Mesh splitting versus nonsplitting in laparoscopic transabdominal preperitoneal inguinal hernia repair

Sherif Albalkiny, Mohamed G. Qassem, Gad M. Behairy

Department of General Surgery, Ain Shams University Hospital, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Gad M. Behairy, MBBCh, MSc, MD, Department of General Surgery, Ain Shams University Hospital, Faculty of Medicine; Ain Shams University, Cairo, 13575, Egypt.
Mob: +201000065645;
e-mail: gad_mo@med.asu.edu.eg

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Aim
Our research was performed to determine the effects of mesh tailoring and splitting to enclose the spermatic cord and to equate this technique in terms of risks, quality of life, and recurrence rate to the conventional transabdominal preperitoneal (TAPP) procedure.
Patients and methods
A total of 40 patients with mean age of 33.6±8.8 years, ranging from 18 to 60 years, underwent laparoscopic hernia repair (TAPP), where group I underwent repair with mesh splitting technique, whereas group II underwent the standard TAPP approach without mesh splitting. All patients participated in the study completed 2 years of follow-up. Full clinical assessment for all patients was performed, and any postoperative complications such as postoperative pain, wound infection, seroma, hematoma, or recurrence were recorded. After 1 year, testicular perfusion was assessed as well. For evaluation of the quality of life, MOS 36-Health Survey (SF-36) was used.
Results
There was no significant difference between the two groups in terms of recovery time to normal physical activity. All patients reported that their chronic groin pain was reduced over time and completely disappeared after 6 months. The most common encountered complication was postoperative seroma, which occurred in 22 (55%) patients. In terms of incidence of recurrence, only one case was reported in group II after 3 months of follow-up.
Conclusions
No difference in postoperative complaints or complications was demonstrated with mesh splitting and fashioning in laparoscopic hernia repair.
Moreover, proper surgical handling and reduction of suturing and fixation in addition to avoiding nerve and vessels injuries are the main keys to prevent posthernioplasty chronic pain. Additionally, this study could not demonstrate any effects on the testicular integrity from implantation of splitted or nonsplitted mesh.

Keywords:
mesh, preperitoneal, splitting, transabdominal preperitoneal

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Introduction

In the management of inguinal hernias, the development of laparoscopic procedures to repair inguinal hernias using polypropylene mesh has already been shown to be of useful value [1,2].

For inguinal hernia repair nowadays, laparoscopic inguinal hernia repair has become a feasible option. In fact, total extraperitoneal and transabdominal preperitoneal (TAPP) are the two most commonly used laparoscopic procedures for inguinal hernia repair [3].

TAPP repair is generally considered an easier and simpler approach that has the advantage of having the opportunity to perform diagnostic laparoscopy [4].

Privileges of minimally invasive surgery were provided to the patients through the laparoscopic approach, as has been proved by several studies [5,6]. Laparoscopic repair is associated with less postoperative pain, prompter return to normal activities, and less chronic pain than the traditional, tension-free mesh hernia repair. Nowadays, most laparoscopic repairs of inguinal hernias are carried out by placing the mesh into the preperitoneal space [7].

According to Pelissier, postoperative disabling pain could be minimized through placement of polypropylene mesh into the preperitoneal space [8–10].

A physiological method of reconstruction, through using the intra-abdominal pressure to compress the mesh against the abdominal wall, was achieved via placement of the mesh in the pre peritoneal space. Additionally, this helps to reduce postoperative chronic pain as it prohibits the contact with the sensory nerves

(ilioinguinal, iliohypogastric, and genital branch of the genitofemoral nerve) running into the inguinal region [11–13].

Fixation of the mesh is an issue that has been viciously argued for a long time. Most surgeons prefer to fix the mesh in some such way or another. To place and secure a mesh in the preperitoneal space, different methods are used, including using absorbable and nonabsorbable tacks, fibrin sealant, and sutures [14].

The sole drive for mesh fixation is to prevent its migration or displacement, which can lead to hernia recurrence, although its mechanics are neither investigated in detail nor well understood [6,15].

Curling of mesh at the lower aspect could potentially displace the whole mesh if it is not placed properly or the preperitoneal space is inadequately dissected to properly accommodate the entire mesh or the mesh is too large or if the mesh is not secured adequately [16].

Migration of the inferomedial part of the mesh from the cave of Retzius could happened during abdominal desufflation, especially in the presence of a direct defect according to Fiennes and Taylor [17,18].

Both incised [19] and nonincised [20] meshes are employed in laparoscopic as well as traditional surgeries for inguinal hernia repair to achieve tension-free and enforced repair. A possible advantage of the incised mesh is better fixation by its fashioning around the cord structures and creating a new internal ring [21].

In our study, we assume that tailoring of the mesh and splitting it to enclose the cord then reapproximating the slit edges superiorly will reduce mesh migration or displacement and consequently will reduce the recurrence rate.

Moreover, achieving adequate proper dissection to expose all the potential hernias sites in the inguinal region such as direct, indirect, and femoral hernia area, along with the use of appropriate mesh size to adequately overlap the myopectineal orifice and the previously mentioned potential hernias sites will continue to reduce the recurrence rate in laparoscopic herniorrhaphy.

Patients and methods

This prospective study included 63 patients who underwent laparoscopic repair of inguinal hernias between August 2016 and August 2018 at Ain Shams University Hospitals.

A total of 23 patients were excluded from our study: eight patients owing to loss of contact and follow-up, three patients were converted to open technique procedure, and 12 patients were repaired using total extraperitoneal technique. Therefore, the study was completed on 40 patients.

Patients were randomly assigned to surgical procedures by card selection (odd and even numbers). After their approval to participate in the study (IRB approval ethical committee, Department of General Surgery, Ain Shams University), a written informed consent was obtained from all patients before being assigned to surgery.

After their approval to participate in the study, all patients underwent TAPP hernia repair, where group I (20 patients) underwent TAPP repair with mesh splitting technique, whereas group II (20 patients) underwent standard TAPP repair with nonsplitted mesh.

All the patients who participated in our study completed 2 years of follow-up, and those who did not complete 2 years of follow-up were excluded from the study.

Patients were included in the study if they were 18 years or older presenting with inguinal hernias either bilateral inguinal hernia or recurrent inguinal hernia.

Moreover, patients with unilateral inguinal hernia demanding to be operated laparoscopically were included as well. Patients were capable of understanding and giving signed consent for laparoscopic treatment of inguinal hernia.

On the contrary, high-risk patients who were not fit for general anesthesia or peritoneal insufflation, multiple previous lower abdominal surgeries, coagulopathy, or patients with a complicated hernia such as strangulated or obstructed hernias were excluded from the study.

The following data were collected for each patient: age, sex, previous hernia repairs, preoperative comorbidities, American Society of Anesthesiologists (ASA) classification, operative time, estimated blood loss, length of hospital stay, recovery time to normal physical activity, complications, postoperative pain, recurrence rate, and follow-up.

Surgical technique for transabdominal preperitoneal repair

The patient was placed in supine position in a Trendelenburg position. After adequate general anesthesia was obtained, the abdomen was prepared and draped in the usual sterile manner. Pneumoperitoneum was established through open 'Hasson' technique in both groups.

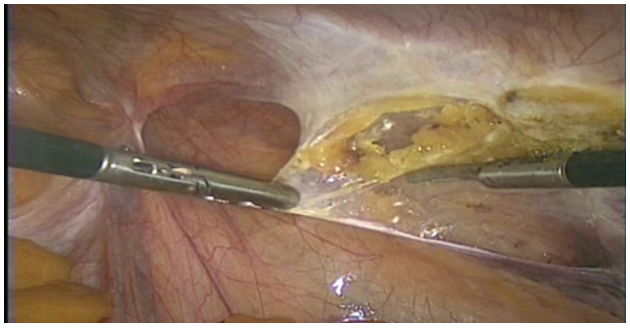
Opposite to the hernia side, both the surgeon and the assistant stand on the same side.

Proper intraabdominal exploration was performed. For the unilateral procedure, a 5-mm ipsilateral port was inserted one inch above the umbilicus in the midclavicular line and another 5-mm contralateral port was inserted one inch below or at level of the umbilicus in midclavicular line.

On the contrary, for the bilateral cases, two 5-mm ports were inserted 1 inch above the level of the umbilicus on either side in midclavicular line. The peritoneum and preperitoneal space were bluntly dissected from the spermatic cord and vessels (Fig. 1).

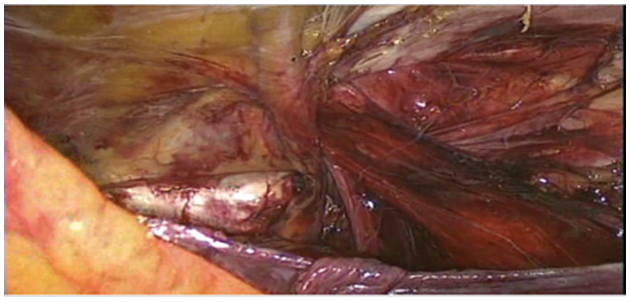
The hernia sac was reduced meticulously, carefully preserving the spermatic vessels and vas deferens and exposing triangle of Doom in between (Fig. 2).

Figure 1



Dissection of preperitoneal space.

Figure 2



Reduction of hernial sac and exposure of triangle of Doom.

Preperitoneal space was dissected meticulously to expose pubic ramus and Cooper's ligament. Adequate dissection of the preperitoneal retropubic space (space of Retzius) enables easier positioning and proper flattening of the mesh (Fig. 3).

A 10×15 cm synthetic polypropylene mesh was inserted after creating a peritoneal window and dissecting the hernia sac. Mesh was fixed with three titanium tacks without splitting it around the spermatic cord in group II, whereas in group I, mesh was incised and split superiorly and then the slit edges was tailored around the cord and reapproximated adequately and then tacks were applied on the overlapped part superiorly to anchor the mesh to the abdominal wall with care not to injure the inferior epigastric vessels (Fig. 4).

After completion of mesh fixation, the peritoneal window was closed either with 2–0 Vicryl or PDS. The umbilical fascia and port-site incisions were closed, and the patient was transferred to the recovery room. Postoperative orders included a uniform set of analgesics for all patients.

Follow-up

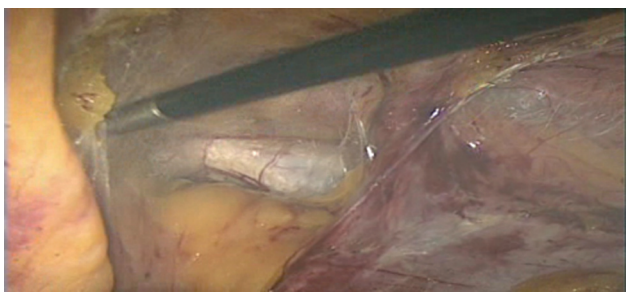
Patients were examined postoperatively at 4 weeks, 3 months, 6 months, 1 year, and then after 2 years.

Assessment was done for possible postoperative complications, including the following:

(1) Wound infection.
(2) Postoperative seroma.
(3) Postoperative hematoma.
(4) Recurrence (i.e., if detected clinically will be confirmed by ultrasound scan).
(5) Postoperative testicular perfusion through color duplex ultrasound after 1 year.

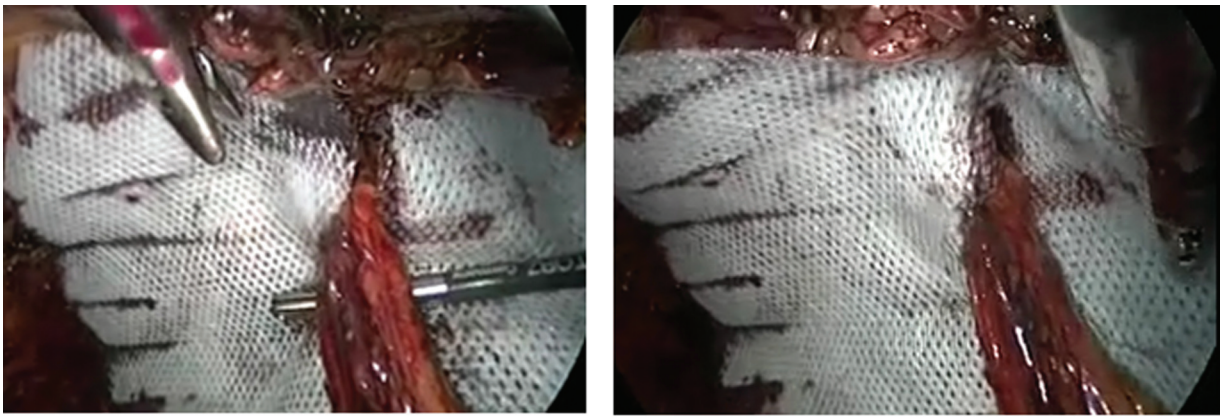
Postoperative pain was evaluated by the numerical rating score (NRS) at first day postoperative,

Figure 3



Exposure of Bogros space and Cooper's ligament.

Figure 4



Mesh splitting and fashioning around the cord in group I.

4 weeks, 3 months, and 6 months after surgery. The NRS scoring is 0 (no pain), 1–3 (mild pain), 4–6 (moderate pain), and 7–10 (severe pain).

Chronic pain was considered if the pain duration is more than 3 months [22].

Quality of life

The MOS 36-Item Short Form Health Survey (SF-36) [23], which is formed of eight aspects, was used for the evaluation of quality of life: general health, role physical, physical functions, bodily pain, role emotional, social functions, vitality, and mental health. Quality-of-life evaluation was completed preoperatively and 3 months after surgery through phone call and written record.

Results

Using the Social Science Statistical Kit, the collected data were revamped, coded, tabulated, and applied on a PC (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0.; IBM Corp., Armonk, New York, USA).

Data were presented and suitable analysis was done according to the type of data obtained for each parameter.

Descriptive statistics

(1) Mean, SD, and range were used for parametric numerical data.
(2) Frequency and percentage were used for non-numerical data.

Analytical statistics

(1) Student *t* test was used to assess the statistical significance of the difference between two study group means.
(2) χ^2 test was used to examine the relationship between two qualitative variables.
(3) Fisher's exact test used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells.
    (a) *P* value: level of significance and *P* value less than 0.05: significant.

A total of 40 patients with mean age of 33.6±8.8 years, ranging from 18 to 60 years underwent laparoscopic hernia repair (TAPP), where group I underwent repair with mesh splitting technique, whereas group II underwent the standard TAPP approach without mesh splitting.

Both groups have preoperative comorbidities like hypertension, diabetes, chronic obstructive pulmonary disease, and chronic liver disease that did not affect the surgical outcome, where 24 patients were ASA I and 16 patients were ASA II. On the contrary, high-risk patients who were not fit for general anesthesia or peritoneal insufflation were excluded from our study (Table 1).

In group I, mean operative time for primary hernia repair was 82.38±28.92, whereas that for group II was 79.3±26.83, with no statistically significance difference between the two groups. On the contrary, operative time was relatively longer in recurrent or bilateral cases in both groups.

All operations were completed laparoscopically with uneventful course; moreover, minimal blood loss was reported in both groups. All cases were discharged home on the next postoperative day (Table 3).

During the preoperative assessment, quality of life for all patients was evaluated using MOS SF-36 health

survey, with no significance difference between the two groups (Table 2).

Preoperative MOS SF-36 health survey scores between the two groups

In terms of recovery time to normal physical activity, there was no substantial difference between the two groups, with a mean recovery time of 7.5±1.196 days for group I and 8.1±1.296 days for group II (Table 3).

The most common encountered complication was postoperative seroma, which occurred in 22 (55%) patients, with no statistically significance between the two groups; diagnosis was confirmed by ultrasound and resolved spontaneously in 100% of patients within 6–12 weeks (Table 4).

A major concern is postoperative pain following hernioplasty, either open or laparoscopic. Usually its origin can be owing to nerve injury or entrapment or the mesh itself.

In our study, we used the NRS system to evaluate postoperative groin pain. The mean pain score recorded in group I was relatively higher than that recorded for group II; however, statistically it was not significant, as *P* value was 0.065.

All patients reported that their chronic groin pain was reduced over time and completely disappeared after 6 months (Table 5).

In terms of incidence of recurrence, one case was reported in group II, at 3 months of follow-up, which might be related to noncompliance with the postoperative instructions regarding weight lifting, and this patient was managed through open anterior hernia repair (Table 4).

The MOS 36-Item Short Form Health Survey (SF-36) was used for evaluation of quality of life preoperatively and 3 months after surgery (Tables 2 and 6). There was no significant difference between the two groups ($P>0.05$) (Table 6).

Table 1 Demographic data of the patients

	Group I (mean±SD)	Group II (mean±SD)	*P* value	Significance
Age	34.75±9.3	32.45±8	0.408	NS
Preoperative comorbidities	*n* (%)	*n* (%)	*P* value	Significance
DM	1 (5)	3 (15)	0.605	NS
COPD	2 (10)	1 (5)	1.0	NS
HTN	3 (15)	4 (20)	1.0	NS
CLD	1 (5)	1 (5)	1.0	NS
ASA classification				
ASA I	13 (65)	11 (55)	0.19	NS
ASA II	7 (35)	9 (45)	0.24	NS

ASA, American Society of Anesthesiologists; CLD, chronic lung disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HTN, hypertension.

Table 4 Postoperative complications

	Group I [*n* (%)]	Group II [*n* (%)]	*P* value	Significance
Recurrence	0	1 (5)	0.548	NS
Postoperative seroma	12 (60)	10 (50)	0.525	NS

Table 2 Preoperative MOS SF-36 health survey scores

	Group I (mean±SD)	Group II (mean±SD)	*P* value	Significance
General health	84±9	85±11	0.754	NS
Bodily pain	74±10	73±11	0.765	NS
Role physical	80±8	81±9	0.712	NS
Physical functions	81±16	79±15	0.685	NS
Role emotional	74±11	76±12	0.585	NS
Social functions	77±13	79±11	0.54	NS
Vitality	72±14	75±13	0.486	NS
Mental health	78±9	80±11	0.572	NS

Table 3 Operative data of the patients

	Group I (mean±SD)	Group II (mean±SD)	*P* value	Significance
Operative time (min)				
1ry hernia	82.38±28.92	79.3±26.83	0.729	NS
Recurrent hernia	103.5±16.62	97.5±3.5	0.122	NS
Estimated blood loss (ml)	80	76.5±9.33	1.0	NS
Recovery time to normal physical activity (days)	7.5±1.196	8.1±1.296	0.329	NS

Table 5 Postoperative pain score

Postoperative pain score (NRS)	Group I (mean ±SD)	Group II (mean ±SD)	*P* value	Significance
At first day	5.25±1.48	4.5±1.23	0.065	NS
4 weeks	4.25±0.6	4±0.4	0.129	NS
3 months	2.45±0.6	2.2±0.3	0.1	NS
6 months	1.45±0.9	1.6±0.5	0.5	NS

NRS, numerical rating score.

Table 6 Postoperative MOS SF-36 health survey scores

	Group I (mean±SD)	Group II (mean±SD)	*P* value	Significance
General health	80±16	80±9	0.712	NS
Bodily pain	85±9	84±11	0.754	NS
Role physical	70±9	72±11	0.532	NS
Physical functions	70±12	71±8	0.758	NS
Role emotional	73±7	74±4	0.582	NS
Social functions	78±6	79±11	0.723	NS
Vitality	73±13	74±14	0.816	NS
Mental health	77±9	79±11	0.532	NS

Discussion

Repairing of inguinal hernias is one of the most common elective general surgery procedures. Numerous technical advances have been made to aim for a decreased rate of recurrence in both laparoscopic and open inguinal hernioplasty [24].

Recurrence rates of 2% or less are routinely reported from specialty centers performing either laparoscopic or conventional tension-free repairs of inguinal hernia. The recurrence rate after laparoscopic TAPP approach for inguinal hernia repair is 1–4% [25,26]. A variety of hypotheses have been proposed that are responsible for hernia recurrence.

Deans *et al.* [27] acknowledged that rolling of the mesh away from the pubic ramus with exposure of Hesselbach's triangle is responsible for medial recurrence.

After hernioplasty, the two most common causes of inguinal hernia recurrence are incomplete myopectineal orifice dissection and inadequate mesh size [26,28].

Fiennes and Taylor suggested that after laparoscopic inguinal hernia repair, abdominal desufflation elevates the lower edge of the mesh, resulting in displacement of the inferomedial aspect from the retropubic space in the presence of a direct defect [17,18].

Horgan *et al.* [29] also identified the inferior-medial compartment as the weak spot in laparoscopic transperitoneal hernia repair.

Both incised [19] and nonincised [20] mesh implants are employed in laparoscopic as well as conventional hernia repair surgeries to achieve proper reinforcement.

A possible advantage of the incised mesh is to achieve fixation of the mesh by its tailoring around the cord structures to create a new internal ring [21].

TAPP procedure was performed in a randomized clinical trial of Leibl *et al.* [21]. This three-armed study included 360 patients, where incised mesh was used in group I, creating a new inguinal ring by overlapping the two incised sides, and nonincised mesh was used in groups II and III, which was fixed with staples in group II and with nonreabsorbable sutures in group III.

The authors reported no significant differences among the groups regarding operation times, postoperative complaints, and need for pain killers, which were similar to our results.

In comparison, in group III, they reported only one recurrence (no recurrences in groups I and II). This matches our study results, which came out with no recurrence in the mesh splitting group and only one case of recurrence reported in the other group with the nonsplitted mesh.

There were 28 recurrences in another comparative study including 2700 TAPP procedures in a single institution after a median follow-up time of 26 months, 9 (0.3%) of which were attributed to inadequate mesh slit closure [30]. In contrast, a later prospective analysis within the same institution involving 8050 procedures without slit in the mesh reported an overall recurrence rate of 0.4% [31]. This emphasizes that the cause of recurrence was not the mesh slitting rather than poor technique in closing the slit.

Chronic groin pain and quality of life are essential appraisal components after inguinal hernia repair [32]. Postoperative chronic pain is considered an essential factor affecting the quality of life after inguinal hernia repair and is usually presented with groin burning sensation with possible paresthesia in these areas. There are many causes of pain after hernioplasty including suturing of mesh in pubic tubercle periosteum which is the most common cause, nerve

entrapment due to fibrosis or ischemia of the spermatic cord, scarring after surgery, and nerve injury either by stretching or contusion.

NRS is a simple, easy, and effective method for the evaluation of postoperative pain, whereas MOS SF-36 Health Survey is considered an important and effective tool for the assessment of postoperative quality of life [23].

Proper surgical procedures such as reduction of suturing and fixation in addition to avoiding nerve and vessels injuries are crucial to prevent posthernioplasty chronic pain [3,33].

In our study, in terms of postoperative pain and need for pain killers, there was no significant difference between the two groups, which mirrored the findings of a randomized clinical trial by Leibl *et al*. [21].

As the periosteum is the most pain-sensitive tissue of the body, Amid *et al*. [34] advised against a direct bony fixation with staples. Staples should be placed only along Cooper's ligament or ventrally. We agreed with the fact that, because of the possibility of nerve complications, the use of staples should not be universally rejected; however, selective use is recommended for a limit of four to six staples. Both incised [5] and nonincised [6] mesh implants are applied in Leibl *et al*. [21], highlighting the notion that a key-hole mesh could give rise to lasting testicular complaints because of irritation of the genital branch of the genitofemoral nerve or alteration in the arterial perfusion owing to circumferential scarring.

Their research did not identify any risk to the integrity of the testicle either through the extensive dissection sacs or through the application of meshes in the immediate vicinity of the testicular blood vessels, regardless of whether the mesh was incised or not. This was tested and followed up in our study, where no cases of alteration of testicular perfusion were reported after 1 year of follow-up.

Conclusions

No difference in postoperative complaints or complications was demonstrated with mesh splitting and fashioning in laparoscopic hernia repair.

Moreover, proper surgical handling and reduction of suturing and fixation in addition to avoiding nerve and vessels injuries are the main key to prevent posthernioplasty chronic pain. Additionally, this study could not demonstrate any effects on the testicular integrity from implantation of splitted or nonsplitted mesh.

Based upon our study results, it would be more beneficial to extend the use of the mesh splitting technique to larger sample size so as to obtain wider results that can be applied in the surgical practice.

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Conflicts of interest
There are no conflicts of interest.

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