

# Needlescopic Surgery Versus Single-port Laparoscopy for Inguinal Hernia

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## ABSTRACT

**Background and Objectives:** In recent years, 2 modifications of laparoscopic transabdominal preperitoneal (TAPP) inguinal hernia repair—needlescopic (nTAPP) surgery and single-port (sTAPP) surgery—have greatly improved patient outcomes over traditional approaches. For a comparison of these 2 modifications, we sought to investigate and compare the extent of surgical trauma and postoperative consequences for the abdominal wall in these two procedures.

**Methods:** In a retrospective study, 50 nTAPP and 35 sTAPP procedures occurring at a community hospital from November 1, 2009, through July 31, 2012 were reviewed. Intraoperative data, including length of the umbilical skin incision and operative time, were recorded. A follow-up evaluation included investigation of hernia recurrence, postoperative pain, abdominal wall mobility, cosmetic satisfaction, and period of sick leave.

**Results:** The mean umbilical skin incision was  $13 \pm 4$  mm in nTAPP vs  $27 \pm 3$  mm in sTAPP ( $P < .001$ ). The nTAPP procedure required less operating time than the sTAPP procedure ( $54.8 \pm 16.9$  minutes vs  $85.9 \pm 19.7$  minutes;  $P < .001$ ). The mean immediate postoperative pain score on the visual analog scale was  $2.7 \pm 2.1$  in the nTAPP group and  $4.4 \pm 1.9$  in the sTAPP group ( $P = .016$ ). In addition, patients who underwent nTAPP had a shorter period of sick leave ( $11.2 \pm 8.4$  days vs  $24.1 \pm 20.1$  days;  $P = .02$ ). At the follow-up evaluation after approximately 30 months, abdominal wall mobility and cosmetic satisfaction were equally positive, with no hernia recurrence.

**Conclusion:** In patients with uncomplicated inguinal hernia, the nTAPP procedure, with less surgical trauma and operating time, has distinct advantages in reduction of immediate postoperative pain and sick leave time.

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**Key Words:** Inguinal hernia, Needlescopic surgery, Single-incision laparoscopic surgery, Transabdominal preperitoneal repair.

## INTRODUCTION

To date, laparoscopic transabdominal preperitoneal (TAPP) mesh repair has been regarded as one of the standard treatments for inguinal hernia in adults. Recurrence rates after TAPP repair have been reported to be lower than 1%.<sup>1,2</sup> However, patients who undergo the procedure experience a significantly higher incidence of early postoperative pain, which is associated with subsequent chronic pain.<sup>3</sup> Surgical trauma to the abdominal wall, mesh implantation, and mesh fixation in the groin region have been indicated as possible causes of the pain. The ideal mesh material is still being debated, but mesh fixation with fibrin glue or the alternate choice of self-fixating mesh with microhooks has obvious advantages in reducing chronic groin pain.<sup>1</sup> In the context of surgical tissue trauma at trocar sites, guidelines suggest that the use of a 10-mm trocar in the umbilical region or in the oblique abdominal wall predisposes patients to local nerve or vessel injury and port-site hernia.<sup>1</sup> Thus, an improvement in current laparoscopic hernia surgery has been the further reduction of the size of the abdominal wall incision for trocar insertion.<sup>4</sup> Modified TAPP repairs by needlescopic surgery (nTAPP), with the use of smaller trocars than the standard 10-mm optical trocars and 5-mm working trocars, have been shown to be superior in patient outcomes over conventional TAPP repairs.<sup>5,6</sup> Also TAPP repairs in single-incision laparoscopic surgery (sTAPP), with a reduction in the number of ports to only 1 umbilical port, have been put forward with good initial results.<sup>7,8</sup> However, a direct comparison between these 2 advanced minimally invasive approaches is still missing. The purpose of this study was to compare the perioperative extent of surgical trauma and its postoperative impact on the abdominal wall after nTAPP and sTAPP repair.

## MATERIALS AND METHODS

### Patients and Data Collection

For this retrospective cohort study with institutional review board approval, 85 patients with a single-sided primary inguinal hernia were recruited at a community hospital between November 1, 2009, and July 31, 2012. In this period of 32 months, 50 patients underwent nTAPP mesh repair, and 35 had an sTAPP procedure. Demographic and surgical data, including gender, age, body mass index, location and size of the inguinal hernia, length of the umbilical skin incision for the trocar port, operative time, and length of hospital stay were retrospectively retrieved from surgical records. On postoperative day 3, all patients were scheduled for a wound check and removal of skin staples. In October 2013, the patients were asked to complete a questionnaire and undergo a physical examination in the outpatient clinic. The following information was then recorded: hernia recurrence; postoperative pain, according to the visual analog scale (VAS) (0 = no pain; 10 = worst pain); postoperative mobility of the abdominal wall, determined by Janda's test, a sit-up exercise (0 = no recovery of normal muscle power; 5 = full recovery of normal muscle power)<sup>9</sup>; postoperative cosmetic satisfaction, according to the cosmetic VAS (0 = completely dissatisfied; 10 = completely satisfied); and period of sick leave after hospital discharge for employed workers.

### Surgical Technique

The operative procedure in laparoscopic TAPP mesh repair was described in depth in our previous study.<sup>5</sup> In brief, it involved establishing pneumoperitoneum, dissecting the peritoneal flap and the preperitoneal space with an electric hook, placing a 15 × 9-cm Parietene ProGrip self-fixating monofilament polypropylene mesh (Covidien, Dublin, Ireland), and closing the peritoneal flap with a V-Loc barbed suture (Covidien). In the nTAPP group, the length of the transverse skin incision at the umbilicus was first measured, and an 8-mm trocar was inserted for the use of a 5-mm optical instrument. Under optical view, a 5-mm trocar for the electric hook on the right side of the abdomen and a 2-mm trocar for the grasping forceps on the left side of the abdomen were placed at the level of the umbilicus on the midclavicular line. In the sTAPP group, the umbilical skin incision length was also first measured, and a GelPoint advanced-access platform (Applied Medical, Rancho Santa Margarita, California) was placed through the umbilicus. A 5-mm optical trocar and two 5-mm working trocars were then positioned in this single-

port-access device. All nTAPP and sTAPP instruments were straight. The self-fixating Parietene ProGrip mesh, with microhooks on its underside, was folded in a special manner, as demonstrated in our previous publication.<sup>5</sup> It was then inserted into the abdominal cavity through the 8-mm umbilical trocar in the nTAPP group or through the 5–10-mm compatible cannula of the GelPoint advanced-access platform in the sTAPP group. Once hernia repair was completed, the umbilical wound was closed with an absorbable fascia suture and skin staples in all nTAPP and sTAPP procedures. The lateral 5- and 2-mm trocar wounds in the nTAPP group were closed with Steri-Strips adhesive skin closures (3M Health Center, St. Paul, Minnesota). No local anesthetic was applied in the umbilical wound regions. All operations were performed on an elective basis in patients under general anesthesia by the same experienced surgeon.

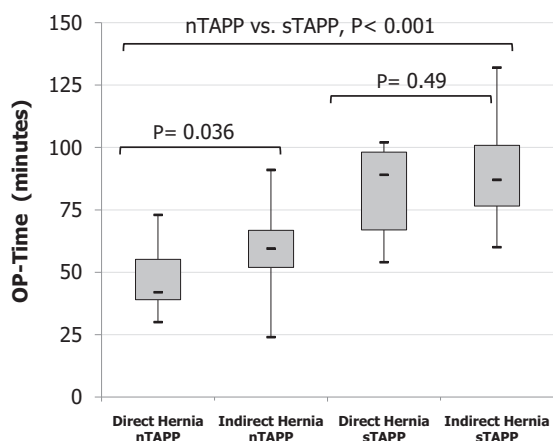
### Statistical Analysis

SPSS 22 for Windows (IBM Corp., Somers, New York) was used for statistical analysis. Data are expressed as percentages for categorical variables and as the mean ± SD for continuous variables. Comparisons between the 2 operative approaches were performed with the  $\chi^2$  test and Student's *t* test, as applicable. All statistical tests were 2-sided, with *P* < .05 indicating statistical significance.

## RESULTS

### Perioperative Outcomes

Patient characteristics in the nTAPP and sTAPP groups were comparable at baseline (male:female 5.4:1 vs 5.3:1; age 52.5 y vs 48.3 y; BMI 25.3 kg/m<sup>2</sup> vs 24.4 kg/m<sup>2</sup>; direct:indirect:pantaloon hernia, 32:58:10% vs 31.4:54.3:14.3%; and hernia diameter, 2.4 cm vs 2.3 cm). There were no intraoperative complications or technique conversions at the time of surgery. Only 2 patients in the sTAPP group required an additional 5-mm trocar port in the lateral abdomen, to create a better view of the operative field. The mean measured umbilical skin incision length was 13 ± 4 mm in the nTAPP group, compared with 27 ± 3 mm in the sTAPP group (*P* < .001). The nTAPP procedure required significantly less operating time than the sTAPP procedure (nTAPP 54.8 ± 16.9 minutes vs sTAPP 85.9 ± 19.7 minutes; *P* < .001). The reduction in operative time was particularly seen in cases of direct hernia (**Figure 1**). The mean length of postoperative hospital stay was 1.8 ± 0.7 days for the nTAPP group and 2.0 ± 0.9 d for the sTAPP group (*P* = .21). By the time of the wound check



**Figure 1.** Operative time of nTAPP and sTAPP hernia repair. The mean operative time for a direct or an indirect hernia was significantly shorter in nTAPP repair (direct: nTAPP 47.1 minutes vs sTAPP 82.5 minutes;  $P < .001$ ; indirect: nTAPP 59.4 minutes vs sTAPP 88.7 minutes;  $P < .001$ ).

on postoperative day 3, one patient in the sTAPP group had a superficial hematoma in the umbilical region that required only conservative treatment. There were no early postoperative complications in the nTAPP group.

### Postoperative Outcomes

After a mean follow-up time of 33.5 months for the nTAPP group and 30.1 months for the sTAPP group, 40 nTAPP patients (80%) and 26 sTAPP patients (74%) were re-examined in the outpatient clinic. The remaining patients returned their questionnaires or were interviewed by telephone. Neither inguinal nor port-site hernia occurred in either group. Regarding immediate postoperative pain, there was a tendency for longer pain duration in the wound region after the sTAPP procedure (nTAPP,  $5.6 \pm 5.5$  days vs sTAPP  $9.8 \pm 8.4$  days;  $P = .072$ ). Also sTAPP patients experienced greater wound pain intensity when they began to resume their regular daily activities after hospital discharge (nTAPP  $2.7 \pm 2.1$  VAS vs sTAPP  $4.4 \pm 1.9$  VAS;  $P = .016$ ). One patient in the nTAPP group had chronic discomfort, with paresthesia in the groin region. One patient in the sTAPP group developed postherniorrhaphy pain syndrome and remained on paid sick leave at home for approximately 2 months. At the time of the follow-up examination, both groups achieved similar results in Janda's clinical test for abdominal wall mobility (nTAPP  $4.7 \pm 0.5$  vs sTAPP  $4.1 \pm 1.1$ ;  $P = .101$ ). However, 7 (20%) patients who underwent sTAPP repair noted a subjective deterioration in abdominal wall mobility in the questionnaire, whereas no patients who underwent nTAPP

repair had such an experience. Cosmetic satisfaction was equally high, with a VAS score of  $9.7 \pm 0.6$  in the nTAPP group and  $9.6 \pm 0.7$  in the sTAPP group ( $P = .836$ ). Sick leave records showed that the nTAPP group had a significantly shorter mean period of sick leave, compared with the sTAPP group (nTAPP  $11.2 \pm 8.4$  days vs sTAPP  $24.1 \pm 20.1$  days;  $P = .02$ ). Notably, even with cessation of postoperative wound pain, 27 nTAPP patients (54%) and 32 (sTAPP patients 91.4%) remained on sick leave at the follow-up assessment ( $P = .045$ ).

### DISCUSSION

In the present study, only patients with uncomplicated inguinal hernias without strangulation or acute pain were included in the investigation, to avoid the possibility that memory of preoperative pain would influence the postoperative pain assessment. Also needlescopic trocars and instruments, per se, are not suitable for bowel resections and removal of any extensive tissue from the abdominal cavity. To avoid technical errors and the effects of the learning curve, the operating surgeon in this study was experienced, having performed approximately 20 nTAPP repairs with an 8-mm optical trocar and two 5-mm working trocars. Before the study, the same surgeon had also performed at least 20 single-incision laparoscopic surgeries for inguinal hernia or cholecystectomy. The results presented in this study should therefore apply to cases involving common hernia and treatment by an experienced surgeon.

For the assessment of perioperative surgical trauma to the abdominal wall, we focused on the umbilical skin incision length and total operative time for each procedure. In the nTAPP group, a larger (8-mm) umbilical trocar was placed, despite the use of a 5-mm optical instrument. The purpose was to allow for gentle mesh insertion without inadvertent adherence of the folded Parietene ProGrip mesh to itself within the trocar cannula. Still, the incisional trauma at the umbilicus in sTAPP patients was twice that in nTAPP patients. Although we encountered only 1 sTAPP patient with postoperative hematoma, there is evidence that a longer surgical skin cut in single-incision laparoscopic surgery is associated with wound complications.<sup>10</sup> Furthermore, the operative time for sTAPP repair of a unilateral hernia (85 minutes) was also significantly longer on average than that required for nTAPP (54 minutes) or conventional TAPP (60 minutes in our previous publication) repair.<sup>5</sup> The increased operative time for sTAPP repair indicates an increase in technical difficulty without obvious benefits in surgical capability, as 2 sTAPP cases (5.7%) in our study still needed an additional working trocar for the creation of a sufficient preperitoneal space.

As mentioned in the literature, operative difficulties for single-incision laparoscopic surgery lie in the lack of triangulation and the restricted movement of surgical instruments.<sup>4</sup> In this study, we did not use curved or articulating instruments to improve triangulation in the sTAPP procedure, as such instruments would add another factor of variation of surgical equipment between the 2 procedures. One concern regarding the nTAPP instruments arose in relation to the 2-mm grasping forceps. The smaller jaws and lesser contact area would theoretically exert more force and tear tissue, particularly under the control of the nondominant left hand in our study. However, such an injury did not occur during dissection in any patients. Some surgeons in our department prefer to perform nTAPP repairs with one 5-mm optical trocar and two 5-mm working trocars, with mesh fixation via absorbable tacks and closure of the peritoneum via extracorporeally knotted running sutures. Particularly in such procedures, no fascial closure (a potential source of postoperative wound pain) was needed for the 5-mm trocar wounds. Such nTAPP repair variation also seems to be safe and feasible, according to unpublished data. Concerning technique variations in single-incision laparoscopic surgery, one study group reported using a single skin incision with 3 separate adjacent fascia punctures in laparoscopic ventral hernia operations.<sup>11</sup> This single-incision multiport technique reduces incisional trauma on the abdominal wall, but preformed proximate fascia defects still have a greater potential to cause a “Swiss cheese” hernia.<sup>12</sup>

Apart from investigating the surgical trauma in nTAPP and sTAPP repair, we investigated postoperative pain, mobility, and cosmesis of the abdominal wall, as well as length of sick leave. We found that the nTAPP procedure was able to further reduce immediate postoperative pain in wound regions. These results of wound pain reduction in nTAPP repair are in concurrence with available studies comparing pain experienced after needlescopic and conventional laparoscopic inguinal hernia repair.<sup>5,13</sup> In contrast, a current review referenced 4 available sTAPP trials and could not verify superiority in pain reduction over conventional TAPP repair.<sup>14</sup> However, reduction of postoperative wound pain in patients who underwent nTAPP did not significantly improve incidence of chronic groin pain. Such pain still occurred in 2% of our nTAPP group, compared with 2.8% in the sTAPP group. Moreover, functional mobility of the abdominal wall is the result of intact motor activity and simultaneous load transfer. Scar tissues with less loading capacity at the umbilicus in the midline therefore suggests a mechanical mismatch in the latter component and predisposes the patient to a functional impairment of the abdominal wall.<sup>15</sup> Despite the greater

extent of such scar tissue in the sTAPP group, the groups regained equal abdominal wall mobility and satisfactory cosmetic results after an approximate observation time of 30 months. We were also able to demonstrate a significantly shortened sick leave period after nTAPP. Taking into account the length of hospital stay added to the subsequent sick leave days, the total time until return to work in the nTAPP group was half that in the sTAPP group. It is also worth noting that more sTAPP than nTAPP patients remained on sick leave, even with an absence of postoperative wound pain. There are nonetheless multiple factors that influence the period of sick leave, including psychological factors related to the larger scar caused by sTAPP repair. Finally, such patient-related outcomes in pain, cosmetic satisfaction, and length of disability are motivation dependent and therefore are subjective measurements. This effect is especially seen in our data on pain duration and sick leave time, with high standard deviations indicating more polarized responses.

## CONCLUSION

In a direct comparison of 2 advanced techniques for laparoscopic TAPP hernia repair, the nTAPP procedure with smaller caliber trocars can further minimize surgical trauma to the abdominal wall tissue. It also requires significantly less operating time than the sTAPP procedure, as it still adheres to the basic principles of triangulation in laparoscopic technique. In uncomplicated hernia repair, the nTAPP procedure has distinct advantages in the immediate postoperative phase in reduced postoperative wound pain and shorter sick leave. However, it offers comparable long-term results in hernia recurrence, abdominal wall mobility, and cosmetic satisfaction. Randomized controlled trials comparing nTAPP, sTAPP, and conventional TAPP repairs are still needed to validate the benefits of needlescopic surgery.

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