

# Laparoscopic transabdominal preperitoneal inguinal hernia repair using needlescopic instruments: a 15-year, single-center experience in 317 patients

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## Abstract

**Background** Laparoscopic inguinal hernia repair is associated with a decrease in postoperative pain, shortened hospital stay, earlier return to normal activity, and decrease in chronic pain. Moreover, laparoscopic surgery performed with needlescopic instruments has more advantages than conventional laparoscopic surgery. However, there are few reports of large-scale laparoscopic transabdominal preperitoneal inguinal hernia repair using needlescopic instruments (nTAPP). This report reviews our experiences with 352 nTAPP in 317 patients during the 15-year period from April 1996 to April 2011.

**Methods** We performed nTAPP as the method of choice in 88.5% of all patients presenting with inguinal hernia. To perform the nTAPP, 3-mm instruments were used. A 5-mm laparoscope was inserted from the umbilicus, and surgical instruments were inserted through 5- and 3-mm trocars. After reduction of the hernia sac and dissection of the preperitoneal space, we placed polyester mesh or polypropylene soft mesh with staple fixation. The peritoneum was closed with 3–0 silk interrupted sutures.

**Results** The mean operative time was 102.9 min for unilateral hernias and 155.8 min for bilateral hernias. There was no conversion to open repair. Forty-three patients (13.6%) used postoperative analgesics, and the

mean frequency of use was 0.5 times. Regarding intraoperative complications, we observed one bladder injury, but no bowel injuries or major vessel injuries. Postoperative complications occurred in 32 patients (10.1%). One patient with a retained lipoma required reoperation. There was no incidence of chronic pain or mesh infection. The operative time for experienced surgeons ( $\geq 20$  repairs) was significantly shorter than that of inexperienced surgeons ( $< 20$  repairs;  $P < 0.05$ ).

**Conclusions** The nTAPP was a safe and useful technique for inguinal hernia repair. Large prospective, randomized controlled trials will be required to establish the benefit of nTAPP.

**Keywords** Inguinal hernia repair · Laparoscopic surgery · Needlescopic instruments · Transabdominal preperitoneal approach

Inguinal hernia repair is one of the most common surgical procedures. Laparoscopic inguinal hernia repair was introduced in the early 1990s, and it is reportedly superior to open mesh repair in terms of a decrease in postoperative pain, shortened hospital stay, earlier return to normal activity, and decrease in postoperative chronic pain in meta-analysis studies and systematic reviews [1–4].

Laparoscopic transabdominal preperitoneal inguinal hernia repair using  $\leq 3$ -mm needlescopic instruments (nTAPP) was reported in 1998 [5, 6]. We reported that nTAPP induces further reduction of postoperative pain in addition to cosmetic improvement [6]. However, the result of a large-scale study on nTAPP has not been reported.

In our department, laparoscopic transabdominal preperitoneal inguinal hernia repair (TAPP) was adapted as a standard operation for adult inguinal hernia in 1992, and

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nTAPP was introduced in 1996. We have performed more than 300 nTAPP procedures. The purpose of this study was to present our results and evaluate the usefulness of nTAPP.

## Materials and methods

### Patients

Between April 1996 and April 2011, 404 TAPP in 358 patients were performed at Hamamatsu University School of Medicine. Our indication for TAPP is Nyhus classification types III and IV [7]. Patients with contraindications for general anesthesia and those with ascites, coagulation disorders, and severe cardiopulmonary disease were excluded from TAPP.

The patients who had undergone a previous abdominal operation underwent preoperative ultrasonography. If they were diagnosed with severe intraabdominal adhesion, they underwent conventional TAPP (cTAPP) using one 12-mm trocar and two 5-mm trocars. Moreover, because of operative findings of severe preperitoneal or intra-abdominal adhesions, a few patients underwent conversion to cTAPP.

As a result, 52 inguinal hernias in 41 patients (11.5%) were excluded from nTAPP. The causes of contraindications were 13 previous lower abdominal operations, ten recurrent hernias, six irreducible hernias, five previous radical prostatectomies, four single-incision laparoscopic surgeries (SILS), and three unknown. All but SILS underwent cTAPP (Table 1).

The remaining 352 inguinal hernias in 317 patients (88.5%) were repaired by nTAPP (Table 2). There was no conversion to open repair. The mean age of the patients was  $63.7 \pm 12$  (range, 24–90) years. Eighty-eight percent of them were men. Bilateral hernias were treated in 35 patients (10%). Of the unilateral hernias, 63.8% were on the right side and 36.2% were on the left. Incidental contralateral hernias were found in 13 patients (4.4%). There were nine irreducible hernias. Prolapsed organs consisted of preperitoneal fat in four patients, omentum in three

**Table 1** Contraindications for nTAPP and numbers of each operation

Contraindications for nTAPP	cTAPP	nTAPP	Total
Previous lower abdominal surgery	13	78	91
Recurrent hernia	10	42	52
Irreducible hernia	6	9	15
Previous radical prostatectomy	5	5	10
Unknown	3	0	3
Total	37	134	171

**Table 2** Patient demographics of nTAPP

Patients	317 (352 hernias)
Age (year)	63.7 (24–90)
Male/female (%)	88/12
Unilateral hernias	282 (90%)
Right/left (%)	63.8/36.2
Bilateral hernias	35 (10%)
Irreducible hernias	9 hernias (2.6%)
Incidental contralateral hernias	13 hernias (4.4%)

**Table 3** Type of hernia

	Primary	Recurrent	Total (%)
Indirect	217	17	234 (68.6)
Direct	63	31	94 (25.8)
Femoral	7	4	11 (2.5)
Combined	12	0	12 (2.8)
Sportsman's hernia	1	0	1 (0.3)
Total	300	52	352 (100)

patients, and sigmoid colon in two patients. Because they were not strangulated hernias, we did not perform organ resection.

A total of 234 hernias (68.6%) were indirect, and 94 (25.8%) were direct (Table 3). Of the remaining hernias, 11 (2.5%) were femoral, 12 (2.8%) were combined, and 1 (0.3%) was a sportsman's hernia. There were 52 (14.8%) recurrent hernias.

### Surgical technique

The nTAPP operative technique has been previously described [6]. Under general anesthesia, a 1-cm transverse incision was made below the umbilicus. Pneumoperitoneum was induced by use of a Veress needle and maintained at 8 mmHg. A 5-mm trocar was then inserted in this site, and a 5-mm, 30° laparoscope was inserted. A 5-mm trocar was inserted at the right lateral border of the rectus abdominis muscle at the level of the umbilicus, and a 3-mm trocar (ENDOPATH access needle; Johnson & Johnson, New Brunswick, NJ) was inserted at the contralateral side. Five-millimeter scissors, dissecting and grasping forceps, and 3-mm grasping forceps (Karl Storz, Tuttlingen, Germany) were inserted through each trocar.

The peritoneum was incised from the anterior iliac spine to the lateral aspect of the plica umbilicalis medialis. The hernia sac was usually excised, but a large hernia sac was left in situ. The inguinal floor was dissected to expose Cooper's ligament, Hesselbach's triangle, and the lateral triangle. Because the maximum diameter of the trocar in our technique was 5 mm, we used soft mesh that could be

inserted from the 5-mm trocar. The mesh used was polyester mesh (Parietex, Covidien, Mansfield, MA; or LARS mesh, Meadox Medical Inc., Oakland, NJ) or polypropylene soft mesh (ProLite Ultra, Atrium Medical Co., Hudson, NH; or PROLENE Soft, Johnson & Johnson). The mesh was inserted from the right 5-mm trocar using 3-mm forceps. The mesh was fixed to Cooper's ligament, the rectus abdominis muscle, and transversus abdominis muscle with ~10 shots of tacker (AbsorbaTack or Protack). The peritoneum was closed with interrupted sutures of 3–0 silk. In cases involving difficult peritoneum closure due to severe peritoneal scarring, we used composite mesh (Bard Composix L/P mesh; DAVOL Inc., Warwick, RI) and closed the peritoneum as much as possible with sutures. Polyester mesh was used in 213 inguinal hernias, polypropylene mesh in 129, and composite mesh in 10.

Because our hospital is an educational institute, 27 surgeons of postgraduate year  $\geq 4$  performed nTAPP. One of three supervising surgeons (TK, AK, or HW) took part in all operations. Eleven surgeons performed  $<6$  nTAPP (group A), five surgeons performed 6–9 repairs (group B), six surgeons performed 10–19 repairs (group C), and five surgeons performed  $\geq 20$  repairs (group D).

#### Postoperative assessment

Postoperative analgesia (15 mg of intramuscular pentazocine or 60 mg of oral loxoprofen) was provided as requested by the patients. Patients were allowed to resume a normal diet and normal activities on the first postoperative day. The patients were discharged home on the second day by clinical pathway after March 2001. All patients were followed up at the outpatient clinic within 4 weeks after discharge. Thereafter, patients were followed up if necessary. All complications and recurrences were recorded. The average follow-up duration of all patients was 7.3 (range, 0.2–15.3 (median, 5.1) years).

#### Statistical analysis

Statistical differences between groups were determined by Student's *t* test or the  $\chi^2$  test. A *P* value  $<0.05$  was regarded as significant. Values were expressed as mean  $\pm$  standard deviation (SD).

## Results

The mean operative time was  $102.9 \pm 26.7$  (range, 47–270) minutes for unilateral hernias and  $155.8 \pm 44.3$  (range, 65–243) minutes for bilateral hernias. The postoperative hospital stay was  $2.6 \pm 1.3$  days for unilateral hernias and  $2.9 \pm 2.7$  days for bilateral hernias. Forty-

**Table 4** Intraoperative and postoperative complications

	<i>n</i>	%
Intraoperative		
Bladder injury	1	0.3
Postoperative		
Seroma/hematoma	20	5.7
Subcutaneous emphysema	4	1.1
Wound infection	1	0.3
Retained lipoma	1	0.3
Paralytic ileus	2	0.6
Urinary retention	1	0.3
Atelectasis	1	0.3
Pneumonia	1	0.3
Asthma attack	1	0.3
Total	33	10.4

three patients (13.6%) used postoperative analgesics, and the mean frequency of use was  $0.5 \pm 1.0$  times.

We saw no intraoperative bowel injury or damage to major vessels or the vas deferens. No deaths related to surgery occurred. Injury to the urinary bladder was seen in one patient (Table 4). The lesion was recognized intraoperatively, and the defect was closed with sutures laparoscopically. A transurethral catheter was inserted and left in place for 3 days. The postoperative course was uneventful.

Postoperative complications occurred in 32 patients (10.1%; Table 4). Complications related to surgery consisted of 20 seromas or hematomas, four subcutaneous emphysema, one wound infection, and one retained lipoma. Only one patient with a retained lipoma required reoperation, which involved resection of the lipoma by an anterior approach 14 months after the operation. Complications not related to surgery consisted of two paralytic ileus, one atelectasis, one urinary retention, one asthma attack, and one pneumonia. There was no incidence of chronic pain or mesh infection.

We observed a total of ten recurrences (2.8%). The recurrence rate in the early stage (before June 2004) was 4.9% (7/142) and that in the later stage (after July 2004) was 1.4% (3/210). The average recurrent duration from operation was 2.1 years (range, 0.5–9.0 (median, 1.5) years). All recurrent patients underwent TAPP and had no re-recurrence.

#### Learning curve

For unilateral hernias, the mean operative time, complication rate, and recurrence rate of each group are listed in Table 5. The operative time of group D was significantly shorter than that of all remaining groups ( $P < 0.05$ ), but

**Table 5** Learning curve of nTAPP

	Group A ( $n < 6$ )	Group B ( $6 \leq n < 10$ )	Group C ( $10 \leq n < 20$ )	Group D ( $n \geq 20$ )	
No. of surgeons	11	5	6	5	
No. of nTAPP	33	34	57	158	
* $P < 0.001$ ; group D versus group A, $P < 0.01$ ; group D versus group B, $P < 0.05$ ; group D versus group C	Operative time (min)	$114 \pm 33.2$	$111.5 \pm 36.4$	$105.2 \pm 22.5$	$97.8 \pm 22.6^*$
	Complication rate (%)	9.1	11.7	10.5	8.9
	Recurrence rate (%)	3.0	5.9	3.5	2.5

there was no significant difference in the complication rate and recurrence rate between the groups.

## Discussion

The advantages of laparoscopic repair over the open approach, including reduced postoperative pain, fewer postoperative hospital stays, earlier return to normal activity, and decreased postoperative chronic pain, have been confirmed by large-scale studies [1–4]. In recent years, the pursuit of minimally invasive surgery has given rise to the concept of natural orifice transluminal surgery (NOTES) and SILS. SILS for inguinal hernia repair has already been reported [8, 9], but it has many problems in becoming a standard operation. The major problems of SILS are the clashing of instruments and the lack of triangular formation. However, nTAPP is procedure that is similar to cTAPP.

Because needlescopic instruments bend easily at the shaft, and because the small jaws of the needlescopic instruments with their limited grasping ability hinder ideal retraction, they are unsuitable for delicate grasping and dissection of hard tissue. Therefore, it is difficult to perform nTAPP in cases with severe adhesion. In our series, many patients with postprostatectomy and irreducible hernias had to undergo conversion to cTAPP, but many patients with recurrent hernias and previous lower abdominal operations could have undergone nTAPP (Table 1). In the future, if needlescopic instruments are further developed, the indications for nTAPP will be more widespread.

Because our institute is a teaching hospital, 27 surgeons performed nTAPP in this study. However, our nTAPP results were acceptable in terms of complication and recurrence rates. In this series, we observed one bladder injury (0.3%), but no bowel injury or major vessel injury. Injury to the bladder, bowel, and major vessels during laparoscopic hernia repair has been reported at rates of 0–0.2, 0–0.3, and 0–0.11% [10]. Groin seroma/hematoma occurred in 5.7% of cases, but most resolved with conservative treatment. The rate of chronic pain after laparoscopic procedures has been reported at 6.8% (0–14.8%) [3], but we have never found chronic pain after nTAPP. The main cause may be that we have used soft and

comparatively lightweight mesh, such as polyester mesh or polypropylene soft mesh. The recurrence rate after laparoscopic herniorrhaphy has been reported at 0–10% [3]. In our 352 nTAPP, a recurrence rate of 2.8% was observed (4.9% in the early stage and 1.4% in the later stage). The average size of mesh in the early stage was  $10.9 \times 8.9$  cm, and that in the later stage was  $13.2 \times 9.2$  cm. Our results may be associated with the mesh size.

The mean operative time for unilateral nTAPP in our institute was 102.9 min, which is longer than the previously reported operative time for cTAPP (65.7 (range, 40–109) min) [3]. In our results, the operative time for surgeons who had performed  $\geq 20$  nTAPP was significantly shorter than that for surgeons who had performed  $< 20$  nTAPP. Because 22 of 27 surgeons had performed  $< 20$  procedures in this study, our results were influenced by the learning curve. Moreover, the operative time was long because of the difficulty of dissection and grasping by needlescopic instruments. It has been reported that there is a significant learning curve in needlescopic surgery and that operative times for needlescopic procedures are 20% longer than those for conventional laparoscopic techniques [5]. It is related to the functional problems of the currently available needlescopic instruments, and it will be improved by innovation of fine-caliber instruments. We think that the ideal needlescopic forceps needs to have a strong shaft and gentle grasping ability.

In a previous study, we reported that the advantage of nTAPP compared with cTAPP is a decrease in postoperative pain and cosmetic improvement [6]. In this large-scale study, 13.6% of patients who had performed nTAPP used postoperative analgesics, and the mean frequency of use was 0.5 times. These postoperative pain results are similar to the results that we have reported.

In this study during a 15-year period, nTAPP was shown to be a safe and useful procedure. In the future, needlescopic surgery will be more developed by the improvement of fine-caliber instruments and the advent of thinner high definition endoscope, although prospective, randomized, controlled trials will be required to establish the benefit.

**Disclosures** Dr. Hidetoshi Wada, Dr. Taizo Kimura, Dr. Akihiro Kawabe, Dr. Masanori Sato, Dr. Yuichirou Miyaki, Dr. Junpei Tochikubo, Dr. Kouji Inamori, and Dr. Norihiko Shiiya have no conflicts of interest or financial ties to disclose.

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