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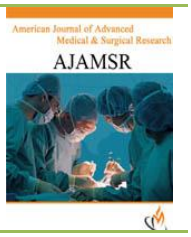

THE MERITS AND DEMERITS OF LAPAROSCOPIC APPENDICECTOMY OVER OPEN APPENDICECTOMY FOR CLINICALLY CONFIRMED APPENDICITIS

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ABSTRACT
Suspected appendicitis is undoubtedly the most common indication for emergency surgical intervention, The aim of this retrospective study is to compare the results of laparoscopic appendicectomy (LA) with that of open appendicectomy (OA) in terms of operating time, post-operative pain, wound infection, duration of hospital stay and time to return to usual activities. 192 patients (104 males and 88 females) of mean age 25.46 years (7-72 years) who underwent OA (n=100) and LA (n =85) for acute appendicitis were included in the study. The results of LA were compared with that of OA in terms of operating time, post operative pain, hospital stay, wound infection (surgical site infection) and time to return to usual activities. Out of total 192 patients, 100 patients underwent OA, 85 patients underwent LA and 7 LA converted to OA. LA has advantages over its open counterpart, in terms of postoperative pain, duration of hospital stay and time to return to usual activities, but not in terms of operating time and wound infection. In diagnosed cases of acute appendicitis LA has got some advantages compared to OA in experienced hands.

INTRODUCTION

In the last decade laparoscopy has significantly affected general surgical procedures for a variety of pathological indications. It is more often applied not only in elective surgery, but also in emergency surgeries. Suspected appendicitis is undoubtedly the most common indication for emergency surgical intervention, with a lifetime risk of 6% [1,2].

Since its introduction by Mc Burney in 1894, appendicectomy has been the treatment of choice for acute appendicitis [3]. Open appendicectomy (OA) has withstood the test of time for more than a century. The procedure is standardized among surgeons and unlike cholecystectomy, OA is typically completed using a small right lower quadrant incision and postoperative recovery is usually uneventful. Since its initial description by Semm in 1983, Laparoscopic appendicectomy (LA) has struggled to prove its superiority over the open technique [4]. The advantages of LA over OA are thought to be less postoperative pain, shorter hospital stay and early return to usual activity [5, 6]. While the incidence of postoperative wound infection is thought to be lower after the laparoscopic technique, the incidence of postoperative intra-abdominal sepsis may be higher in patients operated on for gangrenous or perforated appendicitis [5, 6].There are however notions showing only minimal benefit from LA, with higher cost of this method. The most valuable aspect of laparoscopy in the management of suspected appendicitis is as a diagnostic tool, particularly in women

of child-bearing age [7].

Though multiple prospective randomized trials, meta-analyses [8-11], and systematic reviews [12-15] have been conducted to assess the value of LA over OA, the heterogeneity of the measured variables and other weaknesses in methodology have not allowed to draw definitive conclusions [14,15]. Hence, the 'gold standard' modality of treatment for clinically confirmed appendicitis is still not yet established. This study is aimed to compare the results of LA with that of OA in terms of operating time, post-operative pain, wound infection, duration of hospital stay and time to return to usual activities.

METHODS

Patients and Study Design

In this retrospective study, all patients admitted in the Department of General surgery in Amala Institute of Medical Sciences, diagnosed with appendicitis and underwent surgery between January 2012 to June 2013 (18 months) were included. 'Clinically confirmed' case of appendicitis means an Alvarado score of 7 or more (clinically strongly predictive of appendicitis) or an equivocal score (5-6) with sonological evidence (abdominal ultrasound or contrast-enhanced CT suggestive of appendicitis). Both emergency as well as elective cases were included. They were studied during their stay in the hospital, during review for suture removal and were followed- up until they returned to usual activities. The study protocol was presented to the Institutional Ethical Committee prior to the commencement of study and was approved. The choice of laparoscopic or open surgery was based on patient preference.

All cases of LA converted to OA, cases of OA done through any incision other than a right lower quadrant incision and histopathology showing alternate diagnoses was excluded.

Surgical Procedure

All cases of suspected appendicitis were clinically examined and basic blood tests done. An ultrasound scanning was done as supportive evidence in all patients. All cases with an Alvarado score of 7 or more (group A), and those cases with an equivocal score of 5-6 (group B) with Ultrasound positivity (P) were also considered diagnostic. These patients underwent all the preoperative investigations and pre anaesthetic evaluation. Then the 2 surgical options (LA and OA) are given to the patient and the relatives, and are operated depending on patient's preference. All patients received preoperative iv doses of a 3rdgeneration cephalosporin every 12 hours from the time of diagnosis until surgery.

OA was done through a Gridiron (McArthur-McBurney) or Lanz incision. A double ligation of the stump was performed with an absorbable suture. If the appendix looked normal, it was removed. Distal ileum was inspected in all cases to rule out Meckel's diverticulum. If appendix was found perforated, abdomen and pelvis were irrigated with warm saline solution. Abdomen was closed in layers with absorbable suture (polyglactin) and skin stapled.

LA was performed using 3 ports, with laparoscope at umbilicus. The abdominal cavity was explored to locate the appendix and to rule out alternative diagnoses. The mesoappendix was divided with diathermy and base of appendix endolooped with catgut and divided. In case of perforation, saline irrigation and suction was done. The fascial defect in the umbilical port was closed with polyglactin sutures and skin stapled.

Non-suction drainage was left in situ in cases of abscess and generalized peritonitis in both OA and LA.

Postoperative Course

Intravenous 3rd generation cephalosporin was continued postoperatively until patient starts oral intake. Then it is changed to a 3rd generation oral cephalosporin and continued for a total of 5 days. Patients found to have a complication (gangrenous or perforated appendix) during surgery were treated with a triple antibiotic coverage: cephalosporin, gentamycin or amikacin and metronidazole until the WBC count was within normal limits and the temperature under 99 degree F for 24 hours. Postoperatively all patients received 8th hourly Tramadol injection, dose according to body weight, for pain.

Once bowel sounds appeared, a clear liquid was started, and advanced to regular diet step by step when tolerated and flatus passed. Patients were discharged when they tolerated a regular diet, and were afebrile for 24 hours. They were reviewed after 1 week for stapler removal, or earlier if any adverse symptoms were observed.

The results of LA were compared with that of OA in terms of operating time, post operative pain, hospital stay, wound infection (surgical site infection) and time to return to usual activities.

Operating time was calculated from skin incision to completion of skin closure in both techniques. Post operative pain on post operative day 1 and 2 were analyzed using visual analogue scale [13]. In this scale a score of 0 is allocated for 'no pain' and a score of 10 for 'worst imaginable pain and patient is asked to rate their pain. Hospital stay was calculated from day of surgery to the day of discharge. Infective complications, if occurred during the period of hospitalization, were recorded. Surgical Site Infection are divided into incisional superficial, incisional deep and organ /space related (anatomic location of the procedure itself) [16]. Incisional infection only analyzed the OA group. Southampton scoring system was used for the severity of wound infection (Table 1) [17].

The patients were again studied during review for suture or staple removal and enquired regarding return to usual activities. If not, the patient was followed up until he/she resumed usual activities. As the usual activities depends on the age, sex, occupation and many other social

factors and are highly variable in the study population, 'Activities of Daily Living (ADL)' scale by Katz was applied to analyse the time to return to usual activities (Table 2).

Statistical Analysis

The collected data were analysed using the SPSS version 16.0. Independent *t*-test was used to assess the significance of difference between the OA & LA groups, in terms of 'operating time' and 'time to return to usual activities'. Chi-square test was used to assess the 'wound infection' rates between the two study groups. Mann Whitney U non-parametric test was used to compare the continuous variables, 'post operative pain' and 'hospital stay'. P<0.05 was considered as significant.

RESULTS

A total of 192 patients (104 males and 88 females) of mean age 25.46 years (7-72 years) were included in the study (figure 1). Of this 100 patients underwent an open appendicectomy, 85 underwent a laparoscopic appendicectomy (Table 3). Seven patients who were converted from an LA to OA were excluded from analyzing the primary outcome measures. There was no mortality in either group.

There was no significant difference between the mean ages of the two groups. But there was some difference in the sex predilection between the two groups (OA & LA). When two-thirds of patients (66%) in the OA group were males, 61.2% of patients in LA group were females, probably due to cosmetic concerns. The mean duration of symptoms was 2.22 days (1-6 days) in the study subjects. There were no prior similar episodes in most of the patients (65.6%).The disease characteristics like duration of symptoms, number of prior similar episodes and presence of co-morbidities were similar between the two groups.

Most of the patients could be diagnosed clinically. 158 patients (82.3%) had an Alvarado score of 7 or more. Only 34 patients (17.7%) had a score of 5-6 and ultrasound scanning was used in confirming the diagnosis, though ultrasound scanning was done for all patients. i.e. 82.3% of cases could be diagnosed by clinical examination alone . So, clinical examination still remains the cornerstone for diagnosing acute appendicitis.

Among the 192 patients, 140 (72.9%) were ultrasound positive, while 52 (27.1%) were ultrasound negative i.e. the sensitivity of USG in acute appendicitis is not very good, and is highly operator dependent.

Primary Outcome Measures

Primary outcome measures are depicted in table 4

Operating time

The mean operating time in the whole population was 46.36 minutes. There was no significant difference (P = 0.647) between the two groups in terms of operating time. The mean operating time for OA was 44.4 min and for LA was 45.75 min (Table 4). But, the operating time was found to be highly variable (18-135 min) in the LA group, depending on the surgeon's experience in laparoscopic surgeries. This could be attributed to the learning curve, associated with any laparoscopic procedures. But the operating time was more or less similar between the operating surgeons in the OA group. Obviously, the mean operating time was found to be longer in LCO group (81.86 min).

Post operative pain

Post operative pain was significantly less in the LA group compared to the OA group on post operative day 1 as well as on day 2 (Table 4).On the first post operative day, the mean VAS was 6.37 for OA and 5.16 for LA, and the difference is statistically significant (P=0.0001). On the 2nd post operative day also, pain was significantly less (P=0.0004) in the LA (mean VAS-2.73) group compared to OA (mean VAS-3.71).

Wound infection

The wound infection rate in the whole study population was 12%, out of which 8.8% were minor infection and 3.12% were major infection, as per the Southampton grading system. The total wound infection rates were 16 % in OA and 7.1 % in LA group, but the difference was not statistically significant (P=0.06). All the cases in the LA group were only minor infections. And all cases of major wound infection were found in the OA group. So there appeared to be a significant difference between the two groups in major wound infection rate.

Hospital stay

The mean duration of hospital stay in the whole population was 4.73 days. The mean hospital stay was also significantly less (P=0.0001) in the LA group compared to the OA group. The mean duration of hospital stay was 5.29 days in the OA and 3.92 days in the LA group respectively.

Time to usual activities

The mean time to usual activities in the population was 9.03 days. The patients in the OA group took more time to return to usual activities (mean 10.06 days) compared to the LA group (mean 7.54 days). There was a statistically significant difference (P=0.0003) between the two groups.

Table 1. Southampton wound grading system

Grade	Appearance
0	Normal healing
I	Normal healing with mild bruising or erythema
0. I a	Some bruising
0. I b	Considerable bruising
0. I c	Mild erythema
II	Erythema plus other signs of inflammation
0. II a	At one point
0. II b	Around sutures
0. II c	Along wound
0. II d	Around wound
III	Clear or haemo-serous discharge
0. III a	At one point only(</= 2cm)
0. III b	Along wound (> 2cm)
0. III c	Large volume
0. III d	Prolonged (> 3 days)
Major infection	
IV	Pus
0. IV a	At one point only(</= 2cm)
0. IV b	Along wound (> 2cm)
V	Deep or severe wound infection with or without tissue breakdown; haematoma requiring aspiration

Table 2. KATZ activities of daily living scale

Activities	Fully Independent (1 point)	Dependent (0 point)
Bathing	Receives either no assistance or assistance in bathing only one part of body.	Dependent
Dressing	Gets clothes and dresses without any assistance except for tying shoes.	Dependent
Toileting	Goes to toilet room, uses toilet, arranges clothes, and returns without any assistance.	Dependent
Transferring	Moves in and out of bed and chair without assistance (mechanical walking aids acceptable).	Dependent
Continence	Controls bowel and bladder completely by self (without occasional "accidents").	Dependent
Eating	Feeds self without assistance (except for help with cutting meat or buttering bread).	Dependent

Table 3. Type of surgery undergone

Type of surgery	Frequency (percentage)
OA	100 (52.1)
LA	85 (44.3)
LCO	7 (3.6)

OA: Open appendicectomy; LA: Laparoscopic appendicectomy and LCO: Laparoscopic appendicectomy converted to Open appendicectomy.

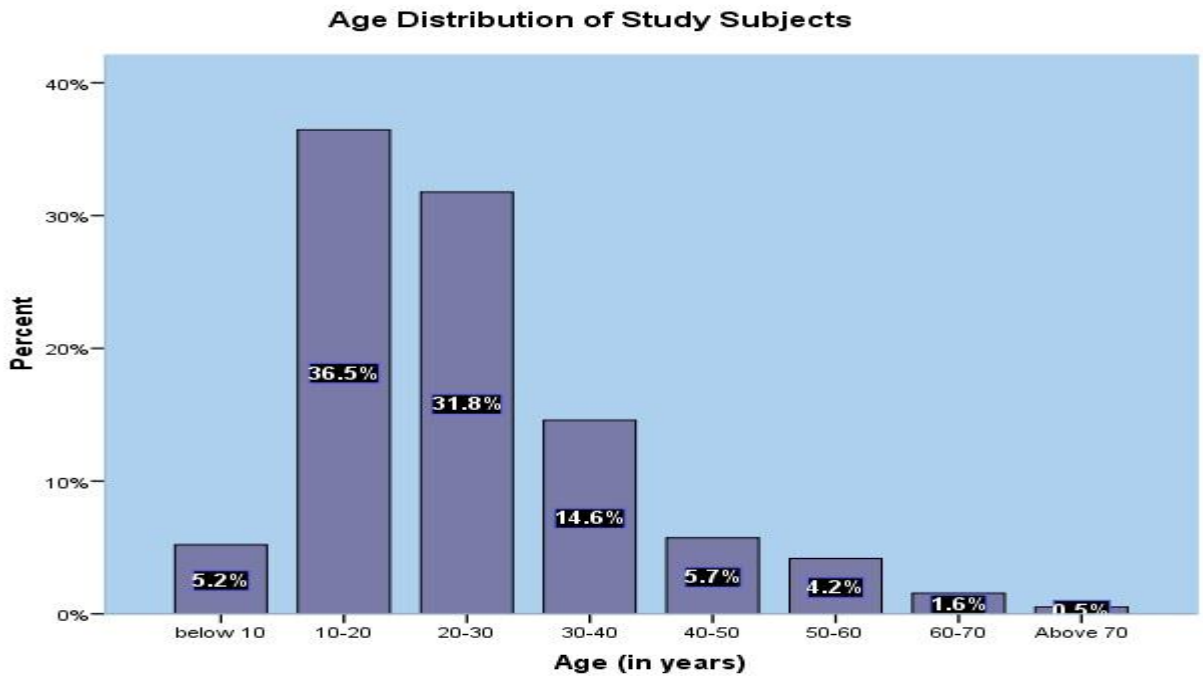
Table 4. Primary outcome measures in patient underwent Open appendicectomy (OA) and Laparoscopic appendicectomy (LA)

Primary outcome measures	OA	LA	P value
Operating time (min)	44.40 (25-100)	45.75 (18-135)	P = 0.647 t-test
Postoperative pain on POD1	6.37 ± 0.73	5.16 ± 0.75	P = 0.0001 Mann Whitney U test

Postoperative pain on POD2		3.71 ± 0.90	2.73 ± 0.74	P = 0.0004 Mann Whitney U test
Wound infection (%)	YES	16 (16)	6 (7.1)	P = 0.06 Chi square test
	NO	84 (84)	79 (92.9)	
Duration of hospital stay (Days)		5.29 ± 1.53	3.92 ± 1.22	P = 0.0001 Mann Whitney U test
Time to usual activities (Days)		10.06 ± 2.31	7.54 ± 1.29	P = 0.0003 t-test

POD 1: Post operative day 1 and POD2: Post operative day 2.

Fig 1. Age wise distribution of study subjects



DISCUSSION

Numerous prospective randomized trials, meta-analyses, and systematic critical reviews have been conducted to assess the value of LA over OA, but there is some variability in the results of these studies [8- 15, 18-21]. The overall mortality of OA is around 0.3%; and morbidity around 11%. Given the large number of procedures done annually, the validation of a minimally invasive technique that would improve outcomes may have a direct impact on patient management and possibly an indirect effect on the economics of health care [19].

Katkhouda *et al*. performed an extensive search of literature comparing LA to OA in adults using the review of Cochrane Central Registry of controlled trials suggested that by all meta- analyses and systematic reviews, the methodological quality of most studies was "poor to moderate"[19]. Only 7 PRS had a sample size of 200 patients or more. The majority of non randomized studies favored laparoscopy. These should be analyzed with caution because of their inherent bias.

Tate *et al*. compared 55 patients after the introduction of LA with 100 patients underwent OA [23]. They found significant benefits in favor of LA. However, in a follow up PRS conducted study could "no longer support the widespread adoption of a laparoscopic alternative to a traditional operation based on initial uncontrolled studies" [18]. The lack of appropriate blinding and inclusion of multiple centers were the main limitations of the studies conducted so far.

In this study, majority of females were chosen LA (61.3%), while majority of males (63.4%) were chosen for OA. This is probably due to the cosmetic advantage of LA over OA. Other than sex, factors which were found to influence the mode of surgery were age, marital status, co-morbid conditions and economic status of the patients. Certain medical conditions like bronchial asthma, chronic obstructive pulmonary disease, and cardiac diseases where general anaesthesia is considered risky, also influenced the decision making. The direct cost involved in an LA was definitely higher than that in OA, and hence some

economically backward class of patients could not afford an LA. Obese patients and women of child bearing age are two groups of patients who are found to benefit from laparoscopy in many previous studies. Obese patients who underwent LA are seen to have an improved postoperative course and reduced complication rate, especially from the wound site, which is a serious problem in this group of patients. LA also gives a much better access in obese patients [24]. Gynaecological diseases are common causes of acute abdominal symptoms, in childbearing women. Laparoscopy makes definite determination of intra abdominal pathology possible and allows for avoidance of unnecessary laparotomy and risk of adhesions, which can be a cause of intestinal obstruction or infertility in long term observation [25].

Alvarado score alone (7 or more) could diagnose 82.3% of cases of appendicitis. And in those with a score of 5 or 6, could be diagnosed with the help of an ultrasound. On the other hand, USG positivity was seen in only 72.9% of cases. The sensitivity of USG in previous studies was around 85% and is highly operator dependent. To conclude, clinical examination and Alvarado scoring system is still the cornerstone of diagnosis in appendicitis.

The overall reported mortality of appendectomy is very low and was estimated in a review of large administrative database at 0.05% for LA and 0.3% for OA, reinforcing the fact that appendicectomy in the absence of peritonitis is a safe procedure, regardless of the technique. In this study, no mortality was found in both groups [22]. Overall complication rates were similar in both groups in most of the studies. The most serious early complication in the LA group, that required a reoperation is injury of the epigastric vessels due to an inadequate trocar placement and is avoidable with the placement of trocars under direct vision lateral to the epigastric arteries [21]. The removal of all cannulas should also be done under direct vision prior to releasing of the pneumoperitoneum to detect any subtle bleeding from the abdominal wall.

Infectious complications like wound infection and intra abdominal abscesses are two variables by which the techniques have been traditionally compared. In this study we found only minor infection in the LA group. Wound infection rate in our study was 12 %, but consisted mainly of minor infection (8.85%), most of which settled without any intervention. Though there was no significant difference between the two groups in terms of wound infection, there was no major infection in the LA group. All the 6 cases of major infection were in the OA group, which required minor surgical interventions and modification or prolongation of antibiotics. So the incidence of major wound infection is definitely less in the LA group.Most studies demonstrated reduced wound infection rate for LA, while others were not. Klingler *et al*. and Katkhouda *et al*. found that infectious complications were similar in both groups [18,19]. Furthermore, the incidence of intra abdominal abscess formation was slightly higher in the laparoscopic group [13-15]. It is possible to reduce this if the sigmoid colon is retracted, the patient is placed in trendelenburg, and the pelvis is completely irrigated and aspirated under direct vision [26].

The operating room time, in most of the previous studies was longer for the LA group, despite the subjective perception that it can be an easier operation [12-14]. This may be due to the inclusion of additional steps for set up, insufflation, trocar entry under direct vision, and diagnostic laparoscopy. There was no significant difference in operating time between the two groups in our study. But, this is again supporting the results of previous studies. Another finding was that the operating time was more or less consistent in the OA group whereas was highly variable in the LA group. This was probably due to difference in technical expertise in LA among different surgeons.

Pain assessment can be done in two ways: subjectively by the visual analogue scale and objectively by the tabulation of pain medications. Some studies show less pain in the first two days after LA [8-11]. In our study also we found the post operative pain was significantly less in the LA group, both on postoperative day 1 & 2,. The need for rescue medications was almost nil on day 2. This is consistent with most of the previous trials and is a definite advantage of the less invasive technique.

The question of whether LA decreases the length of hospitalization has been a matter of debate over the past decade [15,20]. Although, some recent retrospective cohort studies or chart reviews found LA associated with significantly shorter hospital stay, other retrospective investigations reported non-significant differences [27-32]. Even some randomized clinical trials (RCT)and meta-analyses report controversial findings. Sauerland *et al*. summarized the results of 28 RCT and almost 3000 patients and reported a significant decrease in length of hospital stay in LA group [11]. Similar results were found by Golub and colleagues, whereas another meta-analysis failed to show a statistically significant difference [8, 10]. The current literature describes that the difference may be affected by hospital factors, social habits, diverse health care policies and insurance systems in different countries. Duration of hospital stay was significantly longer in the OA group in this study, probably due to the lesser pain, early institution of oral feeds, and early mobilization associated with the laparoscopic technique.

The return to normal activity following appendicectomy is also a subject of debate. A minimally invasive operation by definition should allow for a quicker recovery, shorter convalescence at home, and quicker return to work. Several studies found LA to be associated with significantly earlier return to normal activities compared to OA. The results of a prospective RCT by Katkhouda *et al*. based on the use of an objective instrument to measure the activity showed no difference in scores post operatively and at 2 weeks [26]. Others found improved postoperative

activity in the LA group. But the comparison among the studies is difficult because of the variable definitions of activity. Results in 4 meta-analyses were statistically "highly heterogenous" [8-11]. In contrast, Ignacio et al. found that there was no difference in pain on days 1 and 7 postoperatively or in the time to return to work [33]. The presence of appendiceal perforation or abscess is associated with poorer outcome. In a large retrospective study, stratified analyses were performed for patients with or without perforation [28]. The average length of hospital stay was significantly shorter for LA patients with or without perforation. Similar results were reported by Hebebrand *et al*. [34]. The time to return to usual activities was also much lesser in the LA group in our study, and may be due to the same factors as for hospital stay, added with the increased confidence among patients associated with the smaller wound and lesser stitches.

The conversion rate from LA to OA in most of the previous studies was low (4-5%). In an RCT published by Sakpal and colleagues the conversion rate was 4.16%, and the most common reason was severe acute inflammation (38.7%) followed by adhesions due to prior surgery (25.81%) [35]. Females and elderly (>65 years) had higher likelihood of conversion. Hellberg et al. and Marcin *et al.* in two different studies found the most common cause of conversion to be a difficult anatomy (retrocaecal localization) of the appendix, followed by a significant inflammatory infiltrate or abscess which prevented a safe laparoscopic procedure [36,37]. Infrequent conversions in most of the recent studies result from substantial operative team experience. The main limitations of this study were that it was not a randomized and blinded study and the study focused only on early postoperative complications, and no long term follow up was done. Furthermore, cost analysis was not included and the follow-up was limited to first few days postoperatively.

CONCLUSION

Appendicectomy in the absence of generalized peritonitis, is a safe procedure, regardless of the technique performed. Laparoscopic appendicectomy has advantages over its open counterpart, in terms of postoperative pain, duration of hospital stay, and time to return to usual activities. There is no significant difference in operating time between the two techniques. Rather, LA may take much longer in the learning curve. Though there is no significant difference in wound infection as a whole, major infection that requires intervention is much less in LA.

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DECLARATION OF INTEREST STATEMENT

The authors declare that they have no significant competing financial, professional or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

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