 2014 28:613–623
[6] Schumann et al. Estimating intratidal nonlinearity of respiratory system mechanics: a model study using the enhanced gliding-SLICE Method Physiol Meas 2009 Dec; 30:1341-1356 [5] Schumann et al. Analysis of dynamic intratidal compliance in a lung collapse model. Anesthesiology 2011 May;114(5):1111-1117.
[7] Schumann et al. Analysis of dynamic intratidal compliance in a lung collapse model. Anesthesiology 2011 May;114(5):1111-1117.

Do you plan to share individual participant data with other researchers?

Yes

Description IPD sharing plan

After publication of the results, anonymous, non-personal measurement data such as recorded respiratory mechanics data and ventilation patterns as well as general conditions such as study protocol/statistical analysis plan can be passed on upon application.

Organizational Data

- DRKS-ID: **DRKS00021009**
- Date of Registration in DRKS: **2020/03/11**
- Date of Registration in Partner Registry or other Primary Registry: **[---]***
- Investigator Sponsored/Initiated Trial (IST/IIT): **yes**
- Ethics Approval/Approval of the Ethics Committee: **Approved**
- (leading) Ethics Committee Nr.: **332/19 , Ethik-Kommission der Albert-Ludwigs-Universität Freiburg**

Secondary IDs

Health condition or Problem studied

- ICD10: **C61 - Malignant neoplasm of prostate**
- ICD10: **J98.1 - Pulmonary collapse**

Interventions/Observational Groups

- Arm 1: **As we start the measurements of this interventional study at standard settings and go back to standard settings after completing the intervention, each patient serves as his own control.**
Within a certain period of time all lung-healthy, adult patients, who have to undergo a robot-assisted prostatectomy at the University Medical Centre Freiburg, are offered to participate in the study. After a detailed explanation and written consent, patients will be included until the targeted number of participants of n = 30 is reached.
The intervention consists of the titration of the individual positive-end expiratory pressure with real-time analysis of compliance and ventilation: We will investigate the effect of Trendelenburg positioning on ventilation, compliance and oxygenation at different PEEP levels. If the lungs are under-distended (continuous sequence of recruitment and derecruitment) while the standard PEEP of 7 mbar is applied, the PEEP will be titrated step by step in steps of 3 mbar until a horizontal intratidal compliance profile is reached or up to a maximum of 24 mbar. This titration is carried out individually during real-time intratidal compliance analysis, which prevents overstretching. Thus, the individually optimal PEEP value for each patient can be found. For this purpose, a program with a graphical visualisation of intratidal compliance and the gliding slice model are used (see Summary/Baclground). Regional ventilation is analysed using electroimpedance tomography (EIT, Pulmovista, Draeger medical, Lübeck).
Eventually, in steps of 3 mbar, PEEP will be reduced to the standard level of 7 mbar.

Characteristics

- Study Type: **Interventional**
- Study Type Non-Interventional: **[---]***
- Allocation: **Other**
- Blinding: **[---]***
- Who is blinded: **[---]***
- Control: **Other**
- Purpose: **Basic research/physiological study**
-

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Purpose: **Basic research/physiological study**

Assignment: **Other**

- Phase: **N/A**
- Off-label use (Zulassungsüberschreitende Anwendung eines Arzneimittels): **N/A**

Primary Outcome

Primary outcome is the homogeneity in terms of regional ventilation indicated by the ratio of dorsal and ventral ventilation (electroimpedance tomography). We will compare the ventilation in Trendelenburg positioning while applying the standard PEEP (7 mbar) with ventilation while applying the individually found "best PEEP" (indicated by horizontal intra-tidal compliance).
Because electrocauterisation is less used during urethral anastomosis and could affect electroimpedance tomography, measurements will take place during this phase of the operation.

Secondary Outcome

Dynamic compliance, FiO2, FeO2, PaO2, SpO2, cerebral oxygenation

Countries of recruitment

- DE **Germany**

Locations of Recruitment

- University Medical Center **Klinik für Anästhesiologie und Intensivmedizin, Freiburg im Breisgau**

Recruitment

- Planned/Actual: **Planned**
- (Anticipated or Actual) Date of First Enrollment: **2020/04/05**
- Target Sample Size: **30**

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Target Sample Size: **30**

- Monocenter/Multicenter trial: **Monocenter trial**
- National/International: **National**

Inclusion Criteria

- Gender: **Male**
- Minimum Age: **18 Years**
- Maximum Age: **999 Years**

Additional Inclusion Criteria

written consent
age > 18
elective laparoscopic robotic-assisted radical prostatectomy
ASA classification I-III
BMI < 30 kg x m-2

Exclusion criteria

disapproval of the patient
age < 18 years
pulmonary disease
contraindications for EIT measurements (active implants, e.g. pacemaker, cardioverter)
BMI ≥ 30 kg x m-2

Addresses

- **Primary Sponsor**

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- **Contact for Scientific Queries**

Universitätsklinikum Freiburg Klinik für Anästhesiologie und Intensivmedizin

Contact for Scientific Queries

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Sources of Monetary or Material Support

- **Institutional budget, no external funding (budget of sponsor/PI)**

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Status

- Recruitment Status: **Recruiting planned**
- Study Closing (LPLV): **[---]***

Trial Publications, Results and other documents

- Approval of ethics comm. (mandatory for transfer to Studybox) **EK 332-19 Positives Ethikvotum vom 31.10.2019**
- trial protocol (mandatory for transfer to Studybox) **EK 332-19 Studienprotokoll V4**

** This entry means the parameter is not applicable or has not been set.*

**** This entry means that data is not displayed due to insufficient data privacy clearing.*