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ORIGINAL ARTICLE

Laparoscopic transversus abdominis release for complex ventral hernia repair: technique and initial findings

H. Riediger[1] · P. Holzner[2] · L. Kundel[1] · C. Gröger[1] · U. Adam[1] · D. Adolf[3] · F. Köckerling[1]

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Abstract

Purpose The open Rives–Stoppa retrorectus and transversus abdominis release (TAR) techniques are well established in open ventral and incisional hernia repair. The principles are currently being translated into minimally invasive surgery with different concepts. In this study, we investigate our initial results of transperitoneal laparoscopic TAR for ventral incisional hernia repair (laparoscopic TAR).

Methods Over a 20-month period, 23 consecutive patients with incisional hernias underwent surgery. Laparoscopic TAR was performed transperitoneally with adhesiolysis from the anterior abdominal wall, development of the retrorectus space and TAR, midline reconstruction and extraperitoneal mesh reinforcement.

Results There were 23 incisional hernias, of which 70% were M2–M4 and 60% were W3. Median patient age was 68 years and the median BMI was 31. Median operating time was 313 min, and hospital stay was 4 days. Morbidity was 26% (Clavien–Dindo 1: $n=4$ and $2+3b$: $n=2$).

Conclusion With the laparoscopic TAR, it was possible to treat a series of patients with ventral incisional hernias. The operating times were long. However, with a low rate of perioperative complications the hospital stay was short As feasibility is demonstrated, the clinical relevance of the method has to be further evaluated.

Keywords Incisional hernia · Minimally invasive surgery · Extraperitoneal mesh · Robotic surgery · Laparoscopic TAR

Introduction

The Rives–Stoppa sublay technique has been adopted by the Americas Hernia Society as the gold standard procedure for ventral and incisional hernia repair [1]. An analysis of the Herniamed Registry found that the open sublay procedure with retrorectus mesh placement accounted for 41.4% in 2019 for the largest proportion of all procedures in incisional hernia repair [2]. In a systematic review and meta-analysis including 93 studies with 12,440 non-complex ventral abdominal wall hernias, the surgical site infection (SSI) rate and seroma rate were each estimated to be 5.2% [3]. The recurrence rate after 12 months was 3.2% and after 24 months 4.1% [3].

Sublay placement of the mesh has the lowest risk of recurrence and SSI in open ventral and incisional hernia repair [4].

Since the Rives–Stoppa technique has its limitation in more complex ventral and incisional hernias with larger defect width, the procedure can be expanded by component separation (CompSep).

The anterior component separation (ACS) technique was published in 1990 by Ramirez et al. [5]. CompSep was improved by the posterior component separation (PCS) with transversus abdominis release (TAR) in 2012 by Novitsky et al. [6] (Fig. 1).

ACS and PCS are both complex and require special expertise. It must be stated that, while in the previously mentioned Herniamed analysis CompSep accounted for a smaller proportion of < 5%, these techniques are nowadays of relevance for every hernia surgeon [2]. The TAR, in the technique described by Novitsky, set a major milestone in

✉ H. Riediger
Hartwig.Riediger@vivantes.de

1 Department of Surgery, Vivantes Humboldt Hospital, Academic teaching Hospital of Charité University Medicine, Am Nordgraben 2, 13509 Berlin, Germany

2 Department of General and Visceral Surgery, Faculty of Medicine, Medical Center, University of Freiburg, Freiburg, Germany

3 StatConsult GmbH, Magdeburg, Germany

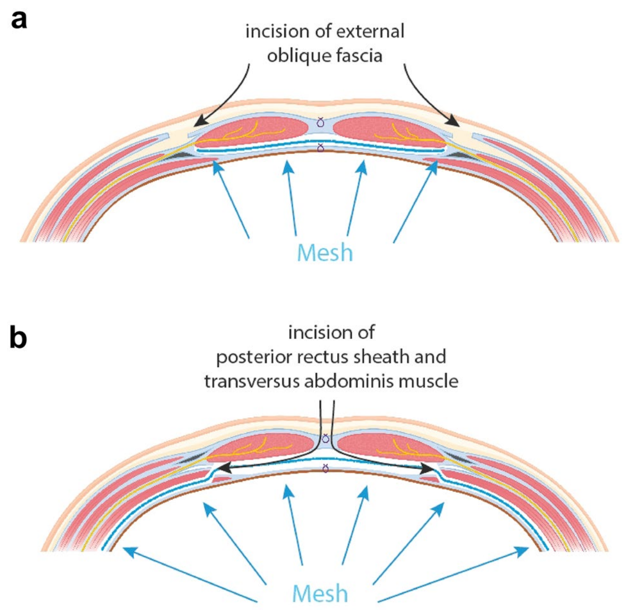

Fig. 1 Comparison of open access and mesh width in **a** anterior and **b** posterior component separation. **a** Mesh width is limited to the retrorectus space in ACS. **b** Mesh width and also length can be extended in TAR. In laparoscopic TAR, the access to the retrorectus layer and TAR is performed through the abdominal cavity

hernia surgery, because it represented an innovative way of creating an extraperitoneal space (Fig. 1b).

A major drawback of open component separation is the increased risk of wound complications. By expanding the procedure with CompSep, the risk can rise to 10% for PCS and to 20% for ACS [7]. A recent meta-analysis of 22 studies with 5,284 patients who had undergone open PCS found a rate of wound complications requiring reoperation of 9.8%, and an overall complication rate of, as high as, 33% [8]. Therefore, there is an urgent need to minimize the access route.

A minimally invasive surgical (MIS) approach can reduce wound complications, as demonstrated by a direct comparison of MIS techniques with CompSep [9]. Besides, minimally invasive access for ACS has long been recommended in the guidelines [10]. However, for PCS a different tactical surgical approach is needed. According to recent reports, robotic technology can pave the way for innovative abdominal wall reconstruction with TAR for ventral and incisional hernias. Such procedures can be performed with low morbidity [1, 11, 12]. With improved safety of the method, even very short hospital stays can be achieved [13–15]. Robotic surgery is likely to play an important role in the treatment of these patients.

In view of the data outlined, the lack of access to a robotic system presents a dilemma. Hence, we deemed a conventional laparoscopic approach to be one way to avoid open surgery for our patients. Conventional laparoscopic abdominal wall reconstruction with TAR is a technique that so far has been reported only for a limited number of cases. The first series reporting on three cases was published by Belyansky et al. [16]. Subsequently, we now report our initial experience with the laparoscopic TAR with regard to the technique and early outcome.

Patients and methods

In the period 3/2020–11/2021, 23 consecutive patients with ventral incisional hernias were operated on with a conventional laparoscopic technique. The procedure is performed transperitoneally. The following steps are part of the procedure: (1) transperitoneal adhesiolysis from the anterior abdominal wall, (2) development of the retrorectus layer, (3) transversus abdominis release together with the cave of Retzius and fatty triangle, (4) reconstruction of the posterior fascia plane, (5) reconstruction of the anterior fascia plane, (6) extraperitoneal mesh placement. All patients were seen preoperatively by at least one qualified hernia surgery specialist (FEBS/AWS) and prepared for the operation.

Technical instruments/equipment and patient positioning

The procedures were performed in a multimedia operating room (OR) equipped with monitors in all four directions. The patient's arms were tucked at the sides to assure unimpeded access from both sides. We used only discrete patient hyperextension (10°–20°). Spreading the legs was important to permit operations also in the patient's body axis. All patients were fitted with a urinary catheter.

Figures 2 and 3 present important elements of the technique. Based on patient positioning and port placement, it is possible to change the working directions by 360°. This provides for the effective and safe release of both sides and for suturing under optimal vision in the longitudinal axis. Surgical measures are performed from both sides.

Surgical concept

The first 12 mm trocar (orange arrow, Fig 3a) is placed under direct vision at Palmer's point in the left upper abdomen. It will be possible later to easily introduce even large meshes via the 12 mm trocar. Further trocars are placed in a similar way as shown in Figure 3. The exact number of trocars may vary. In any case, the release phase should be performed transversely, and the suture phase longitudinally, to the body axis. Complete adhesiolysis from the anterior abdominal wall should be conducted before the actual abdominal wall reconstruction. Bowel adhesiolysis should be done with cold scissors.

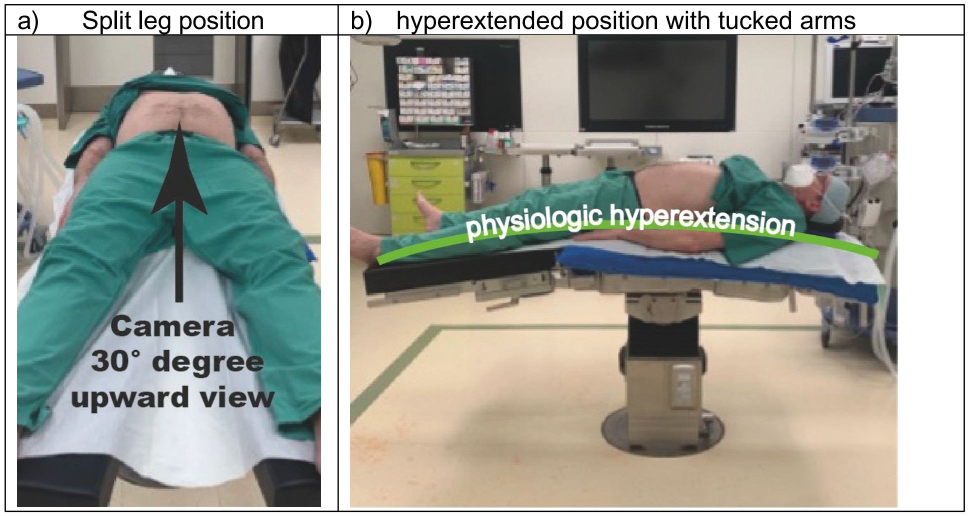

Fig. 2 Recommended patient position for laparoscopic TAR surgery. Positioning with split legs allows an improved camera position when suturing the layers of the abdominal wall. Hyperextension is limited to a moderate and physiologic extent

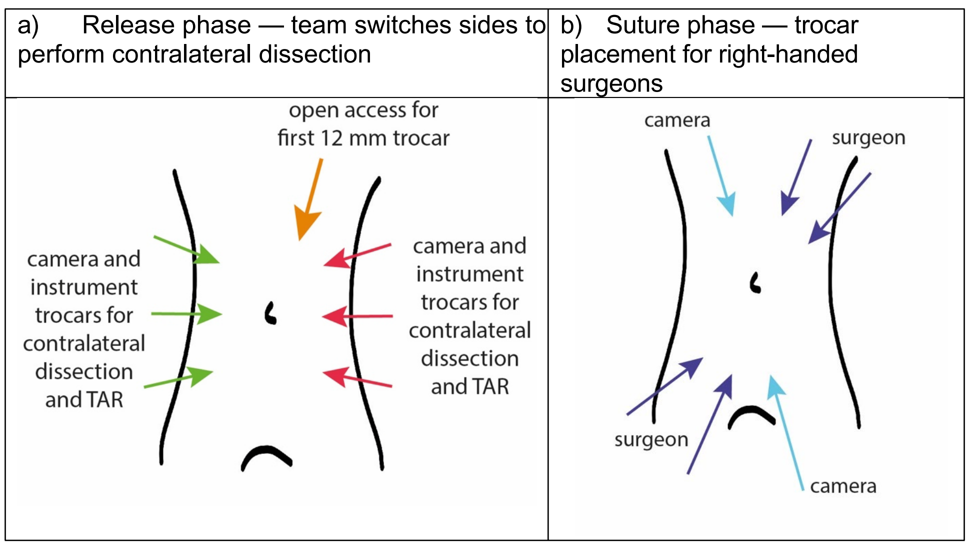

Fig. 3 Recommended port placement for release and suture phase in laparoscopic TAR surgery, (orange arrow: initial open access with 12 mm trocar)

Phase 1 (release phase): the contralateral side is dissected in each case at first. At the medial edge of the rectus fascia the retrorectus space must be opened and developed for transversus abdominis release. In this way, the subxiphoid space and retrosymphysis cave of Retzius are also accessible. The opposite side is developed in an identical manner. By the end of the release phase, the single-layer musculo-fascial abdominal wall is divided into two layers (an anterior (muscle) and a posterior (fascia) plane).

Phase 2 (suture phase): camera position is needed close to the costal arch, the symphysis and the midline for the reconstruction. In this way, first the posterior and then the anterior plane are closed with continuous sutures. For the anterior reconstruction, the hernia sac is gathered with and is used for the restoration of the linea alba. Robust barbed sutures (0 or 1) and a 10 mm needle holder are recommended for posterior and anterior midline reconstruction.

An uncoated polypropylene mesh is inserted for reinforcement into the newly fashioned extraperitoneal space between the posterior and anterior planes. Normally, this measures 30 × 30 cm. Fixation of the mesh is not performed. A wound drain is omitted.

The data on the patients and procedures were prospectively documented in the Herniamed Registry and retrospectively analyzed. All patients gave their informed consent for the documentation of their data in Herniamed.

Results

Perioperative clinical data on laparoscopic TAR patients (n = 23): the median patient age was 68 years. The median BMI was 31 kg/m^2 (25–40). A median hernia location was present in 20 cases, a lateral location in two cases and a combined location in one case. The majority of median hernias (70%) were located in the periumbilical region M2–M4. In seven cases the hernias extended to the midline endpoints (M1 $n = 3$ and M5 $n = 4$). Defect size was < 4 cm ($n = 1$), 4–10 cm ($n = 5$) and > 10 cm ($n = 17$). The smallest hernia of this series was 1 × 2 cm and was fixed with unilateral TAR using 9 × 13 mesh. One of the largest is shown in Fig. 4 as an example of a W3 hernia. Depending on defect size and location, uni- or bilateral laparoscopic TAR was performed.

With a median operating time of ~ 5 h, the procedures were very time consuming. The length of hospital stay was 3 days (median). No patient needed postoperative surveillance at the intensive care unit. There were no bowel injuries during adhesiolysis. The postoperative morbidity was 26% ($n = 6$), with 4/6 having the lowest grade in the Clavien–Dindo (C–D) classification. Because of a lung embolism, one patient needed treatment with anticoagulants but no further interventions. Another patient needed a blood transfusion due to a retroperitoneal hematoma but no further interventions. Another patient with a subcutaneous abscess needed local vacuum therapy under general anesthesia. Re-laparoscopy or re-laparotomy was not necessary in any case (Table 1).

The case of a patient with a history of complicated sigmoid diverticulitis is explained stepwise in the attached

Fig. 4 Pre- and postoperative example of a patient with ventral incisional hernia. Treatment with laparoscopic TAR surgery: defect size: 20 × 15 cm, mesh size: 30 × 30 cm, operating time: 420 min, hospital stay: 8 days

Table 1 Perioperative outcomes following laparoscopic incisional hernia repair (laparoscopic TAR technique; $n = 23$)

	Bilateral TAR ($n = 18$)	Unilateral TAR ($n = 5$)
Defect size in cm (median, range)		
Length	17 (6–25)	6 (1–9)
Width	10 (6–20)	5 (2–8)
Mesh size in cm (median, range)		
Length	30 (25–30)	20 (9–30)
Width	30 (20–30)	20 (13–25)
Operating time in min (median, range)	315 (130–493)	229 (178–334)

	All patients ($n = 23$)
Hospital stay in days (median, range)	3 (3–13)
Morbidity	26%
Dindo Clavien 1	$n = 4$ (antibiotics, anticoagulants)
Dindo Clavien 2	$n = 1$ (blood transfusion)
Dindo Clavien 3b	$n = 1$ (local vacuum treatment)

video and preoperative and postoperative images are shown in Fig. 4.

Discussion

The clinical case series reported here demonstrates that posterior component separation (PCS) with transversus abdominis release (TAR) can be performed with adequate safety in the laparoscopic technique. No complication requiring reoperation occurred in this patient series. Nor did Belyansky et al. report any perioperative complication in his three cases [16]. While Burdakov et al. reported on 100 endoscopic PCS-TARs, of these only 30 cases were performed as laparoscopic bilateral TAR and four as laparoscopic unilateral TAR. The other 66 cases were classified as eTEP-TARs. For further studies, it might be of interest that some surgeons modify the eTEP (extended total extraperitoneal prosthesis) procedure as an eTEP access to the abdominal cavity. The perioperative complication rates were reported by Burdakov et al. only for the entire collective and not separately for the surgical procedure. The early postoperative complication rate was reported to be 7% and the late complication rate was 4%. One hematoma had to be cleared surgically. Four patients contracted a retromuscular space infection. All patients were cured conservatively and removal of the implant was not required [17]. Masurkar et al. reported 89 laparoscopic TAR procedures for 26 primary ventral hernias, 63 incisional hernias and 22 recurrent hernias. He used a so-called TARM procedure with transverse access to the abdominal wall. For three patients (3.4%) conversion to open sublay operation was needed. A mesh infection occurred in one case (1.1%) and the mesh had to be explanted [18]. Binggen et al. reported on a laparoscopic PCS-TAR for a complex abdominal wall hernia without postoperative complication [19]. Hence, at present, data are available on a total of 147 patients with laparoscopic PCS-TAR for ventral and incisional hernia repair. The perioperative outcomes demonstrate that provided the surgeon has commensurate experience in endoscopic surgery, laparoscopic posterior component separation with transversus abdominis release can be performed with adequate safety.

On comparing the perioperative outcomes of open with laparoscopic posterior component separation with transversus abdominis release, one systematic review found for the open procedure a surgical site occurrence (SSO) rate of 21.72%, a complication-related reoperation rate of 9.82% and an overall postoperative complication rate of 33.34% [8]. Even if the results can only be compared to a limited extent, the laparoscopic TAR procedures were found to have a lower perioperative complication rate. As such, here too, the effect of minimally invasive surgery with a reduction of the perioperative complication rates can be seen. Likewise, a comparison of the perioperative complication rates in open versus robotic posterior component separation with transversus abdominis release identified for the robotic minimally invasive procedure a significantly lower SSO rate (5.3 vs 11.5%, OR 0.669.95% CI 0.307–1.458, $p = 0.02$) and postoperative complication rate (9.3 vs 20.7%, OR 0.358, 95% CI 0.218–0.589, $p < 0.001$) [1]. Hence, both conventional laparoscopic and robotic technique seem to be able to significantly reduce perioperative complication rates for minimal-invasive TAR.

Posterior component separation is complex and entails long operating times for open, robotic and laparoscopic procedures [1, 11, 15]. In our own case series, the median operating time was 313 min with a range of 130–493 min. Belyansky et al. reported a mean operating time of 329 min for his three cases [16]. Burdakov et al. reported the operating times only for the eTEP and laparoscopic PCS-TAR together, with a mean operating time of 203 min [17]. Masurkar et al. reported a mean operating time of 192 min [18]. The operating time in the case reported by Binggen et al. was 365 min [19]. Important influencing factors for the operating time are no doubt the defect sizes and the mesh sizes used. In our own case series, the median defect size was 150 cm^2 and the median mesh size 900 cm^2. Masurkar et al. reported for their patient cohort a mean defect size of 110 cm^2 and a mean mesh size of 392 cm^2 [18]. That might explain the differences in the operating times between the various patient collectives undergoing laparoscopic TAR.

However, the open and robotic TAR procedures are also associated with relatively long operating times. The robotic TAR entails a significantly longer operating time than the open technique [1]. Dewulf et al. reported a mean operating time of 242 minutes for the robotic TAR [13]. In a single-center series of 1203 open TARs, the operating time for 28% of patients was longer than 240 min [20]. In one systematic review and meta-analysis that compared open ACS with TAR, the mean operating time for TAR was 249.92 ± 47.92 min [21]. This demonstrates that while the operating times for the laparoscopic and robotic TAR are longer, they are not significantly much longer. In this regard, the surgeon's experience as well as the defect size must be taken into account. Therefore, significantly more studies and data are needed for a definitive evaluation.

Despite the longer operating times, the median hospital stay in our patient collective was very low at 3 days. Belyansky et al. reported for his PCS-TAR cases a hospital stay of 4.7 days [16]. Burdakov et al. reported a hospital stay of 4.6 days for the entire eTEP and laparoscopic TAR collective [17]. In the Masurkar et al. case series the mean hospital stay was 5 days [18]. On comparing robotic with open PCS-TAR, Dewulf et al. identified a significantly lower hospital stay for the minimally invasive technique (3.4 days vs 6.9 days, $p < 0.001$) [13].

Similarly, in one systematic review with meta-analysis that compared robotic vs open PCS-TAR a significantly lower hospital stay was seen for the robotic technique (SMD—4.409.95%—6.000 + 2.818, $p < 0.001$) [1]. In another systematic review, the hospital stay following laparoscopic or robotic TAR was 2.4 ± 1.4 days [9]. Hence, the available data attest to a reduction in hospital stay for laparoscopic or robotic TAR. This demonstrates also in the case of complex TAR the positive effects conferred on the patients by the minimally invasive procedure.

One limitation of the above statements that must be pointed out is the paucity of comparative studies. Besides, often only the early results are known because of the lack of follow-up data. Therefore, there is an urgent need for further comparative studies with patient follow-up. Comparing the outcome of our study with only 23 operated cases with meta-analysis and systematic reviews has also to be viewed critically.

In summary, based on the available data it can be stated that laparoscopic TAR can be performed with an acceptable risk for the patients if the surgeon has commensurate experience in complex hernia surgery and minimally invasive surgery. The perioperative complication rate seems to be lower than that of open TAR. Compared with the open procedure, the operating times for laparoscopic and robotic TAR are acceptably longer. However, the hospital stay associated with minimally invasive techniques is relevantly shorter. This demonstrates the benefits of minimally invasive techniques for the patients. If no robot is available, laparoscopic TAR with potentially lower perioperative complications and a shorter hospital stay appears to be the better alternative to the open procedure. Further data are urgently needed to reach a final decision on this.

Author contributions HR contributed to the study design, draft preparation, data curation and writing of the paper, PH contributed to the analysis and reviewing of the manuscript, LK contributed to data curation and formal analysis, CG contributed to reviewing this manuscript, UA contributed to the study design, DA contributed to the statistical analysis, FK contributed to study design, statistical analysis, writing and reviewing of the manuscript. All authors read and approved the final paper.

Data availability The data that support the findings of this publication are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest All authors declare that they have no financial or non-financial interests that are directly or indirectly related to the submitted work.

Ethical approval All authors certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki. All cases were documented in the Herniamed Registry and all patients have signed a special informed consent declaration agreeing to participate. The Herniamed Registry has ethical approval (BASEC No. 2016-00123, 287/2017 B02).

Human and animal rights The publication of all photographs was authorized by the individuals presented through their written informed consent.

Informed consent All individuals who are displayed in this publication gave written informed consent to the publication of their images.

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