The negative pressure wound therapy may salvage the infected mesh following open incisional hernia repair

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A B S T R A C T

Background: Incisional hernias may occur in 10–25% of patients undergoing laparotomy. In cases of a surgical site infection (SSI) after incisional hernia repair (IHR) secondary operative intervention with mesh removal are often needed. There is only minimal data available in the literature regarding the treatment of a wound infection with negative pressure wound therapy (NPWT). Conducting the study at hand, we aimed to provide more evidence on this topic.

Methods: From April to June 2020 a monocentric retrospective study has been performed. Patients who underwent NPWT due to a SSI with mesh involvement following open IHR from 2007 to 2020 were included. The primary endpoint was the mesh removal rate in the end of NPWT. Main secondary endpoints were the duration of NPWT and the amount of NPWT procedures.

Results: The data of 30 patients were extracted. The average age was 65.9 years (9.9). A total of 13 individuals were male and 17 females. The BMI was on average 31.1 kg/m² (4.9). All patients received a polypropylene mesh. The average duration of NPWT was 31.3 days (22.1). The first wound revision with initiation of a NPWT was conducted on average 31.1 days (34.0) after IHR. The average amount of NPWT procedures was 8.3 (7.2). In 5 of 30 patients (16.6%) the mesh was removed (Open sublay group n = 4 (36.34%) vs. open onlay group n = 1 (5.26%), p = 0.047).

Conclusion: In cases of SSI following IHR the NPWT may facilitate mesh salvage. Further trials with a larger sample size are mandatory to confirm our hypothesis.

1. Introduction

Incisional hernias (IH) are a common complication after abdominal surgery and occur in approximately 10–25% of patients undergoing laparotomy. Up to 30% of these hernias leads to symptoms and often require hernia repair [1–3].

Next to various surgical approaches who has been successfully implemented into IH surgery routine, the open onlay and open sublay techniques remain sufficient approaches to treat these hernias [4]. As one of a main complication a SSIs may occur in up to 30% of cases [4]. Furthermore, the SSI can also lead to mesh infection with an incidence of 1–2% [1–3,5].

Risk factors for SSI with mesh infection include steroid use, smoking, old age, obesity, diabetes and malnutrition [3]. It is a severe complication because it often leads to comorbidities and a prolonged hospital stay. The conservative non-operative treatment includes antibiotic administration and percutaneous or surgical drainage [3,6]. In a recent retrospective analysis by Warren et al., in 2020 (n = 213) a mesh salvage rate of only 18.8% was stated, when local wound care was performed alone [7]. Hence, the mesh removal has often been described as part of a sufficient treatment for mesh infections [8]. In these cases, the IH is treated without a mesh and a relapse can often be expected.
A sufficient strategy to salvage mesh removal may consist of the negative pressure wound therapy (NPWT) but scientific data are limited. Hence, we aimed to analyze our data to reveal more evidence on that topic.

2. Methods

The study occurred at the Helios hospital Berlin-Buch (Germany) between April and June 2020. The data of patients who were operated on due to an IHR from 2007 to June 2020 were analyzed. The study was approved by the Ethics Committee of the ‘Arztekammer Berlin’ (Medical Association Berlin) in May 2020 (Eth-09/20) and conducted in accordance with the ethical standards of the Helsinki Declaration 1975.

The study was registered with the German clinical trial registry DRKS (DRKS00022170). No funding has been received.

The study is based on the patients’ data available from their files. The time of their hospital stay has been analyzed. We did not perform a systematic follow-up.

The manuscript was written according to the STROCSS guidelines [9].

2.1. Surgical approach

The open incisional hernia repair in sublay and onlay technique were performed according to the described techniques by Chevrel [10] and by Rives [11]. All patients received an antibiotic single shot with cefuroxim (1.5 g). Drain tubes were routinely inserted. These approaches were chosen in cases of a hernia gap >7 cm.

As a standard approach at our hospital, when a SSI with mesh infection occurs, wound debridement with NPWT was initiated. In cases of a systemic inflammatory response with detection of a bacteraemia antibiotic agents were administrated according to an antibiogram. The pressure dressing was changed after 72 h. Based on surgeons experience, in cases of a macroscopic mesh inbuilt failure, the mesh was removed.

2.2. Inclusion criteria

Patients who underwent NPWT due to a wound infection with mesh involvement (mesh located inside or next to the wound infection) following open IHR were included.

2.3. Exclusion criteria

Individuals with a SSI following incisional hernia repair, who did not receive the NPWT, were excluded.

2.4. Aims

Primary endpoint: mesh removal rate after finalized NPWT.

Secondary endpoints: Amount of NPWT procedures, duration of hospital stay, Clavien-Dindo-Classification [12] until finalization of NPWT; Mesh removal rate (if available in patients file).

2.5. Database

In April 2020, an MS Excel data sheet was provided. This data was imported into R (ver. 3.6.1), and multiple plausibility checks were performed. In May 2020 inconsistencies of the data were resolved.

3. Results

3.1. Baseline characteristics

The data of 30 patients were analyzed. The average age was 65.9 years (9.9). A total of 13 individuals were male and 17 females. 2 patients had an ASA-Score I, 13 an ASA-Score II and 15 an ASA-Score of III.

The BMI was on average 31.1 kg/m$^2$ (4.9). The baseline characteristics are shown in Table 1.

3.2. Perioperative data

Overall, 19 patients were operated on in open onlay and 11 patients in open sublay technique. In 13 cases a component separation took place. 18 patients suffered from a primary IHR and 12 individuals from a secondary IHR. The operating time was on average 122.6 min (51.1).

Table 2 depicts these perioperative data.

3.3. Primary endpoint

In 5 of 30 patients (16.6%) the mesh was removed. In three cases the removal was conducted within the first year after IHR (Average post-operative day (POD): 36.5 (46.3)). In one case the mesh was removed on the 430 POD.

3.4. Secondary endpoints

The average duration of NPWT was 31.3 days (22.1). The first wound revision with initiation of a NPWT was conducted on average 31.1 days (34.0) after IHR. The average amount of NPWT procedures was 8.3 (7.2); average pressure 72.9 mmHg (7.2). In all cases a suture wound closure was conducted in the end of NPWT. The cumulative length of hospital stay was 47.2 days (28.11). The CDC was revealed during the hospital stay. A total of 27 patients had a CDC grade III (due to their wound infection). Three individuals had a CDC grade IV (2x catheter sepsis with multiorgan failure, 1x respiratory insufficiency; Table 3).

3.5. Univariate analysis on NPWT following open onlay and sublay IHR

A total of 11 patients underwent open Sublay IHR. The average age was 67.27 (SD 8.27) years. Male were 5 and female 6. No patient had an ASA score of I, 8 an ASA score of II and 3 an ASA score of III. The BMI was on average 32.29 (SD 5.34) kg/m$^2$. In three cases the Sublay IHR was performed due to a relapse. The operating time was on average 139.36 (SD 47.23) minutes (Table 4). The average duration of NPWT was 31.27 (SD 28.40) days. On average the first wound revision was 35.55 (SD 49.60) days. The average amount of NPWT procedures was 8.3 (7.2); average pressure 72.9 mmHg. In 4 cases (36.34%) the mesh was removed. The mesh was removed on average 10 (SD 8.66) days after IHR. The average length of hospital stay was 43 (SD 38.33) days (Table 5).

A total of 19 individuals underwent open Onlay IHR. The average age was 65.11 (SD 11.17) years. Male were 8 and female 11. Two patients had an ASA score of I, 5 an ASA score of II and 12 an ASA score of III. The BMI was on average 29.24 (SD 4.32) kg/m$^2$. In 9 cases the Onlay IHR was performed due to a relapse. The operating time was on average 112.89 (SD 59.62) minutes (Table 4). The average duration of NPWT was 31.37 (SD 19.08) days. On average the first wound revision was

### Table 1

| Variable                  | Study group | n = 30 |
|---------------------------|-------------|--------|
| Age years                 | 65.9 (9.9)  |        |
| Gender male               | 13          |        |
| Gender female             | 17          |        |
| ASA preoperative          |             |        |
| I                         | 2           |        |
| II                        | 13          |        |
| III                       | 15          |        |
| IV-V                      | 6           |        |
| BMI kg/m$^2$              | 31.1 (4.9)  |        |

ASA = American Society of Anesthesiologists physical status classification; BMI = Body Mass Index Continuous measurements are presented as mean (SD).
A total of 5 patients received a mesh removal. In 4 cases an open sublay repair was previously performed. The average age was 63.8 (8.79) years. Two patients were male and three were female. Two patients had an ASA score II and three individuals an ASA score III. The BMI was on average 28.33 kg/m². The average operating time was 136.6 (37.5) minutes. The length of hospital stay was on average 46.2 (30.10) days (Table 6).

### 4. Discussion

Already in 1993, Fleischman et al. published the NPWT for open fractures. The authors stated that this therapeutic approach led to an efficient cleaning and conditioning of the wound, with marked proliferation of granulation tissue. No bone infection did occur among their 15 enrolled patients [13]. These findings were also confirmed in an animal model by Morykwas in 1997 [14].

### 3.6. Biometric and perioperative data of mesh removal group

In terms of baseline characteristics, no statistical significant differences were revealed between both groups. Regarding mesh removal rate, a statistical significance was detected (Open sublay group n = 4 (36.34%) vs. open onlay group n = 1 (5.26%), p = 0.047).

| Variable | Study group |
|----------|-------------|
| Mesh placement | onlay 19<br>sublay 11 |
| Component separation | 13 |
| Primary incisional hernia | 18 |
| Relapse | 12 |
| Operating time | minutes 122.6 (51.1) |

Continuous measurements are presented as mean (SD).

* TAR transversus abdominis release.

Onlay and Sublay repair.

### Table 5

Univariate analysis on NPWT following open Onlay and Sublay repair.

| Variable | Study group |
|----------|-------------|
| Duration of NPWT therapy | days 32.6 (22.3) |
| POD of first wound revision | days 31.1 (34.0) |
| Amount of NPWT procedures | n 8.1 (7.1) |
| Average pressure | mmHg 72.9 (9.9) |
| MR < 365 POD | n 5 (16.6%) |
| Average POD of MR | d 14 |
| MR > 365 POD | n 1 (3.3%) |
| POD of MR | d 430 |
| Cumulative LOS | days 47.2 (28.11) |
| CDC Grade | III 90.0% (n = 30) |
| POD of mesh removal | days 10 (SD 8.66) |
| Cumulative LOS | days 43 (SD 28.33) |

CDC Clavien-dindo classification; Continuous measurements are presented as mean (SD); (F) Fisher test; NPWT negative pressure wound therapy; (t) t-Test.

aNo statistical analysis obtainable due to a single variable.

ASA American Society of Anesthesiologists physical status classification; BMI Body Mass Index Continuous measurements are presented as mean (SD); (F) Fisher test; NPWT negative pressure wound therapy; (t) t-Test.

### Table 6

Data on mesh removal group.

| Variable | Study group |
|----------|-------------|
| Age | years 63.8 (8.79) |
| Gender | male 2<br>female 3 |
| ASA preoperative | II 2<br>III 3<br>IV-V 0 |
| BMI | kg/m² 28.33 (6.02) |
| Mesh placement | onlay 1<br>sublay 4 |
| Component separation | 3 |
| Primary incisional hernia | 18 |
| Relapse | 1 |
| Operating time | minutes 136.6 (37.5) |
| LOS | days 46.2 (30.10) |

ASA = American Society of Anesthesiologists physical status classification; BMI Body Mass Index Continuous measurements are presented as mean (SD); LOS Length of hospital stay.

* TAR transversus abdominis release.
According to the NPWT, the mesh could be salvaged in 18.36% of cases. However, the evidence for using NPWT in SSIs with mesh infection is not conclusive. The study included 36 patients who underwent surgery for open hernia repair. Interestingly, in these cases, the mesh could be salvaged more frequently with NPWT than with other methods. The study also highlighted the importance of mesh salvage in reducing the risk of relapse.

However, the NPWT process was associated with higher costs, discomfort, and the need for inpatient treatment. These disadvantages need to be considered when deciding to use NPWT. The study's limitations include a small sample size and a retrospective design. A larger, prospective randomized controlled trial is needed to confirm these findings and to determine the optimal use of NPWT in SSIs with mesh infection.

In conclusion, NPWT is a promising approach for SSIs with mesh infection following open hernia repair. Further studies are needed to elucidate its role in reducing mesh removal-related complications and to determine the optimal settings for NPWT in these cases.
Provenance and peer review
Not commissioned, externally peer reviewed.

Declaration of competing interest
None.

Appendix A. Supplementary data
Supplementary data related to this article can be found at https://doi.org/10.1016/j.amsu.2020.12.013.

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